

# PEOPLE-ENVIRONMENT STUDIES: PROMOTING SUSTAINABLE PLACES AND BEHAVIORS

EDITED BY: Giuseppe Carrus, Tony Peter Craig, Adina Claudia Dumitru and  
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# PEOPLE-ENVIRONMENT STUDIES: PROMOTING SUSTAINABLE PLACES AND BEHAVIORS

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# Social Acceptance of Renewable Energy Technologies in the Post-fukushima Era

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In 2011, the Fukushima nuclear accident occurred, and this had a strong effect on public perceptions of energy facilities and services that relate not only to nuclear energy, but also renewable energy resources. Moreover, the accident has also considerably affected national energy plans in both developing and developed countries. In South Korea, several studies have been conducted since the accident to investigate public perspectives toward particular energy technologies; however, few studies have investigated public perceptions of renewable-energy technologies and tracked the transitions. Therefore, this study examines the trend of South Korean public's perceptions of renewable-energy technologies. Based on data collected in 2016, we validated the structural connections and determined that trust, benefits, risks, and attitude were key determinants of the public's desire to adopt these technologies; specifically, public attitude was found to be the greatest determinant of this desire. Based on the results, both implications and limitations are examined.

**Keywords:** Fukushima, renewable energy, nuclear energy, social acceptance, attitude

## INTRODUCTION

In March 2011, the Fukushima nuclear power plant was struck by a huge tsunami caused by a 9.0-magnitude earthquake approximately 180 km east of Japan's Tohoku region. This seriously damaged the plant, resulting in three meltdowns. The nuclear accident had serious negative effects on the regional and global environment; moreover, the accident also led to a fundamental paradigm shift in most nations in regard to their energy policies (Wittneben, 2012).

The Fukushima nuclear accident also affected public perspectives toward nuclear-energy technologies and facilities; however, several studies have shown that there are notable differences in such public perceptions across different nations (Visschers and Siegrist, 2013; Bird et al., 2014; Richter et al., 2015). Furthermore, compared to the breadth of prior research on public perceptions of nuclear-energy technologies and facilities, few studies have focused on public perceptions of technologies and facilities relating to alternative energy (Cherp and Jewell, 2016; Komiya and Fujii, 2017).

Public perception of alternative-energy sources is considered one of the most important factors influencing the investment allocated to related energy facilities and technologies within national energy plans. Moreover, these perceptions are also affected by events and accidents in other countries (Gamson and Modigliani, 1989; Verplanken, 1989). After the Fukushima accident caused significant public resistance toward nuclear energy, the majority of both developed and developing countries that were considering using nuclear energy as their main energy and electricity supply

resource have completely reviewed and revised their national energy plans (Dhakal, 2009; Chen et al., 2014). For instance, the German government has changed its national energy policies to exclude nuclear energy from its future energy plans and the Japanese government has revised its national energy plan to exclude nuclear energy as a primary energy resource (Betzer et al., 2013; Hong et al., 2013).

The Fukushima nuclear accident allowed the public in most countries to learn of the serious negative effects of nuclear energy technologies and facilities on global environments and citizens' health (Shimura et al., 2015). Consequently, this created a public desire for the implementation of alternative energy resources in order to reduce the usage of nuclear energy. Amongst the various energy resources that are currently under consideration to replace nuclear energy, renewable-energy resources are considered to be one of the most promising (Mbarek et al., 2015).

As renewable-energy resources may play an important role in revised future energy plans, several studies have explored public perceptions of renewable energy. For example, Bang et al. (2000) found that consumer concerns toward renewable energy were notable determinants of consumer attitude toward willingness to adopt renewable energy. Painuly (2001) also indicated that there are various barriers to employing renewable energy in developing countries. In addition, the research of Mallett (2007), and Wüstenhagen and Boehnke (2008) have shown that the public's economic, socio-demographic, and psychological factors can form significant determinants of the public's desire to adopt renewable-energy technologies. However, few studies have focused on the transitions of public attitudes toward renewable-energy technologies (Park and Ohm, 2014).

In South Korea, Park and Ohm (2014) examined public perceptions of renewable energy technologies, proposed an adoption model for renewable energy technologies, and conducted pen-and-paper surveys both before and after the Fukushima nuclear accident. Before the accident, cost was one of the main reasons behind the inhibited usage of renewable-energy technologies; however, after the accident, public attitudes toward the technologies and their perceived low-degree of risk became notable determinants toward desire to adopt the technologies (Park and Ohm, 2014).

Consequently, the current study attempts to explore the following points:

1. Has there been any change in public perceptions of renewable-energy technologies since the Fukushima nuclear accident?
2. What has motivated the public to adopt renewable-energy technologies in South Korea?

In order to address the first research question, the current study reviews the findings and results of Park and Ohm (2014), conducts a pen-and-paper survey in South Korea, and tracks the notable changes in public perspectives toward renewable-energy technologies. As mentioned by Park and Ohm (2014), because there is a substitutional relationship

between renewable and nuclear energy it would be worthwhile to present the effects the Fukushima nuclear accident had on public perceptions toward renewable-energy technologies and examine significant changes in the public perceptions in South Korea in this regard.

Considering the second point, the current study uses the acceptance model for renewable-energy technologies tested by Park and Ohm (2014). Based on the results of the structural-equation modeling method, we can determine the motivations behind the public adoption of the technologies, and then compare the results of the current study with those of prior studies.

The remainder of this study is organized as follows: after presenting the findings of prior studies that have focused on the adoption of renewable energy, the study methodology is examined. The results and key findings are then presented. Finally, the limitations and future studies are examined.

## LITERATURE REVIEW AND HYPOTHESES

### Social Acceptance of Renewable Energy

In order to respond both global warming and environmental pollutions, several nations significantly focus on both facilities and policies of alternative energy resources (Gielen et al., 2019). It means that utilizing alternative energy resources and employing a mixed energy plans are one of the important tasks in establishing the national energy policies (Dagoumas and Koltsaklis, 2019). Moreover, there have been notable efforts in using renewable energy resources for both national and local energy plans (Young and Brans, 2020).

However, there are significant economic, social, and industrial encumbrances related to utilizing renewable energy resources in the plans (Cajot et al., 2017). Among them, social perceptions of specific energy resources and technologies are considered as one of the principal issues in the regional and national levels (Paravantis et al., 2018). With no careful comprehensive procedures on specific energy-related facilities, a number of local or national conflicts can be presented (Kwon, 2018). Because of this reason, a number of researchers and public officials have investigated how to explore social perceptions of specific energy resources, including renewable energy resources (Kim et al., 2020).

Ribeiro et al. (2014) conducted a survey of public opinions on four renewable energy technologies, solar, hydro, biomass, and wind power. Considering 3,646 respondents, they found that there are a positive public perspective toward renewable energy resources, whereas NIMBY syndrome is significantly presented in the areas with biomass facilities. Moreover, they indicated that utilizing solar energy resources and employing hydropower are the appropriate desirable solutions for the economic and environmental contributions, and welfare aspects, respectively.

Liu et al. (2013) attempted to address social diffusion of renewable energy technologies in one of the rural areas in China through a field survey. Based on an analytical framework

developed by the theory of planned behavior, they found that rural residents tend to have supportive perspectives toward renewable energy deployment with consideration of its positive relationships with environment. The results of 212 validated responses also reported that there are notable social and economic factors in determining rural residents' willing to pay for green electricity.

Bertsch et al. (2016) addressed public acceptance of renewable energy and its-related policy. Conducting a survey in Germany, both the national and local levels' determinants of adopting renewable energy sources were examined. The results of a multivariate analysis of covariance showed that there were significant differences between local and national acceptance levels, while socio-demographic information (e.g., age and education) was crucially related to the acceptance levels.

Although there are a number of prior studies on social acceptance of renewable energy resources (Kim et al., 2020), there are certain obstacles to track constant changes of social perceptions and acceptance of the resources. Because time-suitable grasping social opinions is one of the important issues (Kardooni et al., 2018), presenting both potentiality and significance of consistent tracking social opinions should be presented for governmental officers and stakeholders.

## Reviews on the Acceptance of Renewable Energy Facilities in Korea

Notable quantitative studies have explored public perceptions of specific energy technologies and facilities from social-science perspectives. For instance, McGowan and Sauter (2005) showed that, in regard to national energy plans, UK citizens preferred investment in renewable-energy facilities over nuclear-energy facilities.

Moreover, although several significant studies have investigated public attitudes and the adoption of renewable-energy technologies in regional and national perspectives, a limited number of studies have explored public attitudes and energy preferences before and after nuclear accidents, which may have notable effects on the attitudes toward and adoption of particular energy technologies as well as alternative technologies (Eiser et al., 1989). One of the most notable transitions in public attitudes and adoption occurred in the 1970s when the global oil crisis caused citizens to become concerned about their national energy plans, policies, and economy. Returning to the present, in South Korea, Park and Ohm (2014) proposed an integrated research model for adopting renewable-energy technologies, and captured the significant transitions in public attitudes between the periods before and after the Fukushima accident. Considering seven factors, the main determinants of public desire to adopt renewable-energy technologies changed from cost to attitude.

For investigating the transitions, surveying citizens' opinions is considered one of the most accurate and successful research approaches. Consequently, the current study employs the conceptual research model previously validated by Park and Ohm (2014), and captures the notable changes in public perceptions of renewable-energy technologies over time. In the research model

of Park and Ohm (2014), the following hypotheses are considered (Figure 1):

- H1. A higher degree of attitude leads to a higher degree of desire to adopt.
- H2. A higher degree of perceived trust leads to a higher degree of perceived benefits.
- H3. A higher degree of perceived trust leads to a lower degree of perceived risks.
- H4. A higher degree of knowledge leads to a higher degree of perceived benefits.
- H5. A higher degree of knowledge leads to a lower degree of perceived risks.
- H6. A higher degree of perceived benefits leads to a higher degree of public attitude.
- H7. A higher degree of perceived risks leads to a lower degree of public attitude.
- H8. A higher degree of perceived cost leads to a lower degree of desire to adopt.

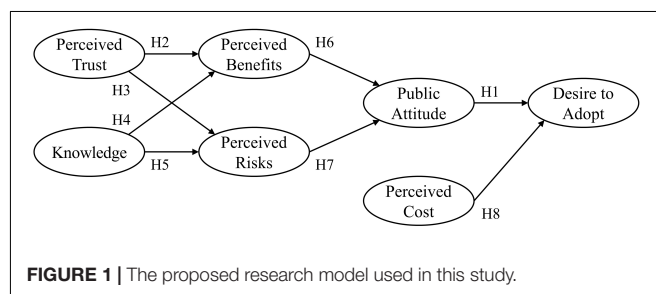
## STUDY METHOD

### Survey Design and Procedure

Following the procedures of the survey-design methodology used by Park and Ohm (2014), the current study employed identical questionnaire items to those used in the main survey of Park and Ohm (2014).

We followed all procedures presented by Park and Ohm (2014): (1) exploring unique characteristics, (2) presenting selected constructs, (3) examining the potentiality and validity of the constructs, (4) conducting a pilot test with validity tests, and (5) presenting the survey.

In addition to two-time survey sessions in 2010 and 2012, which were conducted in prior studies (Park and Ohm, 2014), we conducted additional survey in 2016. All questionnaire items, sampling procedures and outlier filtering methodologies (a stratified quota sampling) were identical with prior survey sessions in 2010 and 2012. The survey was distributed to 1,500 potential respondents in 6 regions and 18 cities in South Korea. In order to ensure the representativeness of the





sample in the survey, the current study applied a stratified quota-sampling method. After excluding incomplete and invalidated responses, 991 (66.1% of response rate) samples were used in the statistical analysis.

## Measurements

All measurements in this study were validated by prior studies (Park and Ohm, 2014). All participants were instructed to mark each item with a 7-point Likert scale (7: strongly agree/1: strongly disagree). The perceived trust was examined by three items (Cronbach's alpha: 0.890; e.g., "I believe that renewable energy technologies can improve our energy generation industry successfully."). Three items contributed to the perceived benefits (Cronbach's alpha: 0.912; e.g., "Renewable energy technologies may help us develop increased industrial competitive advantages."). Moreover, the perceived cost was presented by three items (Cronbach's alpha: 0.888; e.g., "I think the maintenance cost of using renewable energy technologies and generators is expensive"), while three items composed the perceived risks (Cronbach's alpha: 0.921; e.g., "Renewable energy technologies and plants can harm our society including animals and plants."). Three items were employed to examine the desire to adopt (Cronbach's alpha: 0.909; e.g., "If I could, I would prefer to use renewable energy technologies and generators."). The public attitude was presented by three items (Cronbach's alpha: 0.879; e.g., "Applying renewable energy technologies is extremely good for us"). Lastly, the public

knowledge was organized by three items (Cronbach's alpha: 0.904; e.g., "how familiar are you with renewable energy sources and technologies?").

## DATA ANALYSIS

A structural-equation modeling (SEM) method was used to capture the structural changes in the research model. In addition, by computing the total effects of the factors relating to approval and comparing the results of the computations and SEM (2010, 2012, and 2016), the current study aims to track significant changes in the structural relationships within the research model.

## RESULTS

### Analysis Methods

The connections in the research model were examined and analyzed using SEM. In order to test the reliability of the employed constructs, we employed confirmatory-factor analysis. The current study meets the recommendations of previous SEM studies in regard to internal (all Cronbach's alphas were higher than 0.7), convergent (all factor loadings, composite reliability, and average variance extracted values were higher than 0.7, 0.7, and 0.5, respectively), and discriminant reliability tests (The correlation values between two specific

**TABLE 1 |** The fit indices of the measurement and research models (M: The measurement model, R: The research model; Anderson and Gerbing, 1988; Bagozzi and Yi, 1988; Jöreskog and Sörbom, 1996; Kenny and McCoach, 2003; Hoe, 2008).

Fit indices	Before the Fukushima accident	Post-Fukushima		Satisfaction levels
	2010	2012	2016	
$\chi^2/\text{d.f.}$	4.08 <sup>M</sup> , 4.07 <sup>R</sup>	4.44 <sup>M</sup> , 4.01 <sup>R</sup>	4.32 <sup>M</sup> , 4.32 <sup>R</sup>	<5.00
Normed fit index	0.94 <sup>M</sup> , 0.95 <sup>R</sup>	0.91 <sup>M</sup> , 0.93 <sup>R</sup>	0.90 <sup>M</sup> , 0.90 <sup>R</sup>	>0.80
Incremental fit index	0.97 <sup>M</sup> , 0.96 <sup>R</sup>	0.94 <sup>M</sup> , 0.91 <sup>R</sup>	0.92 <sup>M</sup> , 0.92 <sup>R</sup>	>0.90
Comparative fit index	0.94 <sup>M</sup> , 0.94 <sup>R</sup>	0.92 <sup>M</sup> , 0.90 <sup>R</sup>	0.92 <sup>M</sup> , 0.91 <sup>R</sup>	>0.80
Goodness-of-fit index	0.95 <sup>M</sup> , 0.94 <sup>R</sup>	0.96 <sup>M</sup> , 0.92 <sup>R</sup>	0.93 <sup>M</sup> , 0.90 <sup>R</sup>	>0.80
Adjusted goodness-of-fit index	0.95 <sup>M</sup> , 0.95 <sup>R</sup>	0.95 <sup>M</sup> , 0.94 <sup>R</sup>	0.93 <sup>M</sup> , 0.92 <sup>R</sup>	>0.80
Standardized root mean square residual	0.05 <sup>M</sup> , 0.06 <sup>R</sup>	0.05 <sup>M</sup> , 0.05 <sup>R</sup>	0.07 <sup>M</sup> , 0.07 <sup>R</sup>	<0.08
Root mean square error of approximation	0.04 <sup>M</sup> , 0.05 <sup>R</sup>	0.05 <sup>M</sup> , 0.05 <sup>R</sup>	0.06 <sup>M</sup> , 0.07 <sup>R</sup>	<0.08

**TABLE 2 |** Summary of the structural results from 2016 (\* $p < 0.001$ ).

Hypothesis	Standardized path coefficient	SE	CR	Results
H1. Attitude → Adoption	0.821*	0.038	81.712	Supported
H2. Trust → Benefits	0.517*	0.041	68.105	Supported
H3. Trust → Risks	-0.135*	0.029	-5.877	Supported
H4. Knowledge → Benefits	-0.103	0.037	-4.789	Not supported
H5. Knowledge → Risks	-0.078	0.045	-2.822	Not supported
H6. Benefits → Attitude	0.518*	0.044	72.988	Supported
H7. Risks → Attitude	-0.694*	0.025	-79.218	Supported
H8. Cost → Adoption	-0.409*	0.031	-45.766	Supported

Attitude > Public attitude; Adoption > Public desire to adopt; Trust > Perceived trust; Benefits > Perceived benefits; Risks > Perceived risks; Knowledge > Public knowledge; Cost > Perceived cost.

constructs were lower than the square roots of the average variance extracted).

## Fit Indices

The current study computed the fit indices of the measurement and research models by considering if the collected data were well-represented by the measurement and research models. The fit indices of the measurement and research models were found to be acceptable (Table 1).

## Hypothesis Testing

### Structural Results of the Research Model

The structural results of the research model are summarized in Table 2, and a comparison is presented in Figure 2. The results of the data that was collected in 2016 supported six hypotheses, while two hypotheses concerning knowledge-benefits and knowledge-risks were not significant (H4,  $\beta = -0.103$ ,  $CR = -4.789$ ,  $p > 0.05$ ; H5,  $\beta = -0.078$ ,  $CR = -2.822$ ,  $p > 0.05$ ). Public desire to adopt renewable technologies was significantly determined by two factors, public attitude and perceived cost, while the effects of public attitude on the desire to adopt (H1,  $\beta = 0.821$ ,  $CR = 81.712$ ,  $p < 0.001$ ) were greater than those of perceived cost (H8,  $\beta = -0.409$ ,  $CR = -45.766$ ,  $p < 0.001$ ). Perceived benefits had positive effects on the attitude (H6,  $\beta = 0.518$ ,  $CR = 72.988$ ,  $p < 0.001$ ), while the attitude was negatively affected by perceived risks (H7,  $\beta = -0.694$ ,  $CR = -79.218$ ,  $p < 0.001$ ).

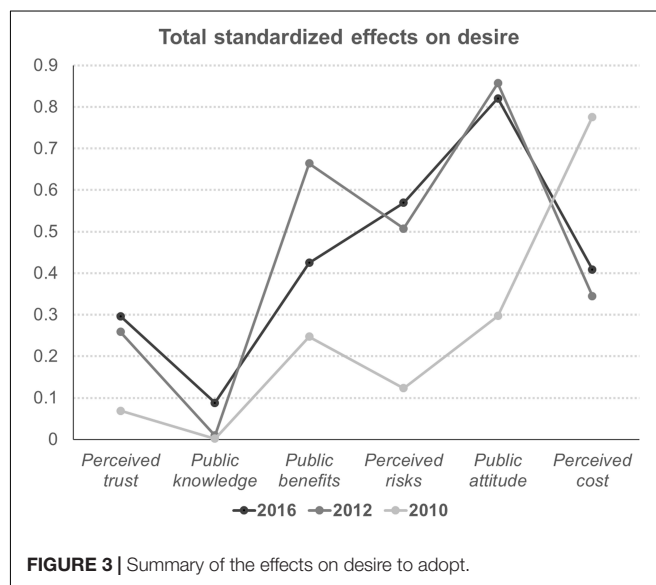
### Sum of Total Absolute Effects on the Intention

In order to present the key motivations behind users' attitudes toward renewable-energy technologies, the total standardized effects of motivations and barriers in regard to this attitude were computed. Table 3 and Figure 3 present a summary of the total effects on desire to adopt. Although the effect perceived cost had

**TABLE 3** | Total standardized effects on the desire to adopt.

Year	Trust	Knowledge	Benefits	Risks	Attitude	Cost
2016	0.297	0.088	0.425	0.570	0.821	0.409
2012	0.259	0.009	0.664	0.507	0.857	0.345
2010	0.069	0.002	0.248	0.124	0.297	0.776

*Trust > Perceived trust; Knowledge > Public knowledge; Benefits > Perceived benefits; Risks > Perceived risks; Attitude > Public attitude; Cost > Perceived cost.*



**FIGURE 3** | Summary of the effects on desire to adopt.

**TABLE 4** | Total standardized effects on attitude.

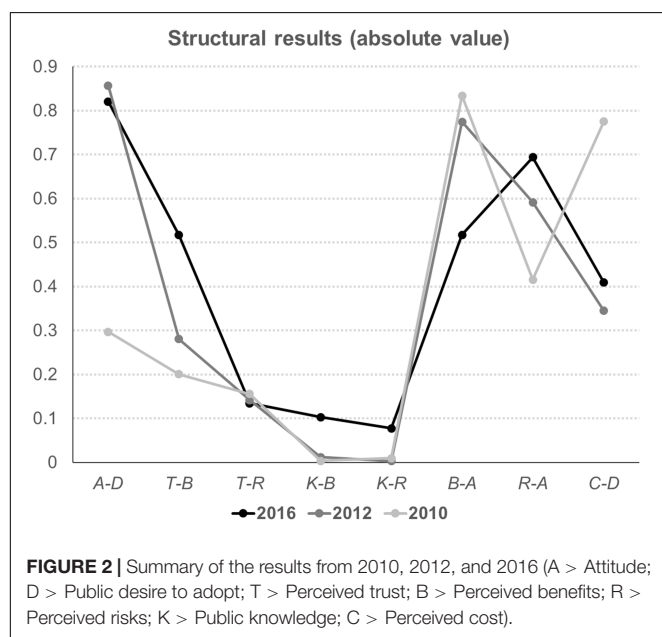
Year	Trust	Knowledge	Benefits	Risks
2016	0.362	0.107	0.518	0.694
2012	0.302	0.011	0.775	0.592
2010	0.233	0.007	0.834	0.416

*Trust > Perceived trust; Knowledge > Public knowledge; Benefits > Perceived benefits; Risks > Perceived risks.*

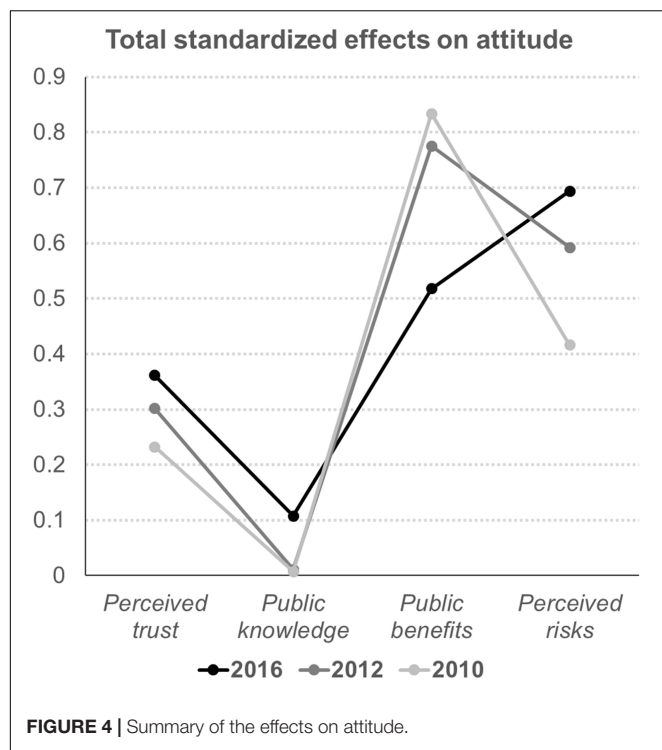
on desire to adopt significantly diminished between 2010 and 2012 (0.776  $\rightarrow$  0.345), it became moderately influential in 2016 (0.409). Compared to the role of cost, public attitude consistently remained a main determinant of desire to adopt (0.821 in 2016). The effects of perceived risks of adoption are becoming more important (0.124 in 2010  $\rightarrow$  0.507 in 2012  $\rightarrow$  0.570 in 2016), while the effects of perceived benefits of adoption are abating (0.248  $\rightarrow$  0.664  $\rightarrow$  0.425). Although public knowledge of renewable-energy technologies has been increasing, the effects of public knowledge are still lower than those of perceived trust (0.088 and 0.297).

### Sum of Total Absolute Effects on the Attitude

The transitions of the effects of perceived trust, public knowledge, public benefits, and perceived risks on public desire to adopt renewable-energy technologies were quite similar to those concerning attitude. In addition, public attitude played a notable role in affecting desire to adopt, while the effects of perceived



**FIGURE 2** | Summary of the results from 2010, 2012, and 2016 (A > Attitude; D > Public desire to adopt; T > Perceived trust; B > Perceived benefits; R > Perceived risks; K > Public knowledge; C > Perceived cost).



cost on desire to adopt have increased. Similar to the effects of the constructs on adoption, the roles of public knowledge, perceived trust, and risks in regard to determining public attitude have also been growing in importance (Table 4 and Figure 4). However, the effects of perceived benefits on attitude have reduced (0.775 → 0.518).

## CONCLUSION

This study aims to track users' perceptions of renewable-energy technologies in the "post-Fukushima era." Based on the findings of a previously conducted study on the South Korean public's perception of such technologies, this study re-examines the research model used in this previous study and investigates the effects of the employed antecedents on public attitude toward and desire to adopt renewable-energy technologies. This study aimed to track the effects the Fukushima nuclear accident had on public perspectives toward renewable-energy technologies in South Korea. As previous studies, both before and after the incident, have fragmentarily observed public perceptions on such technologies, this study conducted a survey in 2016, 5 years after the accident. Then, we compared the results of the data collected by the survey and the results of previous studies. Two factors, the perceived risks and benefits, significantly affected the attitude, while the risks and benefits were mainly determined by perceived trust in the technologies. Although two factors, the risks and benefits, which were confirmed in prior research as determinants of public desire to adopt such technologies, are also presented in this study as the antecedents of the desire to

adopt, there are notable transitions in the post-Fukushima era (Park and Ohm, 2014).

Since the Fukushima nuclear accident, the South Korea public has tended to adopt more risk-oriented perspectives toward particular energy technologies. It means that H7 was magnified after the Fukushima accident in South Korea [Total standardized effects (TSE): 0.416 (2010) → 0.592 (2012) → 0.694 (2016)]. In regard to motivations, a more comprehensive understanding of perceived trust is developing (H2 and H3); moreover, public knowledge of renewable-energy technologies is becoming important in forming public attitude toward and desire to adopt the technologies [H4 and H5; TSE: 0.007 (2010) → 0.011 (2012) → 0.107 (2016)].

This means that citizens are becoming familiar with renewable-energy technologies, and are beginning to understand the potential risks and benefits of such technologies (H7). Although the Fukushima nuclear accident, which occurred in a country close to South Korea, was not directly associated with renewable-energy technologies, the results of the current study provide notable evidence that the incident has continually and consistently influenced the public's perceptions of particular energy technologies.

Moreover, the results from 2016 also contribute to providing a better understanding of the sequential relationships of users' perceived trust-benefits and risks, attitude, and desire to adopt, and also show the significant roles perceived risk and trust in renewable-energy technologies play in regard to the diffusion, distribution, and success of the technologies in South Korea.

## IMPLICATIONS, LIMITATIONS, AND FUTURE STUDIES

Consistent with the findings of prior studies, the current study validates the structural connections between desire to adopt, attitude, benefits (and risks), and trust in renewable-energy technologies in South Korea. However, some transitions were observed in 2016 that conflicted with the results from 2010 and 2012. Two variables, public attitude and perceived cost, still affect public desire to adopt renewable-energy technologies; however, perceived risk is becoming more important. Although public benefits is still significant, its significance in determining public attitude has become more moderate compared to its status in 2010 and 2012.

Although the Fukushima accident does not have direct connections with renewable-energy technologies, it has led to notable lessons for the public. After the accident, the potential risks of energy technologies, which are mainly dependent on perceived trust, are beginning to become one of the most significant determinants of public attitude. Moreover, the key determinant of public attitude has changed from perceived benefits to risks. This means that citizens are more concerned about the potential harmfulness of energy technologies than their advantages. Although the effects of public knowledge are slight, the importance and significance of this knowledge are increasing.

As presented in the results, trust is still the key determinant of benefits and risks. This means that the South Korean government

and its industry should be more responsible and make its national energy plans sustainable and eco-friendly, focusing on the distribution of renewable-energy technologies and aiding public usage and consumption of the technologies.

In effect, the government and industry should focus on the revision of legislation, the enforcement of ordinances and regulations, the provision of subsidies and benefits, and the incubation of social trust in renewable-energy technologies. Moreover, the government should include the public as one of the key participants in the decision-making process concerning the revision, provision, and incubation of energy policies.

Although the current study presents some findings, there are several limitations. First, for several reasons, it is not easy to generalize the results of the current study. For example, because the survey described in this study was conducted in South Korea, regional and cultural characteristics may have had an effect on the public's perceptions. Second, the current study applies a research model for public perceptions that was validated in prior research along with the motivations tested therein (Park and Ohm, 2014). Several studies have indicated that other motivations can be significantly related to the adoption of energy technologies (Assefa and Frostell, 2007; Huijts et al., 2012). Consequently, future research should address these limitations and extend the findings of the current study.

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## DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Department of Interaction Science, Sungkyunkwan University. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

EP fully conducted and wrote the manuscript.

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**Conflict of Interest:** The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# I Am vs. We Are: How Biospheric Values and Environmental Identity of Individuals and Groups Can Influence Pro-environmental Behaviour

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Most research in environmental psychology is conducted in individualistic countries and focuses on factors pertaining to individuals. It is yet unclear whether these findings also apply to more collectivistic countries, in which group factors might play a prominent role. In the current paper, we test the individual-focused value–identity–behaviour pathway, in which personal biospheric values relate to pro-environmental actions via environmental self-identity, in an individualistic and a collectivistic country. Furthermore, we test in both countries whether a new group-focused pathway also exists, in which group values relate to pro-environmental behaviour via environmental group identity, particularly in collectivistic countries. Questionnaire studies were conducted among Dutch ( $N = 161$ ) and Chinese ( $N = 168$ ) students. Our results indicated that personal biospheric values, mostly via environmental self-identity, predict pro-environmental behaviour in both countries. We also found initial support for our newly proposed value–identity–behaviour pathway at the group level, particularly in China. Yet, in both countries, the association between group-level variables and pro-environmental behaviour was weaker than for personal-level variables, and partly overlapped with personal-level variables. Our findings show the relevance of personal- and group-level factors in understanding pro-environmental behaviour in both individualistic and collectivistic countries, which has strong theoretical and practical implications, particularly for developing international strategies to promote pro-environmental actions across the world.

**Keywords:** biospheric values, environmental identity, personal and group approach, pro-environmental behaviour, sustainability, cross-cultural study

## INTRODUCTION AND HYPOTHESIS

Behaviour change is crucial to sustainability, especially when it comes to the mitigation of human-caused ongoing environmental problems (e.g., climate change, pollution) (Fischer et al., 2012; Goudie, 2013; UNFCCC, 2015; IPCC, 2018). To move towards a sustainable lifestyle, individuals need to engage in various pro-environmental behaviour urgently: behaviour that minimises the negative impact of one's actions on nature and the environment (Kollmuss and Agyeman, 2002; IPCC, 2018).



Despite continuous efforts to promote pro-environmental behaviour, more actions are needed to reach international climate targets (IPCC, 2018). Interventions would be more efficient and effective if they target key antecedents of the desired sustainable behaviour (Steg, 2017). Thus, it is crucial to acquire a profound understanding of factors that may underlie and promote pro-environmental behaviour all over the world.

It has been theorised that pro-environmental behaviour is rooted in biospheric values, which reflect the importance people attach to caring about nature and the environment (Stern and Dietz, 1994; De Groot and Steg, 2010). Whereas, both individuals and groups are believed to endorse values, research so far mainly focused on the influence of personal values on pro-environmental behaviour and showed that personal biospheric values often indirectly predict a range of pro-environmental behaviour (Schultz and Zelezny, 1999; De Groot and Steg, 2009; Van der Werff et al., 2013a). Nevertheless, perceived group values may promote pro-environmental behaviour as well (Bouman and Steg, 2019, 2020), and this might be particularly the case in collectivistic cultures where people are more likely to act in line with the group interests (Triandis, 1988). Accordingly, the current paper aims to test how personal biospheric values and perceived group values relate to pro-environmental behaviour.

Specifically, in the present study, we aim to replicate the well-established personal-level pathway wherein personal biospheric values motivate pro-environmental behaviour via strengthening individuals' environmental self-identity (i.e., the degree to which individuals see themselves as environmentally friendly) and investigate whether this pathway can be extended to the group level, that is, whether perceived group biospheric values can motivate pro-environmental behaviour via environmental group identity (i.e., the degree to which the group is seen as environmentally-friendly). Importantly, we test the relevance and the robustness of the personal and group pathways in predicting pro-environmental behaviour in an individualistic country (i.e., the Netherlands) and a collectivistic country (i.e., China).

Personal values are stable, desirable and trans-situational goals that guide individual attitudes, evaluations and behaviour (Schwartz, 1992). Individuals endorse all values to some degree, but differ in how much they endorse and prioritise each value. The more someone endorses and prioritises a value, the more decisive this value will be for this person's attitudes, evaluations and behaviour. When focusing on the environmental domain, previous research identified four types of personal values that are most clearly related to pro-environmental behaviour, namely, altruistic, egoistic, hedonic, and biospheric values (De Groot and Steg, 2007b; Steg et al., 2014). Biospheric and altruistic values advocate benefits for the environment or others, respectively. The more individuals endorse biospheric and altruistic values, the more they tend to act pro-environmentally. In contrast, egoistic and hedonic values advocate self-interest and personal comfort. The more individuals endorse egoistic and hedonic values, the more reluctant they generally are to act pro-environmentally, mostly because pro-environmental behaviour can be financially costly, effortful or uncomfortable (De Groot and Steg, 2009; Steg et al., 2014; Jans et al., 2018; Bouman and

Steg, 2019). Personal biospheric values appear particularly strong and robust predictors of pro-environmental attitudes, intentions and behaviour (Ojea and Loureiro, 2007; De Groot and Steg, 2009; Van der Werff and Steg, 2016; Bouman et al., 2018), which is why we focus on biospheric values in the current paper.

Personal biospheric values often influence pro-environmental behaviour indirectly, and one crucial mediator is someone's environmental self-identity (Van der Werff et al., 2013a). Self-identity is the label that one uses to describe oneself (Cook et al., 2002). Accordingly, environmental self-identity is defined as the extent to which individuals see themselves as someone who acts in an environmentally friendly way (Van der Werff et al., 2013a). The stronger one's environmental self-identity is, the more likely people are to engage in a wide range of pro-environmental behaviour (Cornelissen et al., 2008; Whitmarsh and O'Neill, 2010) because people are motivated to be consistent and act in line with how they see themselves (Van der Werff et al., 2013b). When people strongly care about nature and the environment—that is, when they strongly endorse biospheric values—they are more likely to see themselves as an environmentally friendly person; in turn, the more people consider themselves as environmentally friendly, the more likely they behave in pro-environmental ways (Gatersleben et al., 2012; Van der Werff et al., 2013a).

In addition to personal factors, such as personal biospheric values and environmental self-identity, group factors might play a role in predicting pro-environmental behaviour (Hornsey et al., 2006; Bouman and Steg, 2019, 2020). Yet, the role of group values and environmental group identity are less studied. Therefore, we investigate whether, in parallel to the personal-level pathway, a similar group-level pathway might exist and could also predict pro-environmental behaviour.

Groups generally guide what kind of beliefs and behaviour are appropriate for members (Tajfel, 1974; Feldman, 1984; Terry and Hogg, 1996; Hornsey, 2008). Accordingly, what people think is important to (i.e., perceived group values) and how they characterise (i.e., environmental group identity) their group may influence their beliefs and behaviour (Jans et al., 2018; Bouman and Steg, 2019, 2020). Extending this research, and similar to the personal-level pathway, we propose that perceived group biospheric values (i.e., the extent to which individuals think their group values the environment) may promote pro-environmental behaviour among group members via strengthening an environmental group identity.

Studies so far have shown that perceived group values may influence group members' behaviour, including pro-environmental behaviour (Hanel et al., 2018; Sanderson et al., 2019; Bouman et al., 2020a; Fielding et al., 2020). For example, organisational values have been proven to encourage employees' pro-environmental product purchasing behaviour, particularly when employees identify with the company's environmental concern (Cambrá-Fierro et al., 2008). However, these studies mostly focused on general national values, organisational values or group political values, which did not emphasise the group environmental values. A few very recent studies began to discuss how perceived group's biospheric values may be critical in promoting individuals' pro-environmental behaviour as well

(Jans et al., 2018; Bouman and Steg, 2019, 2020; Bouman et al., 2020a), yet they did not empirically study the process through which these values may translate into action. We will address this gap in the literature and examine the role of group biospheric values in motivating pro-environmental behaviour.

We propose that perceived group biospheric values may similarly relate to pro-environmental behaviour as personal values, but via the environmental identity at the group level. That is, the more people think their group cares about the environment, the more likely they are to see the group as a group that acts environmentally friendly. This stronger environmental group identity may, in turn, promote pro-environmental behaviour. Group identities have been found to influence pro-environmental behaviour (Fielding and Hornsey, 2016). However, most group identities studied before were not directly linked to the environment. For instance, a left-wing political identity was found to influence attitudes towards climate change policy (Unsworth and Fielding, 2014). Yet, a few studies investigated constructs similar to environmental group identity, such as “green consumer,” suggesting that such group identities are promoting pro-environmental behaviour (Moisander, 2000). Nevertheless, to our knowledge, there has not been a study linking group environmental values and group environmental identity together to reveal their relationship with pro-environmental behaviour. Thus, we will extend the current knowledge by investigating the relationship between group biospheric values, environmental group identity and pro-environmental behaviour. We will test if this pathway influences environmental behaviour in addition to the personal pathway, where the association between personal biospheric values and pro-environmental behaviour was mediated by environmental self-identity.

We conduct the study in the Netherlands and China to test whether we could identify the personal and group pathway in two culturally different countries. Previous studies on the personal pathway have been conducted in European countries, Australia or US (e.g., Gatersleben et al., 2012; Van der Werff et al., 2013a; Balunde et al., 2019). Therefore, our study aims to test the robustness and generalisability of the personal pathway with participants from an East Asian country. In addition, we investigate whether our novel group pathway exists in both countries.

It is to be noted that the main purpose of testing both pathways with diverse samples is to test the generalisability of findings, rather than testing for cultural difference, which would arguably require more national representative samples. Yet, we do *explore* whether the influence of both pathways may differ across countries. Cross-cultural studies suggest that China's culture is collective-oriented, while the Netherlands is individual-oriented (Hall, 1977; Hofstede, 2001). Chinese people are found to consider themselves more strongly as part of a larger whole and often prioritise the group's needs over the individual's needs than those in the individualistic countries, such as people in the Netherlands (Triandis, 1989). When the group and individual interests conflict, people from collectivistic cultures more often give priority to the group interests than people in individualistic cultures do (Brewer and Chen, 2007). Accordingly, perceived

group values and group identity may be more influential in a collectivistic culture than in an individualistic culture, and the personal values and identity may be more influential in an individualistic culture than a collectivistic culture<sup>1</sup>.

In summary, the present study will test a personal and a novel group pathway to predict pro-environmental behaviour and explore their predictive power in participants from two countries: the Netherlands and China (see **Figure 1**). We hypothesise: at the personal level, personal biospheric values influence environmental self-identity (Hypothesis 1) and environmental self-identity, in turn, influences pro-environmental behaviour in both individual- and collective-oriented cultures (Hypothesis 2). At the group level, we hypothesise that group biospheric values influence environmental group identity (Hypothesis 3), which, in turn, will influence pro-environmental behaviour in both individual- and collective-oriented cultures (Hypothesis 4). In addition, we explore if the personal pathway would be more strongly related to pro-environmental behaviour in individualistic than in collectivistic cultures, whereas the group pathway might be more strongly related to pro-environmental behaviour in collectivistic than in individualistic cultures.

## MATERIALS AND METHODS

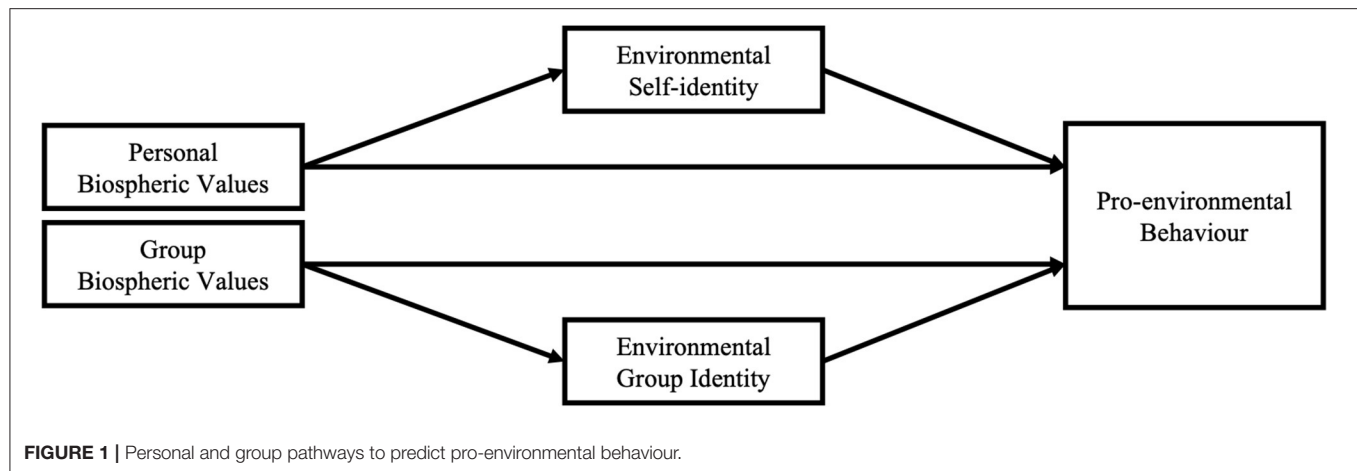
### Participants and Procedure

A link for an online questionnaire in Dutch was sent out to the 1st-year psychology students in the Netherlands, and a Chinese questionnaire in hardcopy was sent to 1st-year business school students in China. For Chinese participants, we translated the relevant scales from English to Chinese (for values and identity). A detailed description of the translation process, which involved back translation, is provided in the **Supplementary Materials**. For Dutch participants, we used previously validated value and identity scales (Van der Werff et al., 2013a; Bouman et al., 2018). Questions for Chinese students were designed for this study only, but questions for Dutch students were part of a larger investigation; we only report data relevant for the present study. Participants from the Netherlands received course credits for their participation, while in China, no compensation was offered.

In both countries, participants were presented with the study introduction and started the online or hardcopy questionnaire after giving their informed consent. Questions on personal, perceived group values, environmental self-identity and group identity were presented, followed by the measures of their daily pro-environmental behaviour. Then, they were asked to indicate their product preference in a choice scenario; however, this measure was not used in the current study<sup>2</sup>. Results of how both

<sup>1</sup>Please note that this does not mean we expect the group pathway to be stronger than the personal pathway in China, which we believe is unlikely considering earlier research (e.g., Bamberg et al., 2007; Bouman et al., 2020b; see also Discussion section).

<sup>2</sup>The purchasing preference scenario was our measure for pro-environmental behaviour as well. It was measured directly after participants reporting their daily pro-environmental behaviour, which might have changed participants' environmental identity or other antecedents influencing the behaviour (Van der Werff et al., 2014a). Besides, we found similar but relatively weaker effects of both pathways on the purchasing preference. We did not report the results in the main paper. Details can be found in **Supplementary Data**.



pathways worked in environmental purchasing preference were similar as for pro-environmental behaviour.

In total, 169 students participated in the Netherlands, of whom 161 filled out all relevant questions for this study; 80% of the participants were female, and age ranged from 17 to 52 years old ( $M = 19.44$ ,  $SD = 3.03$ ). In China, 192 students participated in the study, of whom 168 filled out all relevant questions for this study; 71% were female. Participants' age ranged from 18 to 36 years old ( $M = 20.45$ ,  $SD = 2.44$ ).

## Measures

### Personal Biospheric Values

Participants were instructed to rate the importance of 16 items reflecting altruistic, egoistic, hedonic and biospheric values as “a guiding principle in their lives” on a scale from  $-1 =$  *opposed to my values*,  $0 =$  *not important*, to  $7 =$  *of supreme importance* based on a standard procedure (Schwartz, 1992). In the current study, we only used biospheric values, which were measured with four items: “respecting the earth,” “unity with nature,” “preventing pollution,” and “protecting the environment” (De Groot and Steg, 2007a; Steg et al., 2014). A multiple group method (MGM) confirmatory factor analysis was used to examine whether biospheric values could be distinguished empirically from the other values (De Groot and Steg, 2007b; Stuive et al., 2009). Results confirmed the validity of the value scales in the Netherlands and China (see **Supplementary Materials** for details). The reliability of the personal biospheric values scale was good in both the Netherlands ( $\alpha = 0.90$ ,  $M = 3.97$ ,  $SD = 1.51$ ) and China ( $\alpha = 0.86$ ,  $M = 4.79$ ,  $SD = 1.31$ ).

### Group Biospheric Values

We measured group values with the same scale as personal values, but asking to rate the importance of the different values as a “guiding principle in your fellow students' lives,” i.e., concerning their fellow psychology (the Netherlands) or business school (China) students (e.g., Bouman et al., 2020a). Participants answered on the same scale from  $-1 =$  *opposed to my fellow students' values*,  $0 =$  *not important*, to  $7 =$  *of supreme importance*. The internal consistency of the group biospheric values scale was

good (in the Netherlands:  $\alpha = 0.86$ ,  $M = 3.31$ ,  $SD = 1.35$ ; in China:  $\alpha = 0.89$ ,  $M = 4.36$ ,  $SD = 1.38$ ).

### Environmental Self-Identity

Environmental self-identity was measured with a three-item scale (Van der Werff et al., 2013b): “I am the type of person who acts environmentally friendly,” “Acting environmentally friendly is an important part of who I am” and “I see myself as an environmentally friendly person.” Participants answered on a scale from  $1 =$  *strongly disagree* to  $7 =$  *strongly agree*. The internal consistency of the environmental self-identity scale was excellent (in the Netherlands:  $\alpha = 0.93$ ,  $M = 3.71$ ,  $SD = 1.30$ ; in China:  $\alpha = 0.90$ ,  $M = 4.96$ ,  $SD = 1.02$ ).

### Environmental Group Identity

To measure the environmental group identity, we used a similar scale to the one measuring the environmental self-identity, but referring to the peers in their group. The three items were: “My Fellow psychology/business school students act environmentally friendly,” “Acting environmentally friendly is an important part of who my fellow psychology/business school students are” and “I see my fellow psychology/business school students as environmentally friendly.” Participants rated on a seven-point scale to what extent they agree with the items from  $1 =$  *strongly disagree* to  $7 =$  *strongly agree*. The internal consistency of the environmental group identity was excellent (in the Netherlands:  $\alpha = 0.90$ ,  $M = 3.16$ ,  $SD = 1.10$ ; in China:  $\alpha = 0.94$ ,  $M = 4.71$ ,  $SD = 1.07$ ).

### Pro-environmental Behaviour

Pilot studies were conducted to establish common pro-environmental behaviour for people from both countries. Based on the commonly utilised scales in European countries (Barr, 2003; Cornelissen et al., 2008; Van der Werff et al., 2014a), we selected 13 items that are common to Chinese people as well. Participants from both countries were instructed to rate on a scale from  $1 =$  *not at all* to  $7 =$  *always* how frequently they engaged in each of them (see scales in **Supplementary Materials**). The

**TABLE 1 |** Bivariate correlations between personal and group biospheric values, environmental self- and group identities, and pro-environmental behaviour among Dutch students (highlighted in grey) and Chinese students in the main study.

	1	2	3	4	5
Personal biospheric values	-	0.67**	0.37**	0.22**	0.44**
Group biospheric values	0.62**	-	0.40**	0.50**	0.38**
Environmental self-identity	0.65**	0.33**	-	0.59**	0.56**
Environmental group identity	0.31**	0.35**	0.42**	-	0.33**
Pro-environmental behaviour	0.38**	0.11	0.53**	0.24**	-

\*\* $p < 0.01$ , \* $p < 0.05$ .

internal consistency was good (in the Netherlands:  $\alpha = 0.79$ ,  $M = 4.75$ ,  $SD = 0.82$ ; in China:  $\alpha = 0.77$ ,  $M = 5.06$ ,  $SD = 0.76$ ).

## RESULTS

### Correlations Between Biospheric Values, Environmental Identity, and Pro-environmental Behaviour

We first tested correlations between all relevant variables. In line with our predictions, most of the variables were positively related (see **Table 1**). Notably, personal and group biospheric values were strongly related, and so were environmental self- and group identities. Overall, correlations in the Netherlands and China were very similar. However, in the Netherlands, perceived group biospheric values were not significantly related to pro-environmental behaviour, while in China, they were. In addition, the relationship between personal biospheric values and environmental self-identity was significantly stronger in the Netherlands ( $r = 0.65$ , 95% CIs [0.55, 0.73]) than that in China ( $r = 0.37$ , 95% CIs [0.23, 0.49]).

### Model 1: Personal and Group Pathways in Predicting Pro-environmental Behaviour

To test if personal and group biospheric values affect pro-environmental behaviour via environmental self- or group identity, respectively, we applied bootstrap analysis with the PROCESS macro on SPSS 22.0 (Zhao et al., 2010; Hayes, 2013, 2016). We tested our model in two steps: in Model 1, we ran the analysis for the personal and group pathways separately (i.e., personal biospheric values and environmental self-identity, or group biospheric values and environmental group identity), in order to test each model's ability to predict pro-environmental behaviour. In Model 2, we tested both pathways together to examine how much variance the personal or group pathway uniquely explained when other variables from the other pathway were controlled for.

As displayed in **Figure 2A**, we found support for our hypothesised personal-level pathway (Hypothesis 1 and Hypothesis 2): in both countries, stronger personal biospheric values were associated with a stronger environmental

self-identity, and a stronger environmental self-identity was in turn related to more frequent engagement of pro-environmental behaviour.

In the Netherlands, this personal pathway explained 28% of the variance in pro-environmental behaviour,  $F_{(2,158)} = 30.99$ ,  $p < 0.001$ . As expected, personal biospheric values were significantly related to pro-environmental behaviour; however, the direct association between personal biospheric values and pro-environmental behaviour became non-significant when controlling for environmental self-identity. The indirect effect via environmental self-identity was significant ( $a * b = 0.17$ , 95% CIs [0.10, 0.26]), which suggests there was an indirect-only mediation (Zhao et al., 2010). In line with our hypotheses, stronger personal biospheric values were indicative of more pro-environmental behaviour, and this relationship could be fully explained by biospheric values' positive association with environmental self-identity.

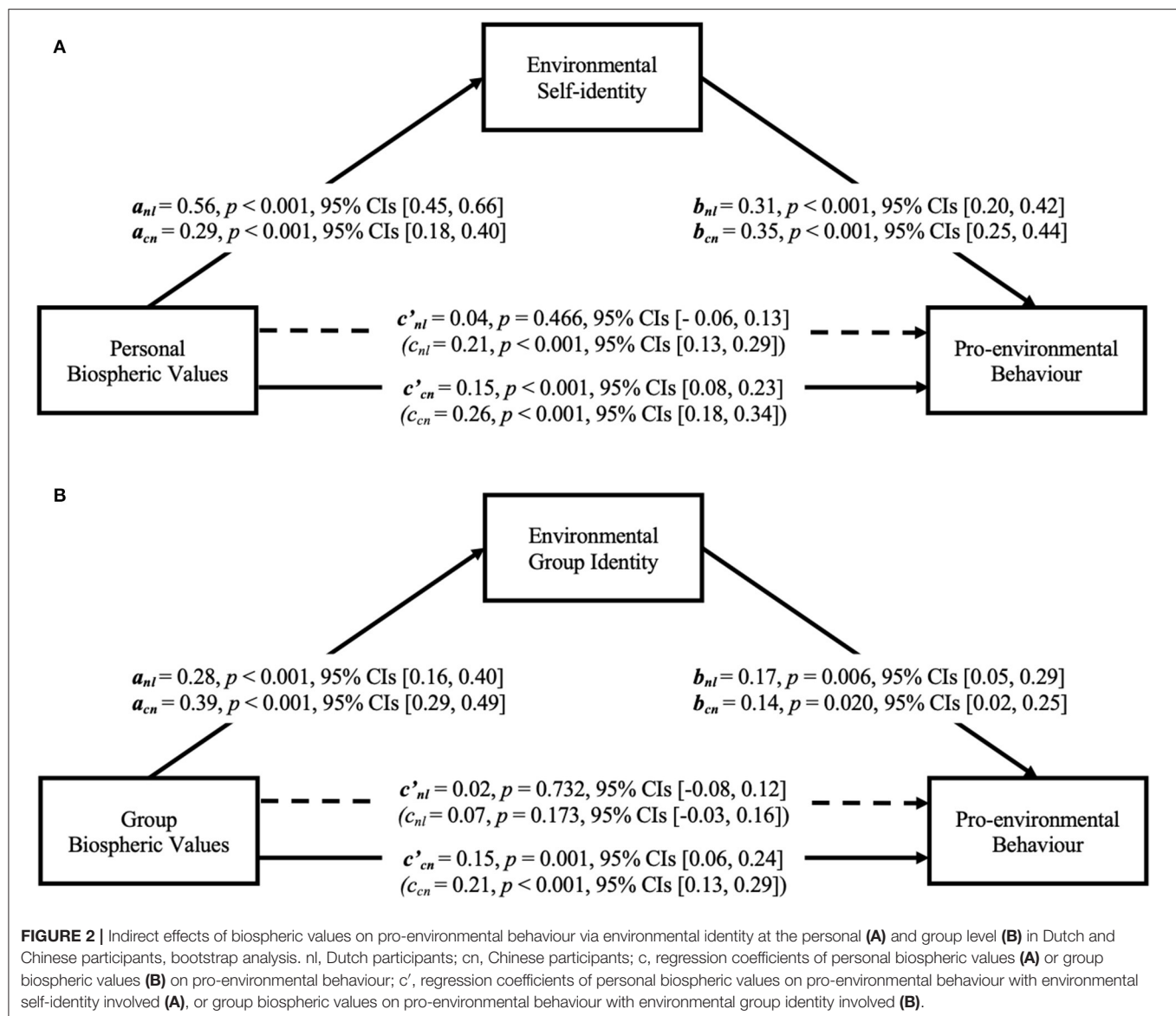
In China, personal biospheric values and environmental self-identity explained 38% of the variance in pro-environmental behaviour,  $F_{(2,165)} = 50.09$ ,  $p < 0.001$ . There was a significant indirect effect of personal biospheric values on pro-environmental behaviour through environmental self-identity ( $a * b = 0.10$ , 95% CIs [0.06, 0.16]) as well; however, the direct effect of biospheric values on pro-environmental behaviour remained significant, which indicates a complementary mediation (Zhao et al., 2010). It provided evidence for our hypotheses: personal biospheric values could predict pro-environmental behaviour, and this seems to partially occur via strengthening environmental self-identity. However, complementary mediation suggests that there are likely to be other mediators as well.

In **Figure 2B**, we also found support for the novel group pathway (Hypothesis 3 and Hypothesis 4): stronger group biospheric values were associated with a stronger environmental group identity, and a stronger environmental group identity, in turn, was related to more pro-environmental behaviour in both countries.

In the Netherlands, group biospheric values and environmental group identity explained 6% of the variance in pro-environmental behaviour,  $F_{(2,158)} = 4.85$ ,  $p = 0.009$ . The association between group biospheric values and pro-environmental behaviour was not significant; however, there was a significant indirect effect of group biospheric values on pro-environmental behaviour through environmental group identity ( $a * b = 0.05$ , 95% CIs [0.01, 0.11]). Therefore, it is an indirect-only mediation (Zhao et al., 2010): group biospheric values predicted pro-environmental behaviour fully via environmental group identity in Dutch samples.

In China, group biospheric values and environmental group identity explained 17% of the variance in pro-environmental behaviour,  $F_{(2,165)} = 16.79$ ,  $p < 0.001$ . There was also a significant indirect effect of group biospheric values on pro-environmental behaviour through environmental group identity ( $a * b = 0.05$ , 95% CIs [0.01, 0.11]). The direct effect of group biospheric values on pro-environmental behaviour was significant, which suggests a complementary mediation again (Zhao et al., 2010). This suggests that there are likely to be other mediators that





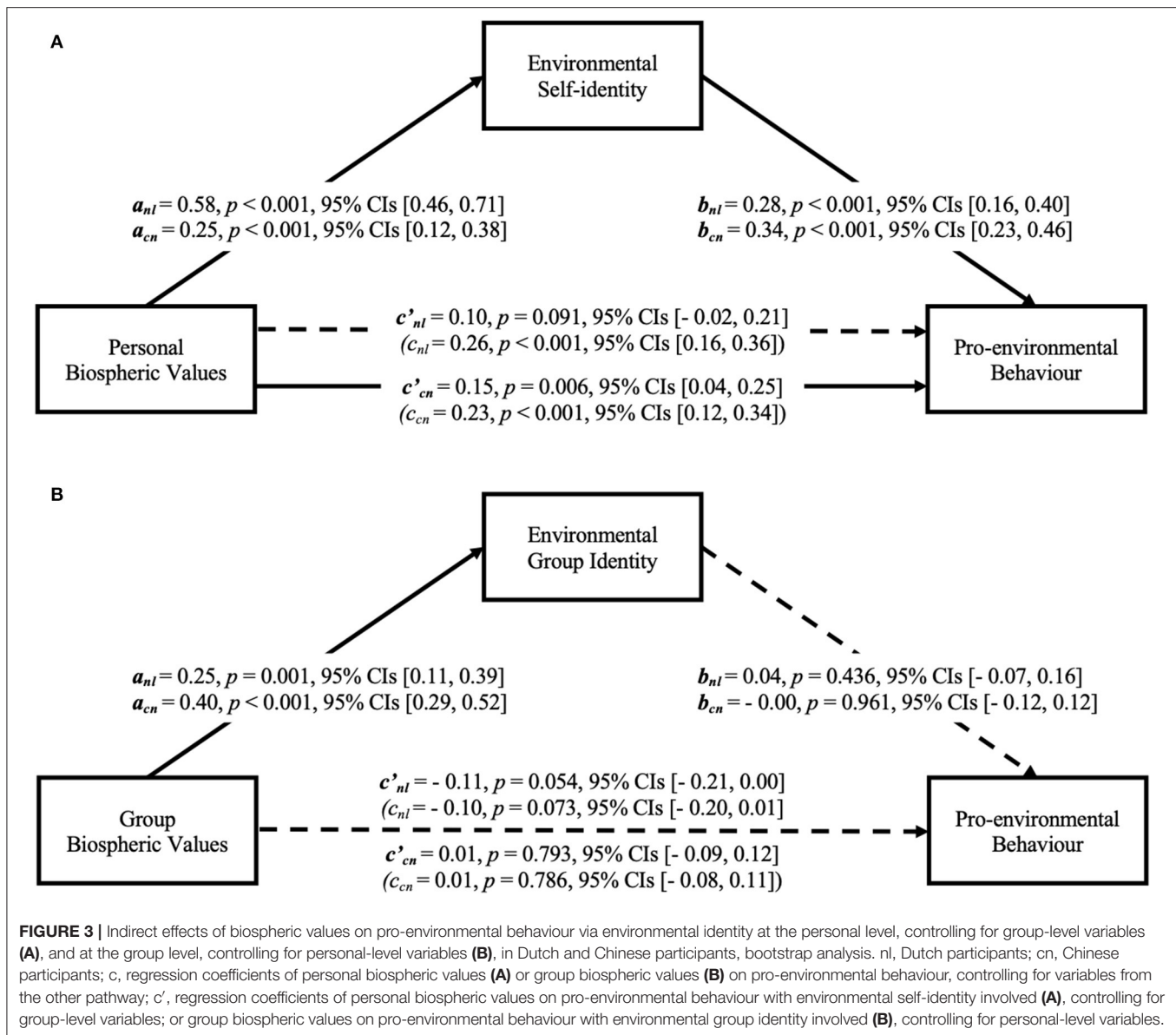
explain the relationship between group biospheric values and pro-environmental behaviour in Chinese samples as well.

## Model 2: Personal and Group Pathways in Predicting Pro-environmental Behaviour

The full model (Model 2) tested both pathways together by including variables from personal and group levels, in order to reveal unique contributions of each pathway (see Figure 3). Results showed that the personal pathway remained significant; however, the group pathway did not explain unique explained variance when controlling for the personal level variables. In the Netherlands, Model 2 explained 30% of the variance in pro-environmental behaviour,  $F_{(4,156)} = 16.64, p < 0.001$ ; and in China, the model explained

38% of the variance in pro-environmental behaviour,  $F_{(4,163)} = 24.77, p < 0.001$ .

As shown in Figure 3A, we found support for the personal pathway when controlling for the group-level factors (Hypothesis 1 and Hypothesis 2): personal biospheric values were associated with environmental self-identity, and environmental self-identity was in turn positively related to pro-environmental behaviour when we controlled for group biospheric values and environmental group identity. In the Netherlands, personal biospheric values were still indirectly related to pro-environmental behaviour via environmental self-identity ( $a * b = 0.16, 95\% \text{ CIs } [0.09, 0.26]$ ), even when variables at the group level were controlled for. The direct effect was not significant, which suggests an indirect-only mediation (Zhao et al., 2010). In China, the indirect effect of personal biospheric values on pro-environmental behaviour through environmental



self-identity was significant ( $a * b = 0.09$ , 95% CIs [0.04, 0.16]) when variables at the group level were controlled for. The direct effect was still significant, which suggests a complementary mediation, and there may be other mediators (Zhao et al., 2010).

However, in Model 2, when personal biospheric values and environmental self-identity were controlled for, the group biospheric values were related to environmental group identity in samples from both countries, but not to pro-environmental behaviour. We did not find a significant relationship between environmental group identity and pro-environmental behaviour either. The indirect effect of group biospheric values on pro-environmental behaviour through environmental group identity was not significant in the Netherlands ( $a * b = 0.01$ , 95% CIs [-0.01, 0.05]) or in China ( $a * b = 0.00$ , 95% CIs [-0.06 to 0.05]) when controlling for the personal-level variables.

## DISCUSSION

### Personal Pathway and Group Pathway Across Countries

This study aimed to test and compare an existing personal and a novel group pathway to explain pro-environmental behaviour in the Netherlands and China. Specifically, in the personal pathway, we tested if personal biospheric values influenced pro-environmental behaviour via one's environmental self-identity. In the group pathway, we proposed and tested whether group biospheric values influenced pro-environmental behaviour via one's environmental group identity. Overall, we found support for the personal and group pathways in participants from both countries. Stronger personal biospheric values were associated with a stronger environmental self-identity, and a



stronger environmental self-identity, in turn, encouraged pro-environmental behaviour. Importantly, we also found support for the group pathway in participants from two countries. Stronger group biospheric values were associated with a stronger environmental group identity, and a stronger environmental group identity also encouraged pro-environmental behaviour. However, when we tested both pathways together, we found that the personal pathway uniquely explained variance in pro-environmental behaviour while the group pathway did not.

Our finding that the personal pathway explains pro-environmental behaviour in a specific sample in an individualistic country is in line with previous research (Gatersleben et al., 2012; Van der Werff et al., 2013a, 2014b) and extends it to a specific sample from a collectivistic country, namely, China. Interestingly, although in both samples we found support for the hypothesised indirect relationship between personal biospheric values and pro-environmental behaviour via environmental self-identity, we observed differences in the strength in which personal biospheric values were directly and indirectly associated with pro-environmental behaviour in participants from two countries. For Dutch students, biospheric values related to pro-environmental behaviour fully via environmental self-identity, to which biospheric values were relatively strongly associated. For Chinese students, the association between biospheric values and environmental self-identity was considerably weaker, and personal biospheric values were also found to directly (i.e., not via environmental self-identity) relate to pro-environmental behaviour here. These differences could be due to cultural differences. Western cultures foster individuals being different from others, while East Asian cultures tend to foster individuals as interdependent with others (Markus and Kitayama, 1991; Vignoles et al., 2016). Accordingly, for our Dutch participants, personal biospheric values could be interpreted as something that distinguishes oneself from others, and thus being more strongly connected with how individuals see themselves; while for Chinese participants, the personal biospheric values could be interpreted as something that aligns individuals with others, thus being less strongly connected with how they see themselves. Therefore, in western countries, personal values may influence pro-environmental behaviour fully through self-identity. In the East Asian context, there may be other reasons why endorsing biospheric values would motivate individuals to engage more in pro-environmental behaviour besides environmental self-identity, such as group factors (e.g., social influence, Schultz et al., 2008). For future research, it is worth investigating other potential factors that link personal biospheric values and pro-environmental behaviour in a more collectivistic culture.

In addition, we found support for the group pathway in our samples from both countries, and results indicated that it might be more predictive of pro-environmental behaviour among Chinese students than among Dutch students. Our study thus provides convergent evidence for the group and social factors influencing environmental behaviour (Schultz et al., 2008; Laidley, 2013; Masson and Fritsche, 2014). Together with recent studies discussing such group-based approaches (Jans et al., 2018; Bouman and Steg, 2019, 2020), our findings

support the possible relations between group biospheric values and pro-environmental cross-culturally and provide insights in the process through which values motivate pro-environmental behaviour. Moreover, our studies imply that group values and group identity are worth investigating, particularly when conducting studies in a collectivistic culture.

Although we found support for our novel group pathway, it is also important to note that the group pathway was less strongly related to pro-environmental behaviour than the personal pathway. Moreover, when we inspected both pathways together, the personal pathway uniquely explained variance in pro-environmental behaviour while the group pathway did not. The observation that single group factors may be less predictive of personal behaviour than corresponding personal factors is in line with earlier research (e.g., Bamberg et al., 2007; Bouman et al., 2020b). Individuals can be influenced by many different groups, and the influence of group values and norms likely depends on many different factors (e.g., identification with the group, relevance of the group for the behaviour, Tajfel and Turner, 1979), which may explain why the groups we selected in our studies had a relatively weak effect on the participants' behaviour. In addition, most measured pro-environmental behaviours were personal and private, and thus measured at the same conceptual level as the personal pathway variables. Arguably, the influence of group factors may have been larger for more collective actions. Accordingly, future research could try to replicate our study with other groups and other behaviours, particularly to investigate whether effect sizes of the group pathway will be stronger when the group is more relevant and when the measured behaviours are more socially oriented.

Importantly, personal and group factors were also related to each other, which explains why effects of group factors may appear less important when controlling for personal-level factors. Interestingly, however, our result also suggests that perceived group values and identity may influence pro-environmental behaviour via the personal pathway, particularly in our Chinese sample. Specifically, the group biospheric values and environmental group identity may influence the environmental self-identity and thereby promote pro-environmental behaviour. This observation could be interpreted as being in line with earlier theorising, which suggests that self-identity development is influenced by others and in-groups (Cooley, 1902; Tajfel and Turner, 1979; Smith and Henry, 1996). Yet, future research is needed to test if the group pathway indeed influences environmental behaviour via the personal pathway.

In addition, to better understand how our novel group pathway may contribute to the existing literature, it is essential to elaborate on how group biospheric values and environmental group identity differ from more frequently studied group factors, such as descriptive and injunctive group norms. Specifically, whereas group values and group identity are respectively about what is important and defining for a group, group norms are about what behaviours are approved (i.e., injunctive norm) and commonly performed (i.e., descriptive norm) by a group (Cialdini et al., 1990). Although these constructs relate to each other—pro-environmental group norms will likely be stronger when there are stronger group biospheric values and when there

is a stronger environmental group identity (and vice versa)—this does not always have to be the case. For example, not all commonly performed behaviours (i.e., descriptive norms) are defining for a group's identity. Importantly, we rather see group values and a corresponding group identity to underlie group norms, explaining why group members (dis)approve and perform certain behaviours. More research is needed on this, in particular on how these constructs relate to each other and how they could be teased apart. The latter may also be important considering some overlap in specific items used to measure identity and norms, which appears undesirable according to the abovementioned reasoning.

Generally, we found that the results for personal and group pathways were rather similar in the student samples from the Netherlands and China, which also has a few implications. Importantly, it suggests that both of our pathways have good generalisability, as the results were stable across different groups of participants (i.e., psychology vs. business students), in different countries (i.e., Netherlands vs. China). It is however important to note that more studies are needed with more national representative samples to draw conclusions about specific countries and cultures, and whether these differ from each other. Our specific sample of Chinese business students may be relatively individualistic compared to other Chinese citizens, whereas our Dutch psychology students may have been more socially oriented than other Dutch citizens. Hence, whereas our data provide first evidence that the personal and group pathway exist across populations, more research is needed to investigate potential cultural and country differences.

The current study also had some limitations. First, it was a correlational study; therefore, no causal conclusions can be drawn. Future research is needed to test the potential causal pathways via experimental design where one or more environmental identities are manipulated to see if it can indeed improve environmental relevant behaviour across countries. Second, we used self-reported measures for pro-environmental behaviour in this study. A future study could also investigate actual behaviour, such as measuring food waste recycling behaviour.

## Implications for Practitioners

Based on our findings, it might be worthwhile to aim to strengthen personal and group biospheric values, as well as environmental self- and group identity to encourage pro-environmental behaviour in individualistic and collectivistic countries. Specifically, our study supports the relationship between environmental self-identity and pro-environmental behaviour across cultures. Previous studies suggest that reinforcing environmental self-identity helps to promote environmental relevant behaviour (Van der Werff et al., 2014a). To promote environmental behaviour, practitioners may try to make the environmental self-identity salient for the targeted participants by making people's past pro-environmental actions salient (Cornelissen et al., 2008; Van der Werff and Steg, 2016).

The existence of a group-level pathway also suggests that interventions targeting the perceived group values and identity could be promising to promote pro-environmental behaviour.

Policymakers could deliver a message emphasising that group members do care about the environment and which characterises the group as “pro-environmental.” It is noteworthy that this is different from a message based on social norms, which would communicate instead that the group finds it important that members act pro-environmental (injunctive norms) or merely that the group acts pro-environmental (descriptive norms). For instance, a neighbourhood energy-saving project may try to convey messages as “we do care about conserving natural resources” and “conservative energy use is an important part of what our community is.”

More importantly, group-level predictors might be easier to adjust than personal-level predictors (see Bouman and Steg, 2019, 2020). Whereas, people might feel they know best what they themselves find important, their perceptions of the group might be more open to being influenced by information they receive from others, which suggests the group approach's potential.

## CONCLUSION

In conclusion, our results indicate support for the well-established personal pathway and, to a lesser extent, for a newly proposed group pathway. Specifically, we replicated earlier findings that personal biospheric values can, via environmental self-identity, predict pro-environmental behaviour and extended these findings to participants from a collectivistic culture. Moreover, we found support for our hypothesised group pathway in participants from both countries, in which biospheric group values relate to pro-environmental behaviour via environmental group identity, although its effects were considerably weaker than for the personal pathway.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors for research purposes, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethical Committee of Psychology, University of Groningen. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

XW, EV, TB, MH, and LS conceptualised the research model. XW, EV, and TB designed the study and collected and analysed the data. XW, EV, TB, and MH drafted the manuscript. EV, TB, MH, and LS engaged in critical revisions of the manuscript. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.618956/full#supplementary-material>

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# Positive Environments and Precautionary Behaviors During the COVID-19 Outbreak

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Theoretically, a positive environment (PE) includes (a) tangible and intangible resources that satisfy human needs, (b) enablers of healthy, pro-social, and pro-environmental behaviors that guarantee socio-environmental quality and wellbeing, and (c) environmental challenges that must be faced and solved. One of the most salient challenges is the global COVID-19 pandemic. This study sought to investigate whether PEs can stimulate responsible actions (i.e., self-care and precautionary behaviors against COVID-19), while maintaining personal wellbeing. Nine hundred and forty-nine Mexicans participated in an online survey encompassing five primary factors: resources, enablers, challenges, responsible health behaviors, and wellbeing. The first three factors examine “resources” such as physical infrastructure as well as family and social support, “enablers” which include information about protective health practices and perceived legitimacy of authorities in handling the pandemic, and “challenges” encompassing threat perception and social pressure to not engage in precautionary measures. Participants also self-reported hedonic wellbeing as well as self-care and precautionary behaviors, which formed the “responsible (health) behavior” factor. Structural equations model ( $n = 714$  after list-wise deletion) showed that “resources,” “challenges,” and “enablers” form a second-order factor, “positive environments,” and this factor strongly covaries with “responsible behavior” and “wellbeing.” These results suggest that PEs are not only buffers against the negative impact of the COVID-19 pandemic but can also stimulate effective responses against a threat while maintaining individual wellbeing. These results can be used to inform the development and maintenance of PE frameworks aimed at minimizing the spread of COVID-19 and encouraging mental and physical health.

**Keywords:** positive environment, resources, challenges, precautionary, COVID-19, wellbeing

## INTRODUCTION

The COVID-19 pandemic constitutes one of the most pressing challenges worldwide currently. Quarantine, social/physical distancing, and self-isolation represent effective frontline precautionary behaviors that reduce viral transmission. These actions invite new questions about sociophysical space and the role it plays in public health and safety. Despite the protective effects on physical health, other potential negative outcomes (i.e., depression, obesity, and feelings of isolation)

may affect the lives of billions of people worldwide. As such, a better understanding of the sociophysical factors that influence safe, precautionary behavior is critical for an effective response moving forward. This paper proposes that positive environments (PEs) (i.e., settings that satisfy human needs, promote responsible behaviors and provide challenges) may encourage individual precautionary response toward pandemics like COVID-19.

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, continues to remain a serious global health emergency, particularly in the Americas. The Pan-American Health Organization (*Organización Panamericana de Salud, OPS*) estimated in August 2020 that while the region accounts for approximately 13% of the global population, it has accounted for around 64% of the reported deaths (United Nations Organization, 2020). As of October, the United States, Brazil, and Mexico, represented the countries with the first, second, and fourth highest total reported deaths worldwide. Combined these three nations accounted for over 440,000 deaths (41% of total deaths worldwide). Mexico has experienced a particularly high rate of death as a percentage of confirmed infected population at 10% (Johns Hopkins CSSE, 2020). Furthermore, it is estimated that COVID-19 will be the number one cause of death in Mexico by the end of 2020 (IHME, 2020). Perhaps more concerning is the likelihood that these are underreported figures and that the full extent of the infection and related death is even greater (Lau et al., 2020).

Beyond the catastrophic direct negative effects of the virus, other indirect mental and physical health concerns like depression, anxiety, and family violence appear to be increasing. The director of the OPS has claimed the Pan-American region is experiencing a “perfect storm” of events leading to an unprecedented mental health crisis. Uncertainty, stress, and stay-at-home orders may have exacerbated these issues that likewise may be underreported in the wake of reduced access to support and extension services (United Nations Organization, 2020). In a sample of Mexican participants taken 1 week after the announcement of a national emergency, 50% reported their *psychological distress* as moderate to severe in the context of a specified event (that may be interpreted by respondents as the COVID-19 pandemic). Female participants reported higher rates across measurements (i.e., anxiety, depression, and stress), while respondents that live with at least one other individual reported higher rates of anxiety and psychological distress (Cortés-Álvarez et al., 2020).

Viral transmission, to the best of our current understanding, is primarily spread *via* personal contact and respiratory droplets (*via* coughing, sneezing, talking, singing, etc.). Airborne transmission over farther distances may be an issue as well, particularly in locations with poor ventilation (Jayaweera et al., 2020; Park et al., 2020; World Health Organization, 2020). It appears that while fomite transmission (from inanimate objects or surfaces) may pose some risk, the likelihood of acquiring the virus in this manner *via* real-life scenarios appears low (Goldman, 2020). While critical research is still needed to understand the specifics how SARS-CoV-2 (the cause of COVID-19) transfers from person-to-person, human contact appears to be the frontline of virus transmission. In the absence of a

vaccine, the best-known way for individuals to prevent virus transmission is *precautionary behavior* (i.e., physical distancing, wearing masks, washing hands, surface cleaning, and avoiding touching the eyes, nose, or mouth) (Lee and You, 2020). Precautionary behaviors may also include isolation of individuals with confirmed cases or those showing COVID-19 like symptoms as well as a temporary cessation of educational, cultural, and economic activities. However, while these measures appear to reduce the chances of viral transmission, they are not without potential negative socio-psychological effects (including depression, stress, anxiety, sleep alteration, social stigma, loss of income, and disruption of normal social life) (Pfefferbaum and North, 2020). As such, a comprehensive understanding of the factors that promote precautionary behaviors without compromising individual wellbeing can inform future policy initiatives and guide mitigation efforts moving forward.

## Positive Environments

Evidence has suggested that a PE represents a sociophysical setting that allows people to cope with emergencies, crises, and environmental challenges. A PE is conceived as “a context that promotes individual and collective benefits and that also influences human predispositions to conserve—in the long run—the sociophysical structures on which life depends” (Corral-Verdugo and Frías-Armenta, 2016, p. 965). PEs allow people to flourish and experience physical and mental wellbeing, while mitigating the negative consequences of stressful, painful, or unpleasant conditions (Valera and Vidal, 2017). In a PE, people experience personal and social growth; personal growth refers to the process of becoming better in a personally meaningful way (Vittersø, 2014), while social growth implies the development of an individual's knowledge and ability in dealing with other individuals and groups (APA, 2021).

The construct also considers the satisfaction of psychosocial needs such as affiliation with others and affection and social support from family, friends, and peers (Deci and Ryan, 2000).

In addition, PEs enable socially and environmentally responsible behaviors that can also be understood as sustainable (Corral-Verdugo and Frías-Armenta, 2016). Therefore, a positive setting provides resources that enable the individual to successfully face environmental challenges while simultaneously requiring the conservation of those resources for future needs.

*Resources* provided by the environment (setting), tangible (material) or intangible (psychosocial), represent core elements of PEs. Evidence has demonstrated that physical environmental resources are crucial components for an effective health crisis response. For instance, access to safe public open space (e.g., exposure to blue-green spaces, rooftops, trails that allow for adequate physical distancing) has demonstrated beneficial effects for mental health (Bratman et al., 2019). Recent studies in pandemic response have suggested that contact with nature may buffer the effects of COVID-19 related stress. In a study of Italian participants, access to views of green areas were associated with a reduction in self-report depression symptoms (Amerio et al., 2020). Similarly, a pre-print study canvassing 77 European countries (61% Spanish sample) found that individuals who maintained contact with natural environments, either through



access to private outdoor spaces or blue-green natural viewsheds, reported fewer depression and anxiety symptoms as well as greater self-report positive mood (Pouso et al., 2020).

Family and social support factors represent another critical resource of PEs that influence how individuals react to major events like the COVID-19 pandemic. Positive family functioning, including family support, has demonstrated a relationship with reduced illness incidence and greater adoption of general health practices (García-Huidobro et al., 2012). Similarly, social support and peer influence have shown to be determinants of precautionary behaviors (Hurdle, 2001). The influence of family and social support appears to be reinforced during health crises, representing an important buffer against the negative effects of contagious outbreaks. In a study of Hong Kong residents during the SARS epidemic of 2003, participants reported greater concern for the feelings of family members and friends (over 60%) and about two-thirds stated that they paid more attention to their mental health than they had 2 months prior. Participants likewise reported greater social support from friends (28% increase) and family members (39%) when in need as well as higher rates of sharing feelings with family (35%) related to their experience 2 months before. In general, these factors were negatively associated with post-traumatic stress, stress perception, and other SARS-related perceptions (Lau et al., 2006). Recent studies suggest the influence of social and familial support may be greater in the wake of a more severe and widespread public health event like COVID-19. A study of the Liaoning Province in mainland China, which used the same items as the previous research, undertaken during the early stages of official response (28th January through 5th February 2020), found participants reported greater support from friends (65%) and family members (64%) and that most (58%) reported increased shared feelings among family members compared to 2 months prior. Furthermore, nearly 78% reported increased care for the feelings of family members (Zhang and Ma, 2020).

Furthermore, in a PE, the responsible actions of individuals are triggered by affordances that enable pro-environmental and prosocial behaviors making possible the conservation and integrity of that environment. These *enablers* of responsible actions include physical urban design that facilitates sustainable actions, information to cope/solve environmental problems, social models of responsible behavior, perceived legitimacy of authorities tasked with addressing important social issues, and government programs guaranteeing access to social justice and equity, (Corral-Verdugo et al., 2017). It is possible to identify enablers of responsible behaviors (i.e., healthy, precautionary) in the framework of COVID-19. Previous research has demonstrated that enablers, like access to relevant information suggesting guidelines for pandemic response (Lau et al., 2003) and perceived legitimacy of authority in managing the health crisis (Hartley and Jarvis, 2020), can help guide official response and encourage public compliance with offered suggestions.

Individual behavior can be triggered by the presence of *environmental challenges* (Corral-Verdugo et al., 2015b). These challenges may be environmental threats, extreme environments, personal adversity, illness, and social problems. If those

challenges combine with the presence of personal capacity and social resources, they can encourage personal and social growth. A trilogy working in sequence (challenges recruit personal capacities and resources which in turn lead to problem solving) manifests in these cases, producing positive outcomes (Suedfeld, 2012). Environmental challenges may serve as catalyzers of pro-environmental reflection and action. Experiencing a crisis prompts individuals to internalize and take action to ameliorate environmental problems (McDonald-Harker et al., 2020). Problem-solving that results from effectively acting in response to environmental challenges is identified as adaptive actions, competency display, and societal development, within the framework of a PE (Corral-Verdugo et al., 2017). The threat represented by COVID-19, undoubtedly, constitutes a formidable challenge for people around the world, even if most people—especially the younger—do not believe they will contract a disease caused by a novel virus (Commodari and La Rosa, 2020; Commodari et al., 2020). Although risk perception of public health crises may result in depression (Ding et al., 2020), threat perception may also lead to compliance of public health recommendations (Barr et al., 2008), and social pressure also affecting compliance with those recommendations (Hurdle, 2001) are instances of environmental challenges in the context of COVID-19. Social pressure is a challenge since it tests the ability or determination of an individual to engage in a behavior. In this case, compliance with precautionary measures. This means that, in addition to be facing the pandemics, people must cope with pressures to not practicing actions preventing them from getting the disease.

These three factors (resources, challenges, and enablers) are the constitutive elements of a PE. The PE that results from their combination influences (and is influenced by) the sustainable behaviors of individuals and, likewise of equal importance, personal wellbeing. These bidirectional influences imply that, in a PE, individuals engage in responsible behaviors and experience wellbeing creating a recursive chain of positive interdependences between settings, behaviors, and wellbeing (Corral-Verdugo et al., 2015b).

*Responsible (sustainable) behaviors* are activities that include pro-environmental and pro-social actions (Tapia-Fonllem et al., 2013). Self-care behaviors are also part of the set of sustainable/responsible behaviors (Corral-Verdugo et al., in press). Self-care consists of a series of actions adopted by individuals to seek personal wellbeing in the physical, mental, spiritual, and intellectual dimensions (Tobón Correa, 2003). Pro-social, pro-environmental and self-care behaviors are significantly interrelated (Corral-Verdugo et al., in press). An individual's health not only depends on personal care, but also on the social system determining the relations between self-care and the protection of the socio-physical environment (Orem, 1993). Pertinent to our study, self-care is related to precautionary behaviors, that is self-protective actions facilitate the practice of precautionary behaviors (Márquez-Serrano et al., 2012), suggesting that those who care for themselves also tend to protect others and their environment. Although, there is some overlapping between self-care and precautionary behavior, they differ in the level of specificity; whereas self-care involves actions

aimed at maintaining general health (in both physical and mental matters), precautionary behaviors are directed to preventing the infection from the SARS-CoV-2 virus.

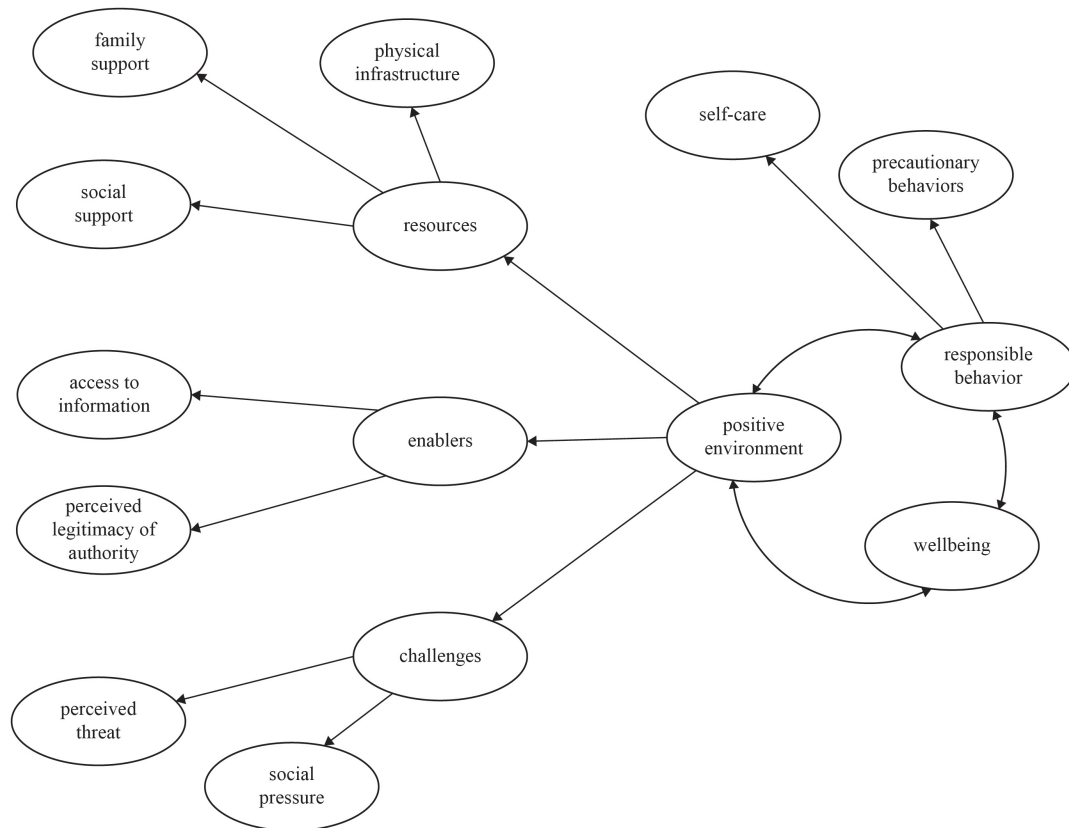
*Wellbeing* is experienced in PEs and is associated with responsible behaviors. Responsible behavior is not, of course, the sole cause of wellbeing, yet in situations where high quality of life and satisfaction exists (i.e., wellbeing), social support, and physical resources (i.e., PE resources) are more likely to be present (Van den Berg et al., 2007; Semenza and March, 2009; Schulte and Vainio, 2010). In addition, the practice of sustainable behaviors has a bidirectional relationship with human wellbeing (Prati et al., 2017). As such, the practice of environmentally and socially responsible behaviors result in higher levels of wellbeing but, simultaneously, the experience of wellbeing stimulates engagement in responsible behaviors. Regarding health care, positive affect and hedonic wellbeing are related to personal care (Kessing et al., 2014). Conversely, anhedonia predicts important clinic events (Denollet et al., 2008) and deficiencies in pleasure are considered to constitute an important affective mechanism impacting self-care (Leventhal, 2012).

**Figure 1** represents the proposed chain of events that link a PE, and its elements, in responsible (sustainable) behaviors and human wellbeing in the context of a pandemic.

Considering the theoretical and antecedent research, the present study was designed to test a model of PEs in the

context of the COVID-19 pandemic. According to this model, a PE, formed by physical, family, and social *resources*, as well as environmental *challenges* (threat perception, social pressure), and environmental *enablers* (information, legitimacy of authorities), should influence and be influenced by responsible (self-care/precautionary) behaviors against COVID-19 as well as influence personal wellbeing. For the PE construct, the theory establishes that resources, enablers, and challenges are factors that *should* be all present, and correlate with each other to produce an optimal level of positivity, and both the expected (responsible) behaviors and wellbeing. In this sense, PE is assumed to be a unitary and coherent construct representing a conjunction of favorable environmental conditions: The interrelation between these conditions is required to produce those effects. Yet, a certain level of positivity may exist in the environment with the presence of two (enablers, resources, for example) or even one (resources, for instance) elements, and the contribution of every indicator to positivity does not depend on the level of contribution of other indicator(s).

Therefore, according to this model, the elements of a PE should interrelate significantly and, in turn, will be associated with responsible behaviors and wellbeing. This predicts that, in a PE, people tend to practice healthy and precautionary behaviors and, simultaneously, experience higher levels of wellbeing.



**FIGURE 1 |** Theoretical model of positive environments and precautionary behaviors against COVID-19.

## MATERIALS AND METHODS

### Participants

Data was collected using a snowball recruitment procedure. Invitations to participate were sent *via* email, text, and social media in keeping with physical distancing guidelines. All participants were informed of the aims, benefits, and study risks before signing a digital consent form prior to participating. The sample included 949 individuals from all the 32 Mexican states. All participants above the legal age of consent in Mexico (18 years) were eligible. Mean age was 40.89 (SD = 14.77), ranging from 18 to 78. Most participants, (501) self-identified as female, 227 identified as males, five as non-binary and 13 preferred not to answer. Approximately, one-third of the participants reported being married (34.9%) and a quarter of the sample reported being single (24.8%), remaining participants reported being either divorced, widowed, or living in cohabitation (5.7, 1.9, and 11.6% respectively) with 21.2% choosing not to respond. Approximately, more than a third of participants completed college degree (35.7%), and about a fourth reported completing a postgraduate degree (24.6%). Less than 2% reported completing elementary or middle school (0.1 and 1.7% respectively) and 14.8% reported completing high school. On a 1–10 subjective social ladder scale (based on MacArthur ladder), 39.5% of respondents classified themselves as having a mid-level social status (5–7 interval), 13.6% self-defined as lower status (1–4 intervals) and 10.6% self-classified as higher status (8–10 interval); 24.2% did not respond.

### Procedure

The questionnaire was distributed between the end of May and the beginning of June 2020, 3 months after the pandemic started in Mexico. During this time, health and government officials continued to issue a “stay at home” request (#quedateencasa), which in most states was mandatory. Likewise, health and government officials disseminated informational campaigns about COVID-19 and hygienic measures to avoid contracting and spreading the virus.

Academic groups from various Mexican educational and research institutions were contacted electronically and invited to participate in the study. Academics were asked to subsequently distribute the invitation within their network. A Facebook page was also created to recruit participants. Data was collected using Qualtrics software. Participants were informed of the study aims and were informed that they could stop responding at any time if they decided to do so. Approximately 2% of those who received the link declined to participate. All the procedures used in this study comply with the ethical standards of national and international human-subjects committees and were approved by the University of Sonora Ethics Committee.

### Instruments

We used different psychosocial instruments to test the PEs model during COVID-19. A positive COVID-related environment was assessed using family support, social support, perception

of legitimate authorities, social pressure to break quarantine, and perception of access to COVID-safe public outdoor areas. Other psychological variables included threat perception and hedonic wellbeing. We evaluated behavioral variables associated to general health practices (i.e., self-care) and pandemic-specific precautionary behavior against COVID-19. The questionnaire also included socioeconomic items such as gender, age, education, and occupation. All instruments were either created or adapted specifically for this study. Several scales were reduced to reduce participant response time.

### General Health Practices

General health practices (state health practices) were assessed using five items from a self-care instrument (Corral-Verdugo et al., *in press*), and one item addressing general health. Questions addressed self-care practices such as exercise and eating habits, where a five-point Likert-type scale ranging from “never” (1) to “always” (5) was used. This reduced version of the scale showed acceptable internal consistency in a similar Mexican sample ( $\alpha = 0.64$ ) (Frias-Armenta et al., *in press*).

### Hedonic Wellbeing

The six reversed-key items in the anhedonic depression subscale from the Mini-MASQ (Casillas and Clark, 2000) scale were utilized to assess hedonic wellbeing. Participants responded to items like “I feel happy” and “I feel that I have a lot of things to do” using a 5-point Likert-type scale of agreement (1 “nothing” to 5 “extremely”). The Mini-MASQ has been previously validated in Mexico (Corral-Frias et al., 2019) and the 8-item anhedonic depression subscale reported acceptable internal consistency ( $\alpha = 0.83$ ).

### Precautionary Behaviors

Precautionary measures against COVID-19 items were adapted from a previous study (Frias-Armenta et al., *in press*). It included seven Likert-type questions assessing COVID-19-related preventive behaviors taken by participants 3 days prior to their participation. The items included how often people try to avoid touching their eyes, nose, and mouth when out in public as well as hand-washing behaviors, use of sanitizing disinfectants to clean items before they come into the home, adherence to stay at home orders, proper sanity behaviors when sneezing/coughing, mask usage, and maintenance of a 6-foot minimum physical distance.

### Legitimacy

This scale was written specifically for this study, based on Tyler (2006) approach to Legitimacy expressed as the support, trust, and confidence in legal authorities. Six items were elaborated but only three were used to improve the model's fit indices. Participants answered using a 5-point Likert-type scale, to items related to their confidence that legal authorities are considering and recommending the best decisions regarding COVID-19, looking out for the best intentions of the public, and acceptance of official decisions. Internal consistency between the three items was acceptable ( $\alpha = 0.83$ ).

## COVID-19 Information

To assess individual information on COVID-19, three 5-point Likert-type (0 = never, 1 = almost = never, 2 = once during the week, 3 = every day, and 4 = more than once in the day) items were constructed specifically for this study. Items asked about the frequency of individual research regarding COVID-19 as well as the manners used to search for information, health measures adopted to prevent the spread of COVID-19, and new health recommendations. Internal consistency between these four items was acceptable ( $\alpha = 0.75$ ).

## Social Pressure to Break COVID-19 Social Distancing

To assess social pressure to break social distancing a scale was specially constructed for this study. The items were formatted using a 5-point Likert-type scale (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, and 4 = strongly agree). Items included statements such as, my friends keep going out and taking part in social gatherings, my friends insist on continuing to take part in social meetings, my friends and family continue lead a normal life unincumbered by precautionary behaviors, and my acquaintances do not believe COVID-19 is dangerous. The internal consistency between these three items was acceptable ( $\alpha = 0.75$ ).

## Threat Perception

To assess threat perception of COVID-19, a translated and modified version of the Perceived Coronavirus Threat Questionnaire was used (Conway et al., 2020). The final instrument consisted of five 5-point Likert-style items. The “I am worried that I or people I love will get sick from the corona virus (COVID-19)” was eliminated. The original six-item translation was validated in student sample and showed good internal consistency ( $\alpha = 0.80$ ). The five items used here also showed good internal consistency ( $\alpha = 0.80$ ).

## Family and Social Support

To assess family and social support an adaptation of the support networks instrument from Villalobos (2009) was used. The instrument elicits responses on the degree to which participants feel supported by family, friends, or other persons and institutions. For this study, eight 5-point Likert-type (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, and 4 = strongly agree) items were used. Some items included were “I can trust good friends” and “In my social circle, people support me.” The items showed acceptable internal consistency ( $\alpha = 0.74$ ).

## Physical Infrastructure (Access to Safe Outdoor Spaces)

Five 5-point Likert items were constructed (1 = Strongly disagree to 5 = Strongly agree) to assess access to safe outdoor environments. Items included statements such as “I have access to an area where I can go out to do a physical activity in a safe way.” The instrument showed acceptable internal consistency ( $\alpha = 0.80$ ).

## Data Analysis and Model Specification

Internal consistency reliability (Cronbach alpha) and univariate (means and standard deviations) analyses were calculated using

SPSS v.25. A structural equation model analyzing the relations between PEs, responsible behaviors and wellbeing was specified and tested using Maximum Likelihood as an estimation method. From the total 949 initial participants, 235 were excluded due to incomplete data, leaving 714 participants for data analysis. In addition, the data was randomly split in half. Then, two structural models were specified with the resulting samples to conduct an additional test of validity for our measures.

In the final model with the total sample, the unidimensionality of the instruments was tested within the measurement model. Significant ( $p < 0.05$ ) and salient ( $\geq 0.30$ ) factor loadings were expected, as indications of convergent construct validity for all measures. To evaluate the model's goodness of fit, three types of fit index indicators were considered: practical, statistical, and population (Bentler, 2007). The statistical indicator was chi squared ( $\chi^2$ ). To make the  $\chi^2$  test less dependent on sample size, we used the relative  $\chi^2$ , which is calculated by dividing the  $\chi^2$  fit index by the degrees of freedom. In accordance with previous research (Schumacker and Lomax, 2004), if this ratio is  $< 5$  the model is deemed to have good fit. Since statistical indicators are particularly sensitive to sample size, practical indicators were also considered. These included the Comparative Fit Index (CFI), and the Bentler–Bonnet Non-Normed Fit Index (BBNNFI). The RMSEA population fit index was also utilized.

Our model proposed that the physical infrastructure, family support, and social support factors emerge from their corresponding indicators' (i.e., items). The common variance of these first-order factors, in turn, constitute the second-order factor “Resources.” Similarly, access to information, and perceived legitimacy of authorities formed the “Enablers” second-order factor, while perceived threat to COVID-19 and social pressure resulted in the “Challenges” second-order factor. The third-order factor “Positive Environment” emerged from the covariance of Resources, Enablers, and Challenges. In addition, “Responsible Behavior” is a second-order factor that is a result of the correlation between “Self-care” and Precautionary Behavior.” “Wellbeing” is a first-order factor assessed using items from the Hedonic Wellbeing scale. These interrelations conformed to the measurement model. The structural model indicated that the PE, Precautionary Behavior, and Wellbeing factors should highly and significantly covary.

## RESULTS

Table 1 shows the means, standard deviations, and internal consistency coefficients (Cronbach's alpha) for each instrument used in this study. For the Self-care and Precautionary behavior scales (part of the responsible behavior factor) the internal consistency coefficients were 0.60 and 0.65, respectively. The Challenges factor (Threat perception and Social Pressure) presented coefficients between 0.75 and 0.80. In turn, the Positive Environment factor (Physical infrastructure, Family support, Social support, Information, and Legitimacy of authorities) showed alpha coefficients between 0.71 and 0.88. Finally, the Hedonic Wellbeing factor produced an alpha coefficient of 0.85.



**TABLE 1 |** Reliability and univariate statistics of scales (scale range of responses: 1–5).

Scale/items	Mean	SD	Alpha
Physical Infrastructure	<b>3.65</b>	<b>1.27</b>	<b>0.80</b>
Access for physical activity	3.57	1.28	
Access to areas to breathe fresh air	3.55	1.25	
Green area close to home to relaxe	3.49	1.35	
Patio, roof, or balcony at home	4.26	1.12	
Natural areas nearby	3.38	1.38	
Family Support	<b>4.15</b>	<b>0.81</b>	<b>0.71</b>
At home, we help each other	4.40	0.74	
At home, we treat each other with love and respect	4.39	0.74	
At home, everyone is by their side (reversed)	3.67	0.99	
Social Support	<b>4.05</b>	<b>0.93</b>	<b>0.88</b>
When in trouble, I can tell my friends	3.90	0.99	
When sad or troubled, my friends make me feel better	3.90	0.95	
I can trust good friends	4.16	0.96	
In my social circle, people support me	4.17	0.85	
I feel supported by people, besides my family and friends	4.13	0.92	
Self-care	<b>3.80</b>	<b>0.89</b>	<b>0.60</b>
Does physical activity regularly to maintain health	3.38	1.02	
Tries to consume healthy food	3.89	0.70	
Engages in activities promoting spirituality	3.06	1.19	
Rests to recover health and energy	4.07	0.79	
Does things that provide pleasure	4.02	0.74	
Tries to be in peace with her/himself	4.38	0.65	
Threat Perception	<b>4.47</b>	<b>1.62</b>	<b>0.80</b>
Thinking of coronavirus makes me feel threatened	4.23	1.58	
Afraid of the coronavirus	4.14	1.66	
Concerned about coronavirus	5.17	1.63	
Worried about catching Coronavirus	4.69	1.56	
Stressed around other people because of COVID	4.16	1.70	
Social Pressure	<b>2.47</b>	<b>1.09</b>	<b>0.75</b>
Most of my friends keep going out on the streets	2.62	1.06	
Most friends keep doing social gatherings	2.07	1.06	
Despite COVID, people continue leading their normal life	3.23	1.21	
Most acquaintances do not believe COVID is dangerous	2.46	1.08	
My friends insist that we meet	2.01	1.06	
Information	<b>3.40</b>	<b>0.92</b>	<b>0.75</b>
Information about number of cases	2.91	1.02	
Information regarding health measures against COVID	3.04	0.86	
Information about new health recommendations	4.26	0.88	
Legitimacy of Authorities	<b>2.89</b>	<b>1.12</b>	<b>0.83</b>
I am confident that authorities will make best decisions	2.84	1.15	
I am confident that authorities have the best intentions	3.04	1.14	
I would accept, without hesitation, their decisions	2.77	1.08	
Precautionary Behaviors Against COVID	<b>4.33</b>	<b>0.86</b>	<b>0.65</b>
Avoid touching eyes, nose, and mouth without washing	3.91	1.07	
Washing hands with soap and water for at least 20 s	4.43	0.75	
Using sanitizer to clean things that come into house	4.23	1.08	
Staying at home	4.03	0.78	
Covering mouth with arm when sneeze/cough	4.68	0.60	
Wear a mask when leaving home	4.79	0.52	
Maintain a six feet minimum distance from others	4.66	0.56	
Hedonic Wellbeing	<b>3.23</b>	<b>0.97</b>	<b>0.85</b>

(Continued)

**TABLE 1 |** Continued

Scale/items	Mean	SD	Alpha
Felt really happy	3.32	0.90	
Felt like I was having a lot of fun	2.85	1.03	
Felt like I had a lot of energy	3.05	0.98	
Felt really “up” or lively	3.22	0.93	
Felt like I had a lot of interesting things to do	3.32	1.02	
Felt like I had a lot to look forward to	3.63	0.96	

In a 1–5 range of response, the highest means resulted from the scales Threat perception (4.47, SD = 1.62); Precautionary Behavior (4.33, SD = 0.86); Family support (4.15, SD = 0.81); and Social support (4.05, SD = 0.93). These were followed by Self-care (3.80, SD = 0.89); Physical infrastructure (3.65, SD = 1.27); Information (3.40, SD = 0.92); and Hedonic Wellbeing (3.23, SD = 0.97); which produced a moderate level of responses. The lowest means were for Legitimacy of authorities (2.89, SD = 1.12), and Social pressure (2.47, SD = 1.09).

The two structural models conducted with the randomly split data produced significant ( $p < 0.05$ ) lambdas and structural coefficients that were similar to each other's values and the ones found in the final structural model (see **Table 2**). High and significant covariances between PE, Responsible Behavior, and Hedonic Wellbeing (0.82, 0.46, and 0.73, first model; 0.80, 0.42, and 0.80, second model) were obtained in these two preliminary models. The goodness of fit indicators [First model:  $\chi^2 = 1770.51$  (1,114 df),  $p < 0.0001$ ,  $BNNFI = 0.90$ ,  $CFI = 0.90$ ;  $RMSEA = 0.04$ ; second model:  $\chi^2 = 1724.66$  (1,114 df),  $p < 0.0001$ ,  $BNNFI = 0.89$ ,  $CFI = 0.90$ ;  $RMSEA = 0.04$ ] reveal that the models are supported by the data.

**Figure 2** shows the results of the structural equation model. All observed indicators (i.e., items) loaded significantly (0.05) on their corresponding first-order factors, indicating convergent construct validity for the scales. “Resources” coherently emerged from its first-order latent variables (physical infrastructure,  $\lambda = 0.47$ ; family support,  $\lambda = 0.62$ ; social support,  $\lambda = 0.58$ ). The indicators of the “Environmental Enablers” factor (access to information,  $\lambda = 0.49$ ; legitimacy of authorities,  $\lambda = 0.49$ ) also loaded saliently and significantly on its second-order latent variable; as well as the indicators of “Environmental Challenges” (perceived threat,  $\lambda = 0.38$ ; social pressure,  $\lambda = 0.36$ ). In turn, those second-order factors made up the higher-order “Positive Environment” factor (Resources,  $\lambda = 0.79$ ; Enablers,  $\lambda = 0.18$ ; Challenges,  $\lambda = -0.52$ ). A similar pattern was detected in the relationship between “Responsible Behavior” and its indicators (Self-care,  $\lambda = 0.71$ ; Precautionary behavior,  $\lambda = 0.69$ ). The lambdas between “Hedonic Wellbeing” and its observed indicators ranged from 0.59 to 0.82). As in the partial-data models, high and significant covariances between PE, Responsible Behavior, and Hedonic Wellbeing (0.82, 0.45, and 0.78) were obtained. The goodness of fit indicators [ $\chi^2 = 2288.65$  (1,114 df),  $p < 0.0001$ , relative  $\chi^2 = 2.05$ ;  $BNNFI = 0.90$ ,  $CFI = 0.90$ ;  $RMSEA = 0.04$ ] reveal that the model is supported by the data. Although the  $p$  value associated to  $\chi^2$  resulted



**TABLE 2 |** Correspondence between lambdas of half-split samples.

Item	Sample 1	Sample 2
	Lambda on factor	Lambda on factor
Physical infrastructure 1	0.70	0.73
Physical infrastructure 2	0.79	0.77
Physical infrastructure 3	0.88	0.89
Physical infrastructure 4	0.24	0.33
Physical infrastructure 5	0.72	0.75
Family support 1	0.82	0.73
Family support 2	0.78	0.69
Family support 3	0.55	0.44
Social support 1	0.78	0.76
Social support 2	0.79	0.82
Social support 3	0.82	0.84
Social support 4	0.78	0.72
Social support 5	0.71	0.68
Access to information 1	0.70	0.66
Access to information 2	0.79	0.76
Access to information 3	0.61	0.68
Authorities Legitimacy 1	0.84	0.91
Authorities Legitimacy 2	0.88	0.89
Authorities Legitimacy 3	0.63	0.65
Perceived threat 1	0.77	0.73
Perceived threat 2	0.86	0.90
Perceived threat 3	0.22	0.23
Perceived threat 4	0.80	0.83
Perceived threat 5	0.76	0.76
Social pressure 1	0.78	0.71
Social pressure 2	0.57	0.60
Social pressure 3	0.52	0.58
Social pressure 4	0.56	0.70
Social pressure 5	0.61	0.51
Social pressure 6	0.56	0.38
Self-care 1	0.22	0.38
Self-care 2	0.37	0.44
Self-care 3	0.33	0.41
Self-care 4	0.52	0.58
Self-care 5	0.60	0.61
Self-care 6	0.66	0.58
Precautionary behavior 1	0.40	0.51
Precautionary behavior 2	0.60	0.64
Precautionary behavior 3	0.57	0.50
Precautionary behavior 4	0.28	0.33
Precautionary behavior 5	0.52	0.44
Precautionary behavior 6	0.41	0.46
Precautionary behavior 7	0.46	0.46
Wellbeing 1	0.77	0.79
Wellbeing 2	0.73	0.73
Wellbeing 3	0.78	0.72
Wellbeing 4	0.85	0.79
Wellbeing 5	0.60	0.57
Wellbeing 6	0.61	0.58
Physical Infrastructure on Resources	0.46	0.47
Family support on Resources	0.65	0.55

(Continued)

**TABLE 2 |** Continued

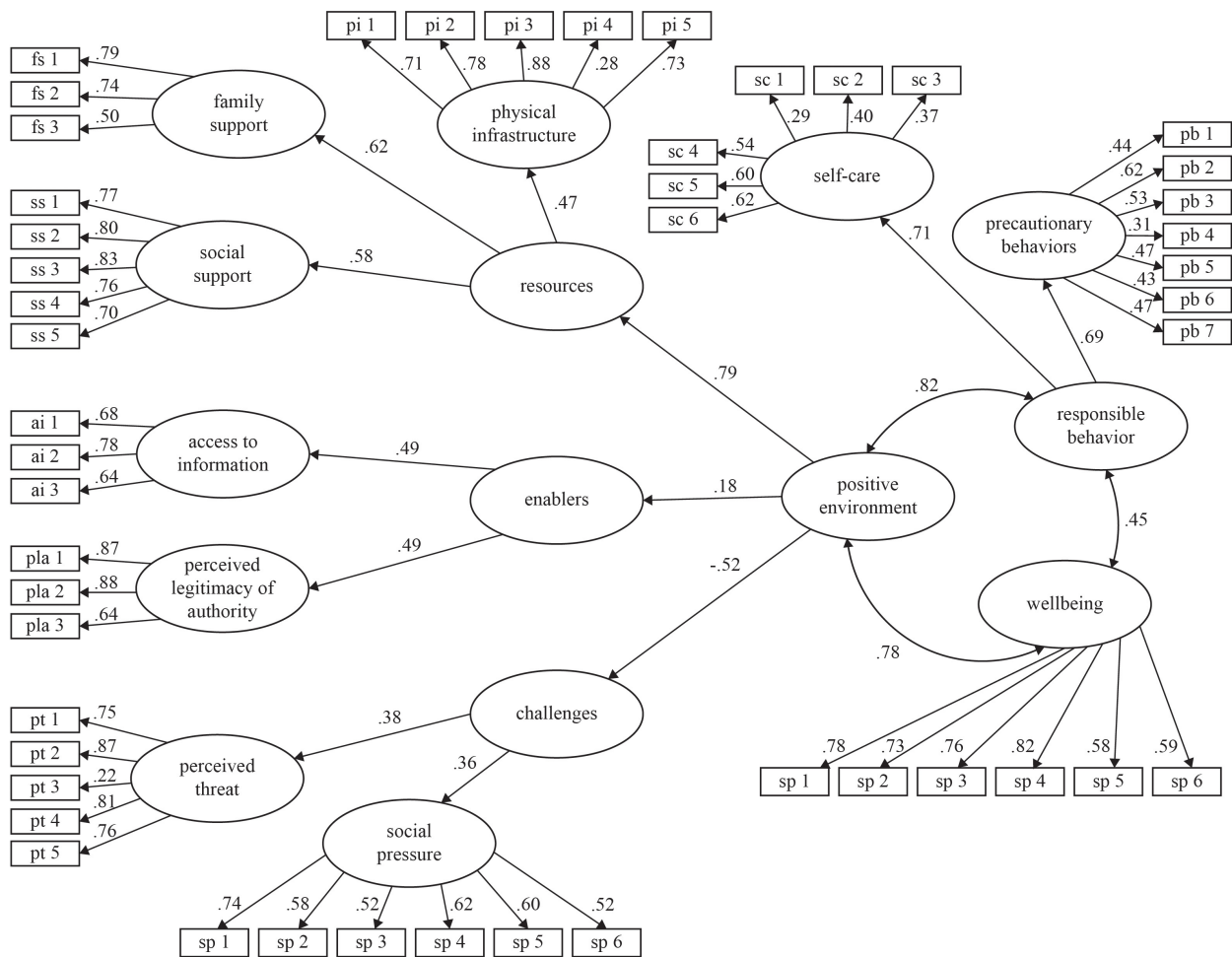
Item	Sample 1	Sample 2
	Lambda on factor	Lambda on factor
Social support on Resources	0.59	0.55
Access to information on Enablers	0.47	0.50
Authorities legitimacy on Enablers	0.47	0.50
Perceived threat on Challenges	0.42	0.47
Social Pressure on Challenges	0.38	0.45
Self-care on Responsible Behavior	0.75	0.66
Precautionary beh. on Responsible beh.	0.73	0.63
Resources on Positive environment	0.78	0.77
Enablers on Positive environment	0.22	0.29
Challenges on Positive environment	−0.49	−0.39

significant (due to the large sample size), the rest of the goodness of fit indicators were appropriate.

## DISCUSSION

This study investigated precautionary behaviors in relation to COVID-19 in the framework of environmental positivity. The results suggest that a PE can be characterized by the availability of physical and social resources, the existence of challenges, and the presence of environmental enablers of sustainable behavior (Corral-Verdugo et al., 2017). A PE, in turn, influences and is influenced by the responsible behaviors of individuals (self-care and precautionary actions that mitigate COVID-19) and the hedonic wellbeing they experience. According to the tested theory, a PE requires the presence of significant relationships between those indicators: they appear together when the environment is positive (Corral-Verdugo and Frías-Armenta, 2016). These features (resources, enablers, challenges, and their interrelation) make PEs sustainable environments. In addition, every element in the model produced favorable and not dissimilar (from each other) scores, which is required to demonstrate that a PE is present. Although variability was noticed in those scores, no significant discrepancies were found among the factors' scores, with most of their means between 4.4 and 3.2 (1–5 range of response). The exceptions were legitimacy of authorities (2.9) and social pressure (2.5). Therefore, in general, it can be said that not only a correlation exists between all the factors, but also that their scores are of similar magnitude. These results are reinforced by the Cronbach's alpha of the whole model (not previously reported in the previous versions of the paper) which resulted = 0.77, indicating internal consistency in the model (i.e., the factors contribute to the PE construct in an evenly way).

An important take away from these results is that the design and maintenance of PEs may represent a viable strategy for facing serious issues like the COVID-19 pandemic, while maintaining individual and group wellbeing. These concepts may further inform official response to other environmental challenges moving forward, like climate change.



**FIGURE 2 |** Test of the model of positive environments and precautionary behaviors against COVID-19. Goodness of fit: Satorra–Bentler  $\chi^2 = 2288.65$  (1,114 df),  $p < 0.0001$ ; BNNFI = 0.90, CFI = 0.90; RMSEA = 0.04.

The scales used to assess the variables of interest demonstrated internal consistency reliability (as assessed by Cronbach's alpha) as well as convergent construct validity. The elevated degree of threat perception is understandable considering the significant losses associated with the pandemic in Mexico. The high rate of infection, death toll, as well as employment and economic losses have put strain on the population to a degree not witnessed in recent memory. Precautionary behaviors also produced high response levels, indicating concern for the propagation of the disease and individual efforts to mitigate the spread of infection. Participants reported high degrees of family and social support, resources that may help counteract the threat of COVID-19.

Scales assessing access to adequate physical infrastructure (areas to do physical activity, outdoor natural areas, household outdoor facilities, etc.), access to accurate information regarding COVID-19, and hedonic wellbeing produced moderate means. Green urban infrastructure and maintenance in many Mexican cities is lacking or unequally distributed (Fernández-Álvarez, 2017), which may explain the relatively low means for these

measures. Individual means of hedonic wellbeing were also moderate, somewhat unusual for a Mexican sample, which normally report high wellbeing (Dugain and Olaberria, 2015). This phenomenon is not totally unexpected as high degrees of wellbeing in the context of an epidemic or pandemic health crisis may not be typical. Yang and Ma (2020) found the coronavirus epidemic led to a 74% drop in overall emotional wellbeing among Chinese participants shortly after official announcement of the outbreak. Considering the expectation that pandemic events will likely reduce individual and collective wellbeing, it is critical to take environmental measures into account. The model demonstrated that variations in wellbeing were associated with the degree to which participants reported environmental positivity (i.e., the more positive the environment, the greater the individual self-report wellbeing).

Participants reported low perception of authority legitimacy in handling the COVID-19 crisis as well as low social pressure to not engage in precautionary behaviors. Legitimacy of authority is traditionally perceived as low in previous studies including

Mexican participants in a wide range of public aspects (Edmonds-Poli and Shirk, 2020), which may explain relatively low reports in this study. Perhaps promisingly, social pressure to not engage in precautionary behaviors was also relatively low, implying participants considered the seriousness of the outbreak or the importance of “flattening the curve” of new infection.

Our findings confirm previous reports of a positive relationship between sustainable (responsible) behaviors and psychological wellbeing (Prati et al., 2017). In this study, responsible (self-care, precautionary) behaviors moderately, positively and significantly correlate with hedonic wellbeing. This seems to imply that, in a PE, individuals who engage in behaviors intended to protect themselves and others (against COVID-19) may experience hedonic wellbeing, regardless of the inconvenience those practices imply. Of course, wellbeing can also be experienced as a consequence of prosocial and pro-environmental behavior outside a PE.

The “Resources” factor loaded four times higher than “Enablers” on environmental positivity. Neither legitimacy of authorities nor access to information contributed to environmental positivity as much as resources available to the individual (particularly social resources). Yet, studies have suggested that Mexican respondents, across different socioeconomic status, tend to engage in acts of solidarity not only directed toward family members and friends but also toward the population-at-large, even in the presence of low levels of enablers. These expressions of solidarity appear to occur with a similar intensity across nations, as the report by Butcher et al. (2010). Feelings of solidarity among individuals may likewise be influenced by relatively low degrees of perceived legitimacy of Mexican authority, thus contributing to a sense of environmental positivity outside of an official sector context (Edmonds-Poli and Shirk, 2020) and practices of reading/accessing information among broad segments of the Mexican population (Kalman and Reyes, 2016). Our results indicate that these and other enablers of environmental positivity must be enhanced to increase both the level of participation in responsible actions and individual wellbeing.

This study is not without limitations. Firstly, due the conditions of physical distancing imposed by the pandemic, obtaining a representative sample was difficult. The sampling technique used may have caused a biased sample, where middle-class and more educated individuals were over-represented. Moreover, several participants did not respond to all the items. Over 200 participants, whose data were not completely available, were left out the analyses, so that the structural models were affected by these losses since the analysis does not allow for a single missing data. Secondly, the model investigated some indicators of environmental positivity during the COVID-19 pandemic but there are certainly other factors that may be of importance. Future studies could include the role played by tangible resources such as access to food, household habitability, and financial resources. Likewise, only information and legitimacy of authority were assessed as enabler and it has been shown that community capacity [see Hartley and Jarvis (2020)] has an important role in the absence of legitimacy of authority. Thirdly, this model presents a high level of complexity because the explanation of complex phenomena is usually not

better served by simpler models. Sustainable environments and behaviors are a case of this type of complex phenomena. Therefore, model estimation results more difficult and goodness of fit may be affected (Gribbons and Hocevar, 1998), which made us to drop three items from one scale.

Finally, since the data was collected through self-report questionnaires, some responses may be influenced by social desirability. In addition, part of the interrelations between the indicators of the PE may be due to the common method variance. Despite these limitations, this study provides clues for the design of PEs that help individuals cope during crisis. The present research likewise adds to our knowledge of the situational and psychological factors associated with precautionary practices against COVID-19.

## Recommendations

Our results suggest that new policies should include efforts to promote PEs by establishing and fostering resources and enablers that may help counter the challenges faced by individuals, particularly as it relates to crisis events like the COVID-19 pandemic. Likewise, we suggest that resources that stimulate social networks (family or community) and provide access to safe outdoor spaces are important for creating PEs. Although social distancing has hindered access to the usual sources of sociality, leading to social isolation and subsequent psychopathology (Usher et al., 2020), the practice represents the first line of defense against the continued spread of COVID-19. Previous literature has shown the importance of social support in mental health recovery after widespread disasters such as Hurricane Katrina (Chan et al., 2015). Despite physical distancing measures, modern technology solutions brought about by widespread access to the internet may help buffer loneliness and isolation by providing a way to provide and receive social support (Saltzman et al., 2020). Online “cocktail” parties, social group chats, keeping up with of friends through social media are only a few ways individuals have attempted to reclaim normalcy in the face of the pandemic. A recent study suggested that before COVID-19, students facing a strong academic stressor had buffering effects from online but not face-to-face feedback (Rodríguez-Hidalgo et al., 2020). The interaction between physical and social qualities of PEs and its influence on precautionary behaviors and wellbeing should also be considered. Previous research by Evans et al. (1996), and Corral-Verdugo et al. (2015a), for instance, has shown that the physical environment of homes affects mutual support and stress of family members. Results of the present study reinforces that evidence, stressing the importance of habitability of households and its effect on family wellbeing.

Access to safe outdoor spaces during periods of physical distancing is critical, particularly considering the rise in rates of self-report loneliness, anxiety, and depression (Pouso et al., 2020). Access to these spaces is important, in part because outdoors is possible to meet people (keeping physical distance), and because parks and streets with green areas are restorative. Many areas have begun to incorporate nature to workplace environments to increase wellbeing during the COVID-19 era. For instance, former triage tents at Mount Sinai Hospital have been converted into “recharge rooms” for healthcare workers on the frontlines of the COVID-19 response (Naomi, 2020).

The “nature-filled settings” include “immersive nature environments with music, scent, lighting, and sound” (Abilities Research Center, 2020). Recent reports have also made long and short-term recommendations to improve access to safe outdoor environments, such as adopting open or slow street initiatives and creating built environments for all users (Slater et al., 2020). It is important to note that policies similar to these, which provide safe access to outdoor areas be incorporated to different living areas and workplaces.

Environmental enablers are likewise critical components of an effective response to adversity. Our results suggest official action should be directed toward providing clear information, data, and evidence of the actions to be taken to prevent further COVID-19 spread, and how those actions, in turn, protect people and foster PEs. Confidence or perceived legitimacy of authority appears deficient at this moment among the sampled population. Trust in authority may serve to encourage social adherence to the guidelines suggested by public officials. Focus should be paid to identifying and addressing deficiencies in perceived trust to promote confidence among all involved parties. However, even in situations of low levels of public trust and political legitimacy nations have been able to contain spread through community capacity (Hartley and Jarvis, 2020). Hong Kong, while in political turmoil, has effectively mitigated the spread of COVID-19. Authors attribute this to community initiative in the absence of widely accepted policy posture. Research in Australia showed that trust in authorities or fear of legal sanctions did not predict compliance (Murphy et al., 2020). These studies generally suggest that public policies need to focus on persuading citizens that everyone has a duty to protect those most vulnerable to the disease. The results of this study support this notion, particularly when considering higher response rates for concern about others, as opposed to concern about one's self in the context of COVID-19. Promoting responsible behavior is critical for the development of positive socio-physical environments, which will in turn increase wellbeing, and result chain reaction of positive coping strategies in the face of crisis.

Given that people, in times of crisis, turn to their leaders for credible scientific information and related guidance, it is pivotal that those voices represent the best information aimed at the best solutions to tackle difficult issues. Technology (the internet, social media) must be leveraged to raise awareness of the critical importance of self-care and use of techniques that promote

wellbeing and PEs. The negative societal effects of the COVID-19 pandemic reach beyond the scope health and behavioral health care. As such, official response to the threat of the pandemic must consider the depth and breadth of the challenges, resources, and enablers that promote PEs and individual wellbeing.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Comité de Ética en Investigación de la Universidad de Sonora. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

VC-V and NC-F contributed by writing, reviewing, and editing. EP-T ran formal analysis and organized databases. VC-V contributed by supervising this study and its methodological tasks (methodology) were designed by VC-V, MF-A, and NC-F. VC-V and ML provided the writing of the original draft. All authors contributed with conceptualization, design of this study, manuscript revision, and read and approved the submitted version.

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# Outdoor Office Work – An Interactive Research Project Showing the Way Out

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The physical boundaries of office work have become increasingly flexible. Work is conducted at multiple locations outside the office, such as at clients' premises, at home, in cafés, or when traveling. However, the boundary between indoor and outdoor environment seems to be strong and normative regarding how office work is performed. The aim of this study was to explore how office work may be conducted outdoors, understanding how it is being experienced by office employees and identifying its contextual preconditions. Based on a two-year interactive research project, the study was conducted together with a Swedish municipality. Fifty-eight participants engaged in the collaborative learning process, including 40 half-day workshops and reflective group discussions, co-interviews, and participants' independent experimentation of bringing work activities outdoors. Data was collected via interviews, group discussions and a custom-made mobile application. The results showed that a wide range of work activities could be done outdoors, both individually and in collaboration with others. Outdoor work activities were associated with many positive experiences by contributing to a sense of well-being, recovery, autonomy, enhanced cognition, better communication, and social relations, but also with feelings of guilt and illegitimacy. Conditions of importance for outdoor office work to happen and function well were found in the physical environment, where proximity to urban greenspaces stood out as important, but also in the sociocultural and organizational domains. Of crucial importance was managers' attitudes, as well as the overall organizational culture on this idea of bringing office work outdoors. To conclude, if working life is to benefit from outdoor office work, leaders, urban planners and policymakers need to collaborate and show the way out.

**Keywords:** outdoor office work, sustainable working life, interactive research, work norms, human nature interactions, urban greenspaces

# INTRODUCTION

In this age of urbanization, many people spend the vast majority of their time indoors, separated from the elements of nature, not the least at work. Why is that? Spending time outdoors and nature contact holds a great potential for various positive effects, both as prevention and treatment, upon well-being and health (Kuo, 2015; Frumkin et al., 2017). Historically, humans have spent most of their daytime outdoors, up to the dawn of industrialization, and the impact of constant indoor stay, in stressful work environments, is still not fully understood. Furthermore, contact with nature can contribute to improved executive functioning (Kaplan, 1995; Stenfors et al., 2019), recovery from stress (Ulrich, 1984), and boost in affective well-being (McMahan and Estes, 2015), with overall implications for cognitive functions and learning at large (Lisberg Jensen, 2009; Kuo et al., 2019). All these mentioned aspects are of relevance for tackling challenges in the working life of today, with its demands on social skills, problem-solving and creativity, possibly counteracting the negative effects of cognitively demanding tasks, and digital connectedness (Kompier, 2006).

Urbanization, resource exploitation, and lifestyle changes impact the possibilities for human contact with nature (Hartig et al., 2014). Remedies are suggested to bring more nature into the city or bring people out into nature (Turner et al., 2004). This study takes its point of departure in the potential of “everyday nature” (Kaplan et al., 1998), focusing on changes in everyday life in the context of work, possibly increasing (office-) workers’ contact with the urban outdoors, including the natural elements therein. The physical environment is a vital aspect often overlooked (Pratt, 2020) when work life is scrutinized for improvements.

The boundaries of physical spaces for work are also changing today and have become increasingly flexible (for some groups) (Allvin et al., 2013; Kossek and Lautsch, 2018), whereby work is being conducted at multiple locations outside the office, such as at home, in cafés, trains, and buses (Dale and Burell, 2008, p. 3). More and more office workplaces are designed as activity-based flex-offices, where employees do not have fixed workstations but share the office space with their colleagues (Bodin Danielsson, 2020). In such workplaces, employees are expected to switch between workspaces designed for particular activities, such as collaboration or concentration (Haapakangas et al., 2018). Aspects of these trends are far from unproblematic and especially lack of access to supportive facilities that enables personal control over unwanted stimuli appears critical (Bodin Danielsson and Theorell, 2019). It is not probable that tomorrow’s workplaces will look like yesterdays. As a matter of fact, the whole idea of traditional office buildings has been questioned with regards to the knowledge-intensive working life of today (Duffy, 2008).

Despite increasing flexibility and boundarylessness, the threshold between indoors and outdoors seems to be high when it comes to office work. The office has a number of different functions at the social, functional, symbolic, and physical level (Söderberg, 2003), serving vital needs of people and their organizations by connecting colleagues, sheltering from wind

and rain, enabling ergonomic seating/work positions, or offering desk-space and other necessary equipment. At the same time, an overreliance on indoor spaces is likely to be unsupportive of a knowledge-intensive working life, where a growing number of people have non-routine, low-regulated works (Allvin et al., 2013). Many white-collar workers spend their workdays seated in office- or meeting room chairs, indoors, while a more flexible organization of the day may diminish sedentary behavior (Li et al., 2017).

Productivity is more intimately intertwined with our individual and intrapersonal capacity and ability to function, than ever. Ellström (2001) among others discusses the importance of a pendulum between different types of work-life learning and that opportunities for reflection and questioning of routines need to be incorporated into everyday work. Creativity is a wanted characteristic of employees, with creative output being something organizations crave. Does the modern office environment promote creativity? The lack of individual spaces and too much sound and movement distractions have been pointed out as a factor influencing creativity negatively (Stokols et al., 2002). On the other hand, the interactive social qualities of open plan offices can have a positive effect (Hoff and Öberg, 2015). A fruitful coupling is suggested between such insights about the prerequisites for creativity in work life with the evidence we have today on how natural surroundings can affect our activity, creativity, executive functions, social interactions, and health. Kuo (2015) describes how a “myriad of studies” have linked contact with nature to human physical and psychological health outcomes, including decreased prevalence of cancer, cardiovascular disease, and depression, through multiple pathways, such as natural sights, natural sounds, and negative air ions; physiological and psychological states, such as relaxation, awe, vitality, and attention restoration.

In addition, the outdoors, with regards to nature exposure, is interesting from a learning perspective (Lisberg Jensen, 2009; Sandell and Öhman, 2010; Mannion et al., 2013; Kuo et al., 2019). Kuo et al. (2019) list a set of direct effects of nature on the “learner” with nature rejuvenating attention, increasing physical activity, relieving stress, boosting self-discipline, and increasing motivation. In addition, they point out a set of moderating factors associated with the context based on evidence for vegetated settings contributing to a calm associated with overall feelings of safety and increasing the likelihood for fostering warm and cooperative relations.

The potential benefits of spending time outdoors and having more contact with natural elements in daily work life are of great relevance for meeting the challenges of today’s knowledge work. Incorporating outdoor office work practices may thus potentially contribute to a more sustainable working life. Attempts to test this have for example been done in academia, where walking seminars improved both perceived seminar quality and sense of well-being among participants (Bälter et al., 2018). However, studies are still largely lacking which investigate outdoor office work regarding possible practices in daily working life, what it may contribute to and its preconditions. Thus, the present study aims to fill this gap.

The overarching aim was to explore possible ways of working in the urban outdoors, as well as its potential benefits and challenges, to understand how such practices can contribute to a more sustainable and innovative working life. The more specific purposes were to: (A) identify and evaluate different forms of office work possible to bring outdoors – into the urban nearby surroundings; (B) understand how outdoor office work is experienced, and finally C) identify different types of contextual conditions of relevance for how outdoor office work is implemented and experienced.

## MATERIALS AND METHODS

### Study Design: An Interactive Research Approach

The data collection took place within the frame of a two-year interactive research project, conducted in collaboration with a municipality in southern Sweden (September 2017–August 2019), and mainly funded by the European Social Fund. Interactive research is characterized by its collaborative approach in creating a change in practice, combined with a critical stance and development of theory (Svensson et al., 2015; Ellström et al., 2020). Mutual learning processes, across organizational borders, disciplines, and fields of practices are in focus (Johannisson et al., 2008; Ellström et al., 2020) to support the participants, as well as the researchers, in critically examining their own understanding (Svensson et al., 2015). Interactive research is part of the macro design rather than any specific research method or technique (Ellström et al., 2020). At the core is, “a two-way flow of problems and knowledge,” where not only the common, but also different interests of the participants and researchers are acknowledged. These activity systems can be seen as collective learning cycles producing common conceptualizations of the change process, through a joint analysis, aiming at going “beneath the surface” (Svensson et al., 2015, p. 353). Interactive research can be described as an approach within the action research family and, according to Eikeland (2007), the very core of action research is about radical self-reflection grounded in one’s own lived experience.

The project involved participants from the municipality making the actual changes in their work practice. The project organization contained a steering committee of directors; a steering group with managers from different departments; a project team of employees representing each group of participants, one project manager from the municipality and one from the university (the main author of this article). There was also a scientific board with six researchers from different universities and fields of expertise (the co-authors). In addition, there was the overarching steering from the European Social Fund.

During the process numerous events were arranged in order to communicate and disseminate the knowledge from the project. During the final phase, a pocket-booklet (see **Figure 1**) summarizing the learnings from the project was produced and a municipality-wide week held with presentations, happenings, and a final conference with an exhibition at the City hall.

### Participants

The data collected, upon which this article is based, derive from participants who took part in the collaborative learning process, constituting the heart of the interactive research project (to be presented in further detail below). The participants were white-collar workers from five different departments within the municipality: The City planning office ( $N = 8$ ), the Streets and parks department ( $N = 13$ ), the HR-department ( $N = 9$ ), the Cultural department ( $N = 16$ ), and the Environmental department ( $N = 12$ ). The participants were recruited on a voluntary basis and were initially reached through various information channels, such as presentations at department meetings, information at the organizational intranet, as well as many meetings with employees and managers spreading the word in their workplace.

From the start of the process 58 participants were enrolled including 14 men and 44 women from 27 to 65 years old. Apart from one participant, who explicitly wanted to be excused, another five fell out due to changes in their work situations (such as leaving their positions), while the others took part in the whole process. The professions represented included planning architects, administrators, HR-consultants, building inspectors, project managers, city planners, librarians, development coordinators, financial assistants, landscape architects, and communications officers. Experiences of a variety of workspaces were represented with participants having an individual office (14), a shared workspace for 2–3 persons (21), and a shared workspace for 4–15 persons (23).

### The Collaborative Learning Process and Qualitative Data Collection

The learning process was organized around seven so-called “learning modules” and six “research seminars.” *The learning modules* were arranged over half-days, with the First author of this article meeting up with groups of participants; usually five different groups with 6–14 persons in each. Most learning modules were repeated a number of times with each group of participants including numerous data collection heats in order to ensure everyone’s participation. In total 45 sessions encompassing qualitative data collection, took place. Each session entailed a check-in where everyone present commented their state of mind at the start, information-sharing about the project as a whole, followed by the processing of some specific questions and themes in reflective group discussions, alternated by various individual reflections and ideation-techniques and a final, individual check-out. In addition, “co-interviews” were conducted in the first and fourth module. This meant that the participants interviewed each other in pairs or threes, on the basis of a few preset, open questions. These, in total 51, co-interviews, as well as a total of 38 group discussions, were all recorded and transcribed. The first learning modules focused on the current ways and spaces of work. After that the participants’ self-managed, active experimentation and “testing” of bringing work outdoors took place during a 15-month period. The subsequent learning modules (from number four) were to follow up these experiences focusing on how working outdoors made them feel, what they needed and what





**FIGURE 1** | The pocket-booklet describing different forms of outdoor office work launched at the end of the interactive research project.

kind of places they used and preferred. *The research seminars* were made up by an introductory lecture, where the researchers involved (the co-authors) presented their research perspectives. The seminar continued with a group discussion, preceded by a “walk-and-talk” in smaller groups, about what had been learnt and could be taken into account for the process of exploring outdoor office work onward. See **Figure 2**, for an overview of the formalized learning process and their themes, as well as the data generated.

*The main data-set* contains material from co-interviews and group discussions during the different learning modules. There was also other material collected during the process which was helpful to further our understanding: A *mapping* procedure was to create an awareness among the participants about their work situation, to unbundle their work activities to see which possible parts could be tested/taken outdoors. A *mobile app* developed in dialogue with the participants enabled them to log their outdoor work endeavors and experiences. The app included a number of descriptive elements of the work situation outdoors including what kind of work activity, but also how many people were involved; whether it was mainly

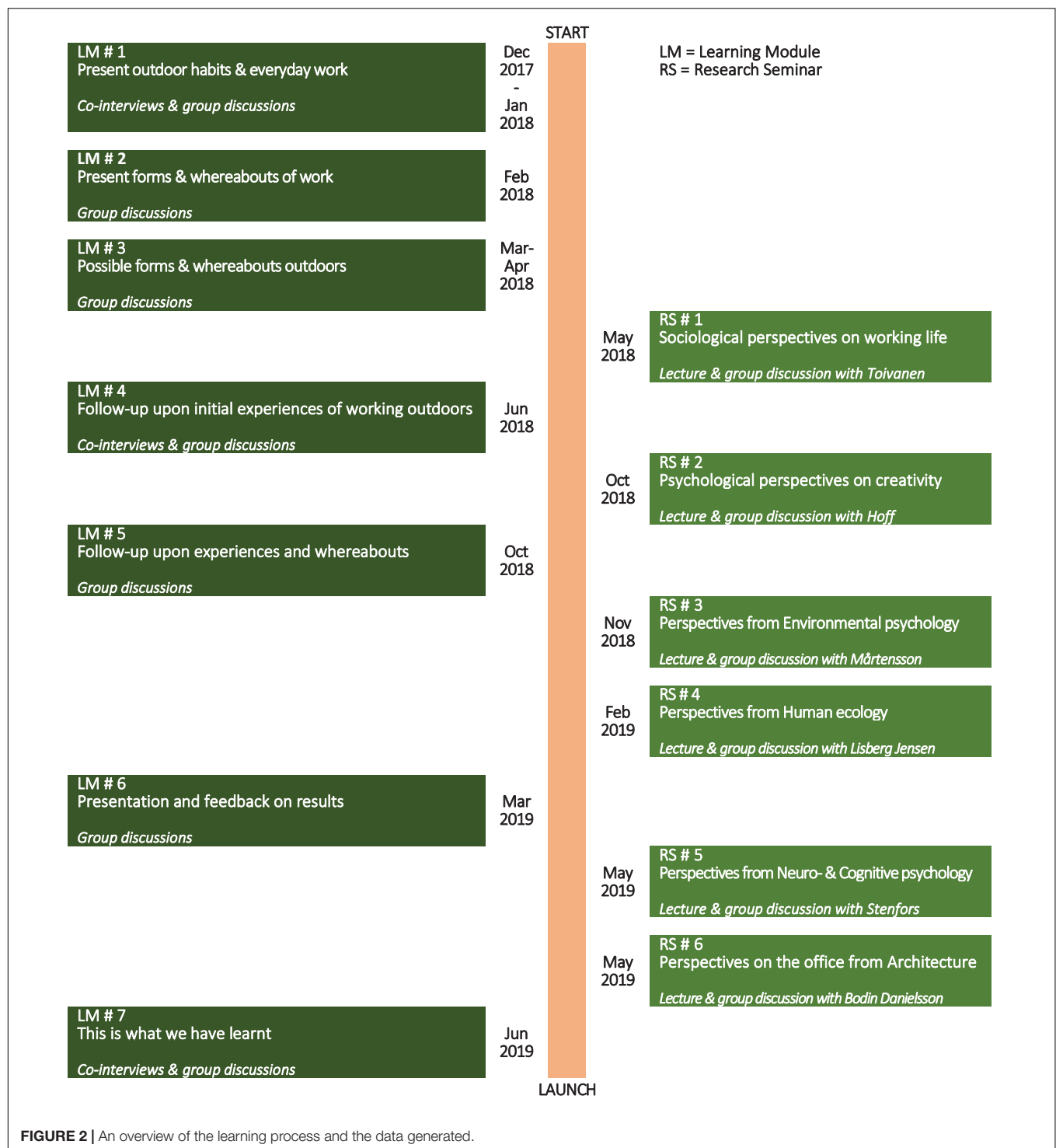
sitting down, standing, walking, or other; what the weather was like; what kind of outdoor setting (outside at the workplace, a park, a square, streets, etcetera); approximate time interval; in addition, there was an open space free for comments (see **Figure 3**).

In total over 700 individual outdoor work activities were logged, unevenly distributed among the participants. Many participants had a hard time keeping up the logging, as the outdoor activities gradually became more and more habitual.

## The Process of Analysis

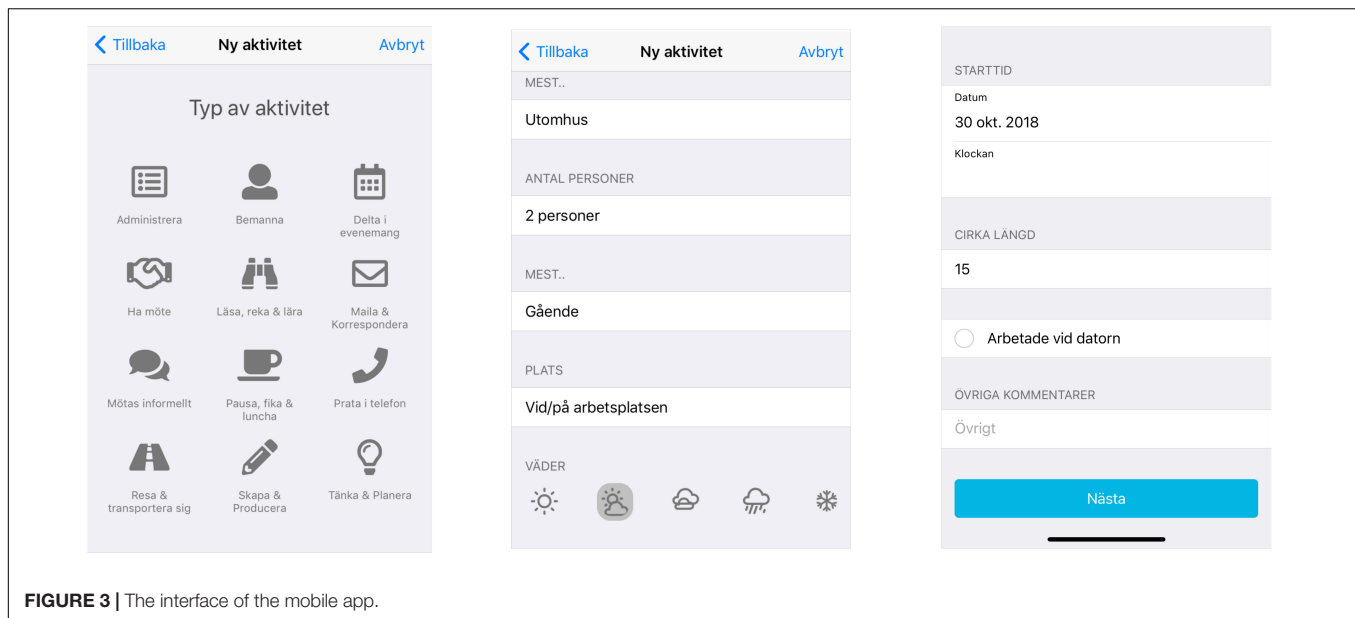
The learning cycles of interactive research entail continuous joint processes of analyzing (Ellström et al., 2020). The procedure with the learning modules and research seminars, and the participant's own, active experimentation in between, was set up and conducted in order to facilitate experiential learning (Kolb, 1984). Thus, the “real-life” experiences in the participants' everyday work setting were central, but so were the common reflections, discussions and conceptualizations, which sought to catch, analyze and draw conclusions from the same, by making the implicit, explicit. The process of





analyzing aimed at making everyone more aware of the underlying values, which govern actions (Argyris, 1976). Eikeland (2006b) points to the need to provide space for learning, and to facilitate “learning-to-learn”. He highlights the importance of an alternation between activities related to “on-stage performance”, where tasks and roles are performed in the work organization, on the one hand, and “back-stage reflections”,

where experiences can be critically analyzed and discussed, on the other. There needs to be an arena for encounters and dialogue between the researchers and participants, in order to organize the processes of collaborative inquiry essential to interactive research (Ellström et al., 2020). In the present project the learning modules filled this function. From a research point of view, the repetition of the learning modules



gave an opportunity of collaboratively analyzing, synthesizing, questioning, altering, and validating the preliminary findings, along the way. That is, during the process, the experiences of conducting work outdoors documented in co-interviews and group discussions, were also analyzed in a step wise procedure of qualitative analysis (Holsti, 1969). This focused on identifying statements referring to more positively and negatively valenced experiences, emotions, and feelings. Statements could occur in a variety of forms, such as a word, phrase, sentence, or paragraph. Categories derived from the empirical material have been further conceptualized after the end of the interactive phase of the research study.

The log kept in the mobile app have mainly served as a complement to the aspects brought up in the group conversations and co-interviews of the learning modules and was of value, especially for broadening the picture when it came to the identification of different forms of outdoor work.

## Ethics Statement

The project was conducted in accordance with Swedish national legislation. All data collected has been anonymized when presented and the data in the mobile app was untraceable to any certain individual. Participation in the project was voluntary and participants gave their informed consent. In the context and practice of action research, there are multiple ways of understanding and enacting ethics and while a further elaboration upon these falls outside of the scope of this text, some important elements and implications are discussed by Brydon-Miller (2012) as well as by Eikeland (2006a).

## RESULTS

The results will be presented in accordance with the three main questions guiding the interactive research project, about

different forms of bringing office work outdoors, how it is being experienced, as well as what conditions it requires that are of relevance for outdoor office work to happen and function well. A tree may be envisioned as a tentative metaphor for the various results: The main branches are then different forms of doing office work outdoors; the fruit illustrating what experiences outdoor office work may bring about; the soil representing the sociocultural dimensions, within which the structural organizational conditions – the trunk, that is – need to be firmly supported through its roots; and finally, there is the surroundings, illustrating the physical environment as a context for outdoor office work.

## Unbundling Opportunities for Action

At the outset of the learning process, doubts were expressed by participants as to whether it would be doable to bring any substantial amount of work activities outdoors. The hesitation was mainly attributed to the fact that they needed various things at their workplaces and most of all they thought about the dependency upon their personal computers and access to ICT-systems for nearly everything – and that it probably would not work well to bring it/their laptops with them, outdoors.

Against this background, the mapping of participants' activities during an ordinary work week served an important purpose in unbundling the work and opening up for finding opportunities of bringing some of it outdoors. More concretely, mapping resulted in the following twelve typical work activities being identified:

- Thinking and planning (solving problems, getting ideas, analyzing, structuring thoughts, etc.)
- Creating and producing (texts, drawings, presentations, other material, and artifacts)
- Talking on the phone

- Participating in events (workshops, conferences, courses, etc.)
- E-mailing and corresponding
- Administrating (reporting, ordering, etc.)
- Reading, scouting, and learning (activities that were about “taking things in”)
- Holding/attending meetings (planned, formal ones)
- Meeting informally (unplanned, smaller ones, spontaneous chats included)
- To man/crew (such as the helpdesk at the library)
- Traveling and transporting oneself (back and forth to different meetings and events)
- Taking a break, lunch break or “fika” (Swedish word for tea or a coffee break)

These categories were, and are not, to be regarded as stand-alone concepts, but rather as a working material facilitating the planning and communication of the outdoor work activities, also making up a framework for the experience registering in the mobile app. Thus, the main point was for the concepts to be clear and agreed upon among participants and researchers. Not far into the process, reflections about the current situation, the mapping and the planning that took place during the first four months of the process (learning module 1, 2, and 3), led up to a sense of heightened awareness among the participants, regarding what they did, what they needed, appreciated – and not – in their habitual whereabouts of work.

## Forms of Outdoor Office Work Identified

Based upon the participants’ active experimentation of bringing parts of their typical work activities outdoors, logging in the mobile app, as well as a continuous follow-up along the process, nine forms of doing work outdoors were identified and categorized into four main kinds: collaborative work activities, individual work activities, outward-facing work activities, and in-between work activities.

### Collaborative Work Activities

#### *Walk and talk*

Taking a walk in order to talk was one of the most popular work activities to do outdoors. This most commonly used outdoor form of work is – more or less – well known and spread before and outside of this exploration. It was perceived as easy to make happen, as it did not require any special plans or arrangements. All that was needed was a nice, preferably green and calm enough path for walking, in proximity to the workplace and some comfortable shoes and clothes suited for the weather. These were appreciated for breaking up an otherwise sedentary workday, and for contributing to feelings of enhanced openness and ease in the conversations, as this participant expressed it:

*“I feel that the conversations become really good, especially when one walks and moves about (...) It is as if something extra happens...”*

The “Walk and talk” was usually taken in pairs, or maybe in threes, but could also involve more participants when

constituting parts of bigger meetings and events, whether held indoors or outdoors, as in the next form for outdoor office work.

### *Outdoor meeting*

Not only meetings in motion were performed outside, but also regular “sitting meetings,” as well as more formal and extensive ones. “Outdoor meetings” could be organized much like indoor meetings but were conducted under bare sky (or under a pergola). It could be a couple, or a group of colleagues, locating their meeting to the inner courtyard, or just in front of, their workplace, or elsewhere in the surroundings, as in a park. Clearly, the smaller meetings were closer at hand, as this participant comments:

*“Often, meeting two by two has been the easiest, where you do not need so many aids. If one is to go things through, demanding that one has access to a lot of files and such, then it has been easier to do it inside. But sometimes you mostly need to sit down and talk something through, or plan something and then it has worked well to take it outdoors.”*

Outdoor meetings could however also be various forms of department- and unit meetings, project meetings and workshops, as well as meetings with external collaborators and guests. Sometimes these meetings were organized very much in the same way as indoor meetings with people mainly sitting down. At other times they also contained walk and talks, to and in a nearby park, as well as standing and sitting gatherings. In one case, it was all prepared with an overall program, a map and particular questions for the various sessions. When it came to these bigger and more formal outdoor meetings it was clear that they demanded more preparation and planning than the ordinary (indoor) ones. However, even so, they showed to hold a potential, as commented upon by one participant:

*“We have had one (...) but, I actually think that we can have more departmental meetings outdoors. Because everyone was really gratified.”*

### Individual Work Activities

#### *Outdoor office*

One form of bringing work outdoors was that of participants simply going outside by themselves, sitting down, doing things basically in the same way as inside of the office places, with or without their laptops.

Participants’ views upon using the laptops while practicing “Outdoor office” were two-tiered. One, meaning that laptops should be left inside, either because the quality of the visuals/the screens were not sufficient, or because they stated that detaching themselves from the computer and constant connectedness was the whole point of going outdoors. The other, finding it quite alright to work with the laptop outdoors, as long as the screen was good enough and as long as it was possible to find a place to sit down, with sufficient shade under a parasol, awning, or the like. A few stated that they were so dependent upon their computers and ICT-systems for everything that they would have a hard time to find ways of working outdoors at all, if they could not make it work with their laptops, which was the case for this participant:

*"I started by sitting with sun-glasses and the computer, but realized that it did not work, so I folded up the parasol and then I could take my sun-glasses off. Just enhanced the light on the computer and then it went perfectly well. I think that I sat there for three, four hours."*

Some form of roof protecting from sun and rain, as well as a place comfortable enough to sit down and, when bringing it – a table for the laptop, were some of the obvious needs brought up. One also frequently mentioned aspect was that of wanting something behind one's back when working to avoid the unwished-for feeling of being watched from behind.

### Outdoor reading

Bringing something to read, or go through, outdoors was perceived and described as an especially simple and intuitive way of breaking a piece of work out and thereby making outdoor work happen. Therefore, it was found to deserve a form of its own, even if it could be seen as a variant of doing "Outdoor office."

### Think walk

Having a walk, in order to think, was another way of conducting work outdoors. The purposes were many and varied among participants. They took a "Think walk" in order to structure their thoughts, to plan, to analyze, to reflect, and solve a particular problem or to just let their mind wander, get inspired and develop their ideas. Just like with "Walk and talk" the main needs in connection to this form of outdoor work was access to, and knowledge about, good walking paths and routes, away from traffic and other noisy and potentially hazardous elements.

## Outward-Facing Work Activities

### Outdoor Learning

This form for outdoor work has a well-known base and sibling in outdoor pedagogy, in educational settings. In this context – of work, it was mainly seen as a way of experiencing things and places in the city, at first hand – and was used both individually and in groups. "Outdoor learning" became somewhat of a reminder that there may be good reasons to question the increasing habit of (always) turning to information, pictures and maps on the internet, instead of leaving the office to get a talk with people and to see and experience different sites and artifacts for oneself, when possible. This form of outdoor work included various types of field trips and study visits and may contribute not only to learning, but also to the development of relations, as this participant described:

*"Yesterday, we had a unit-trip (...) where we walked and saw different things (...) and were outdoors. And it was so much energy that it gave and joyfulness and feeling of community. So, I believe in outdoor activities, where one experiences the same things and not just sit inside four walls."*

### Pop out service

The typical work activity "to man/crew" – that is, to be available at a certain place and responsible for some service to the public, may be seen as impossible to bring outdoors. However, some participants actually took their operation outside of the building, or on a tour. The examples were not many, but still a potentially important way of moving work outdoors. One of the workplaces

was a library situated in an area where shootings were a recurring hazard. There, they brought their helpdesk – i.e., themselves, on a blanket – out, in the middle of the square right outside the premises of the library. By doing so, they found that people who did not normally come inside to the library, met up and joined their activities. Thus, lowering the threshold to interact with the organization and contributing to a sense of community and safety.

It may be added that the outward-facing dimension showed to be present in other forms of outdoor work as well, as spending time and moving about outdoors led up to unexpected and unplanned for meetings. One of the participants, who had access to one of the most favorable outdoor areas right outside the workplace regarded this as a positive aspect of it and described how individual outdoor work activities or meetings can become a form of Pop out service:

*"Due to the fact that we have begun to spend more time outdoors, it has led to more informal meetings. So, we have actually become a kind of, not attacked I should say, but actors move about in the area and then they have seen us and thereby started conversations, also which have become new meetings, in a positive way. Whom, if we would have been sitting indoors, we never would have encountered. So, in some way it makes us visible in the neighborhood where we operate."*

## In-Between Work Activities

### Outdoor transportation

Transporting oneself – going from here to there, was an integrated part of many of the participants' work week, which almost *per se* meant some contact with the outdoors. Still, the project participation led to the logic of getting to places in the fastest possible way (by car or bus) being questioned. The possibility and point of instead using some kind of "Outdoor transportation," such as going by bike or walking was raised. This change of mode in some cases turned the transportation into "Walk and talks," and even "biking meetings," in a couple of cases.

### Outdoor break

Going outdoors when having a break was the most common way of getting outside of the office building during the workday, both before and at the end of the project. However, the practice of taking an "Outdoor break" became accentuated and lifted as more important than before.

To sum up, the described forms of working outdoors were embraced and used to varying extent among participants, possibly due to a diversity of a number of factors, such as personal preferences, workplaces, outdoor environments, work roles, and professions. Some activities were closer at hand and occurred more frequently, such as "Walk and talk" and "Outdoor reading," while others were more dependent on weather and other attributes of the physical environment, especially those performed sitting down for a substantial amount of time. However, every one of the typical work activities identified to be possible to do outdoors were practiced by some participants, though more or less frequently. A common reflection among participants was that the process made them conscious about their room for maneuver. Consequently, despite the initially



anticipated limitations, after the 18-month learning process of reflection, active experimentation and follow-up discussions, it was evident that a wide range of work activities could be brought outdoors and serve several purposes, both individually and together with others.

## Experiencing Outdoor Office Work

How did participants experience working outdoors? The qualitative thematic analysis of the group discussions and co-interviews provided a more detailed understanding of how participants experienced their outdoor work as rewarding and/or problematic. The analysis identified 12 subthemes that were organized into five main themes. The participants experienced wellbeing and recovery, autonomy and distance, enhanced cognition, improved communication and relations and finally also some inner resistance and illegitimacy.

### Well-Being and Recovery

#### *Feeling good*

When asked to recollect how spending time outdoors in general made them feel (during leisure-time, vacations or in everyday life) participants frequently expressed things like “it feels good” or “great” and the same adjectives continued to come up frequently when asked about how they experienced working outdoors. Apart from terms such as “good” and “great,” words like “lascivious,” “happiness,” “lively,” “lovely,” “enjoyable,” “very, very nice” were prevalently used.

#### *In contact with nature*

Another very prevalent theme was a feeling of noticing and being in connection with the shifting outdoor environment, especially with nature phenomena. Participants expressed that it was nice to see daylight, feel the grass, the scents, the sun, the heat, the sounds, that they felt like one with nature (and even the seagulls!).

#### *Energized*

Feelings of alertness were also frequently mentioned. The participants stated that they felt more alert, got more energy, better endurance, focus, and concentration – also spilling over onto when going back indoors. Some participants also mentioned feeling more productive, when working outdoors.

#### *Calm*

This theme comprises many expressions for a feeling of becoming calmer, that it was perceived as de-stressing, but also much about the need to let the many, constant impressions out, rinsing ones’ head, get rid of bad energy, as well as comments about better sleep after spending more time outdoors.

### Autonomy and Distance

#### *Free and empowered*

Many were those mentioning feelings of freedom and autonomy, in terms of “when outdoors I totally decide for myself” and also comments about that it was a good feeling to get/feel trusted by the managers, as some of the participants did, while others did not. One of the latter expressed that she more and more felt like “an animal in a cage,” when sensing that it was not accepted to leave the office for an outdoor work activity.

#### *Given a chance of getting away*

This is about the chance of getting away, getting some distance and sometimes being on one’s own, not being disturbed, disrupted, and getting a change of environment.

#### *Able to breathe*

Working outdoors was mentioned as a way to get oxygen and being able to breathe, both in a literal and more symbolic sense. There were also examples of participants taking a deep breath, when trying to recapture what the outdoors made them feel.

### Enhanced Cognition

#### *Able to think*

This theme was made up by many comments about the outdoor work activities giving concentration and better focus, especially the “think walks” gave space for thought, such as mental preparation, reflection, for thinking things through, solving problems, structuring, and batching work activities and assignments.

#### *Inspired and creative*

The feeling of being inspired and more creative was often expressed in those very words, but also as seeing other things, new perspectives, new ideas and generally opening the mind up.

### Improved Communication and Relations

#### *More open and equal conversations*

Descriptions of more relaxed situations, more laidback, more open and deeper conversations and a different, better dialogue were reoccurring. And also comments about other relations and new constellations, a sense of community by experiencing common things, as well as perceptions of more equal relations. These dimensions were often brought up in relation to experiences of walking (beside one another) and talking, both when it comes to the openness of the conversations and to a lessened presence of hierarchies. One participant felt that she had a hard time finding a good way of describing it, but put it like this:

*“When you walk together you have a different type of dialogue than when you sit opposite from one another and talk (. . .) I think that it becomes a kind of, I don’t know, equal, or that you – I, at least – feel that one gets a deeper dialogue.”*

### Inner Resistance and Illegitimacy

#### *Difficulties in changing habits*

The participants experience some difficulties and more or less practical hindrances for bringing work outdoors, but most of all they mention the difficulty in changing habits.

#### *Guilt and expectations from others*

Spending time outdoors while working evoked feelings of guilt and many were the comments on the illegitimacy of “sitting outdoors – enjoying oneself.” They also pondered about whether it was themselves mainly, or others (managers and maybe colleagues) who upheld these norms. This is how one participant expressed the emotion:

*“I do the very same work-task as I would have indoors. But, I feel a bit guilty. As if it is a bit mischievous to go outside. And I don’t know why. Is it me thinking like that?”*



Apart from this explicit reflection about where norms reside, there were many comments about their existence, for example expressed in terms of: “I feel a bit guilty,” “frivolous,” “as if one escapes,” “I feel resistance from my inner norms,” “there is an unwritten rule that you do not work outdoors.”

## Conditions for Outdoor Office Work

One of the most prominent possible obstacles to working outdoors, brought up by the participants at the beginning of the learning process, was that of the Swedish weather – that it would be too cold, rainy or too windy most of the time, for outdoor office work to be attractive and well-functioning. As mentioned previously, participants also anticipated that it would be difficult to be away from the office, not having direct access to various work-material and technology – especially their own computers and ICT-systems. However, even if these were factors of importance for what, when, how often and with what ease work activities could be pursued outdoors, there were other factors emerging as even more cardinal; both when it comes to physical, as well as sociocultural and structural organizational conditions.

### Physical Conditions

#### *Proximity to a pleasant outdoor environment*

For outdoor work to happen at all, access to an attractive and well-functioning outdoor environment was of utmost importance. It basically needed to be right outside the workplace, if it was not to be experienced as inconvenient and/or too time consuming to alter the normal indoors with outdoors. Depending on work activity, different types of settings were needed and appreciated, however with some familiar characteristics of being green, lush, and tranquil enough. Secluded places were wanted for sitting down by oneself, or when gathering for an outdoor meeting, while a “think walk” or “walk and talk” required nice and easily accessible walking paths, on safe distance from traffic and noise.

#### *Infrastructure fit for the purpose*

Outdoor work encompassing sitting down, such as “outdoor office,” “outdoor reading,” and “outdoor meeting,” required some infrastructure and artifacts designated to support the activities they had planned for. These included both physical, technical and/or symbolic ones, such as shields for rain-, wind-, and sun, meeting arrangements, comfortable seating and appropriate tables, some kind of screen/board for sharing visualizations, and also access to Wi-Fi, power outlets and, also things like blankets and coffee. Outdoor office arrangements were also asked for to legitimize outdoor work activities, just like “walk and talk-maps” were wanted both for practical/informative and more symbolic reasons.

### Sociocultural and Structural Organizational Conditions

#### *Apt and clear policies, rules, and regulations*

There are rules and regulations to consider related to outdoor work, such as work safety, insurances and health, as well as HR-policies, management- and reporting-systems. Drawing upon the question-marks brought up by participants, now and

then, throughout the learning process, there was an ambiguity surrounding these formal issues as to whether they, in their existing forms, actually admitted this kind of flexibility becoming institutionalized, or not (after and outside of the interactive research project, that is).

#### *Leadership based upon trust*

Furthermore, the perceived attitude of managers toward flexible working conditions in general and the idea of bringing work outdoors specifically, were found to be of great importance for the participants as a barrier or enabler. The value of managers themselves suggesting, for example, a “walk and talk,” could not be overstated, from a policy perspective. Another most important dimension according to the experiences of participants was that of leadership style; whether it was predominantly based upon a need of (direct) control, or trust. Leadership built upon trust, admitting room for action and autonomy in the everyday work situation, was seen as absolutely essential.

#### *Open-minded and supportive culture*

Culture was a topic frequently revisited, more and more often, as the learning process proceeded. The perceived attitude and culture in the closest work group was of importance for participants, whether they felt that it was accepted or not to leave the office for a while. One participant expressed it like this:

*“I reflected a bit upon what it is. Why your colleagues a kind of look twice when you are on your way out. Is it that they think that one is more ineffective when going outdoors. What is one afraid of? That you will shirk work. . . that you will not be as effective?”*

Also, the overall organizational culture was discussed and brought up as an important factor in this context. Values and norms about work emerged as one of the – if not the one – most important aspect hindering outdoor work activities to happen and/or be incorporated into everyday working life. With reference to the feeling of guilt, witnessed and shared by many, participants asked themselves and one another: How pleasant is work allowed to be?

As shown above, there are both elements in the physical setting as well as sociocultural and structural dimensions of importance to understand and develop, when integrating urban outdoor spaces into everyday working life. Thus, there are barriers and challenges of different kinds to overcome. Basically, all of the mentioned facilitating factors and needs can be regarded as crucial in order for outdoor office work to take place, be attractive, well-functioning and beneficial, while the lack of them, or their opposites were brought up as factors standing in the way.

## DISCUSSION

The general results of the presented project show that there are pleasant experiences from spending time outdoors and having contact with nature also in the context of office work. Benefits from being outdoors have been found in many other studies in other contexts (Mangone et al., 2017; Twohig-Bennett and Jones, 2018).

The findings of the first research question about *identifying work forms*, was that nine different work activities may be brought outdoors for various purposes, both individually and together with others, for activities facing outwards (as when providing the service outdoors) and for transporting oneself or having a break.

The second research question aimed at understanding *how outdoor office work is experienced*. The findings show that when working outdoors participants experienced predominantly positive feelings of wellbeing and recovery, autonomy and distance, enhanced cognition, improved communication and relations, but also feelings of guilt and illegitimacy.

The findings of the third research question about *identifying contextual conditions* of relevance for outdoor office work clarified that proximity to attractive outdoor greenspaces and walkable surroundings are important for outdoor work to happen and moreover some physical facilities may be needed for it to function well, such as furniture, wifi and sun-/rain-/windshields. In addition, sociocultural and structural organizational conditions related to policies as well as norms about where work should take place were central. An organizational culture and a leadership that facilitated outdoor work was decisive for the ability of developing such work habits.

## Well-Being and Functioning in a Knowledge Intense Working Life

The knowledge intense and boundaryless character of today's office work (Kompier, 2006; Allvin et al., 2013) entailing high cognitive demands, means that cognitive capacities are vital in order to manage work. At the same time, a high load of intellectual work demands can increase the risk of cognitive stress and stress related mental health conditions, commonly characterized by cognitive dysfunction in the domains of executive functions and memory which are important not least in order to manage and perform knowledge work (Stenfors et al., 2013a,b). It is as such imperative to develop and enable the utilization of workspaces and work practices which support and replenish these cognitive capacities and support mental health and wellbeing. In the present project, results show that enabling and incorporating outdoor work among office workers/employees can serve such purposes (i.e., support different aspects of cognitive and mental health and functioning) and thus support a more sustainable work life, provided that qualitatively suitable outdoor spaces were available in close proximity to the workplaces. Some of the key qualities sought for in an outdoor workspace were greenspace, tranquility, and walkability. More specifically, outdoor office work was by the participants experienced as beneficial from the aspects of wellbeing, for restoration of cognitive capacities, and for enabling distance to cognitively and emotionally taxing contexts. Outdoor work opportunities thus appeared to play a role in freeing up cognitive resources required for more demanding problem solving, planning, and processing, as well as allowing an expansion of the mind in terms of reflective thinking.

The experienced benefits of working outdoors expressed by the participants corroborate the systematic findings of previous

controlled studies on how especially outdoor nature contact can facilitate cognitive restoration and better executive cognitive performance (Stenfors et al., 2019), in line with Attention restoration theory (Kaplan, 1995), which also support reflective and creative thinking (Williams et al., 2018).

However, it is worth noting that optimal environments with regard to performance on standardized tasks may differ between demanding executive cognitive tasks – which are more sensitive to stress and cognitive overload via e.g., distractors/stressors in the environment (e.g., Shields et al., 2016) – versus monotonous tasks with low executive load. For example, Jiang et al. (2021) found that performance on a simulated driving task during a prolonged time (90 min) was optimal in a simulated freeway landscape with moderate levels of greenness and more complexity, rather than higher greenness and less complexity. That is, for such types of long-duration monotonous tasks, the environment should provide an adequate level of stimulation (that is, not being over-relaxing) to keep an adequate level of arousal, according to the authors, in order to perform the task optimally. Arousal *per se* was however not measured in the study.

It is furthermore worth noting that the optimal level and type of environmental stimulation when performing different tasks is individual and context dependent, where the sense of personal control is important (Shields et al., 2016; Tsai et al., 2019). Hence, the individual's control over the physical and social working environment is vital, as discussed further below.

The boosts in wellbeing and feelings of connectedness with nature, which participants experienced while doing office work outdoors (feeling good, energized, calm etc.), also mirror the positive effects of outdoor nature contact found on different aspects of positive affective experiences in prior work (e.g., Kuo, 2015; McMahan and Estes, 2015). Furthermore, outdoor office work was reported to enhance the social climate and different types of communication (open and equal conversations) with a positive bearing on both the work itself, as well as social relationships – another well-known key factor to a health-supporting work situation (e.g., Stansfeld and Candy, 2006).

## Personal Control

The beneficial experiences of outdoor office work could be interpreted also from a job control perspective, as conducting work outdoors might give an increased sense of control. As the participants expressed under the themes “wellbeing and recovery,” and “autonomy and distance,” working away from unwanted taxing stimuli in the office gave opportunities for recovery and to be undisturbed. It is well-documented that the possibility to withdraw in order to concentrate or have a private meeting is an important aspect of job satisfaction (Bodin Danielsson and Bodin, 2009; Bodin Danielsson and Theorell, 2019). The general urge to gain some sense of control in the work situation is often related to the combat of different indoor stressors, but applicable also to the evaluation of the surroundings regarding its feasibility, accessibility, and pleasantness (Lindelöw et al., 2014). The major environmental stressors in open office environments are visual and sound disturbances (Sundstrom, 1986; Jahncke et al., 2011) and crowding (Langer and Sægert, 1975). They have negative impacts on various outcomes,

e.g., employees' health and well-being (Dean et al., 1975; Wallenius, 2004).

The project participants experienced outdoor work to facilitate "enhanced cognition" in several ways, which can be contrasted with the fact that indoor open plan offices have been shown to have negative influence on employees' ability to concentrate and be productive (De Been and Beijer, 2014). Having a sense of control is in stress research considered to reduce stressful events (Lazarus, 1966). At work the individual's control depends on various factors, for example on the ability to plan and execute work activities (Karasek and Theorell, 1990), but also on control over the physical work setting. Among office workers it has been found that the individual's sense of control over physical aspects of the physical environment mediates the relationship between perceived distractions and perceived job performance (Lee and Brand, 2010), something which might be a reason for expanding possibilities for outdoor office work in the future.

## Creativity and the Need for Space and Inspiration

Creative performance appears also to benefit from outdoor work as expressed by the participants ("inspired and creative"). The theme "autonomy and distance," which also relates to the need for control (and solitude) is another example of how outdoor office work can play a role for creativity. With many employees sitting in open plan offices, the lack of spaces for solitude, reflection and silence might hinder creative thinking (Stokols et al., 2002; Hoff and Öberg, 2015).

The participants' experiences of working outdoors can in several other ways be related to what is described as conditions for creativity, which include both psychosocial and physical aspects. Organizational psychologists have stressed psychosocial climate aspects such as, freedom, openness and playfulness as some of the essential dimensions of a creative work climate (Isaksen et al., 1999). Similar conceptions were found in the participants' descriptions of outdoor work, for example in the subthemes, "free and empowered," "open and equal conversations," and "inspired and creative." A fourth dimension stressed by Isaksen et al. (1999) is idea time, and that could be connected to the "autonomy and distance" theme.

Just like the participants reported that outdoor work made them feel "inspired and creative," research literature has demonstrated that physical outdoor aspects affect the creative process in several ways (Atchley et al., 2012; Oppezzo and Schwartz, 2014). Oppezzo and Schwartz (2014) found in an experimental study that participants who completed several types of creativity tasks outdoors outperformed those who did the tasks indoors.

The response theme "wellbeing and recovery" goes in line with another part of the creative process, a phase in which slowing down is essential. The creative process consists of several phases (Cropley and Cropley, 2010). After problem definition, a phase called incubation takes place, which means taking a break from active work and shifting to less focused cognition. During

incubation inspiration is sought and unconscious processing takes place (Dijksterhuis and Meurs, 2006), something which helps the creative team before deciding which ideas to implement. Some part of the outdoor working time of the present participants might have functioned as incubation.

## The Landscapes of Outdoor Office Work

For outdoor office work to happen and function well there needs to be access to the particular "affordances" office-workers look for, the attributes which make it feasible to carry out their tasks and the characteristics of a landscape which make it worthwhile to move their work outdoors.

Several of the identified positive experiences of outdoor office work in the present study, which are important for well-being and functioning in a workplace context have also been highlighted from a design perspective. For example, Ulrich's Supportive Design Theory (Ulrich, 1991, 1997) suggested primarily three health supporting design characteristics which serve to reduce stress and enhance recovery. These characteristics include those that facilitate and enable a sense of control, social support, and positive distraction (Ulrich, 1991, 1997). Jiang et al. (2019) further proposed to add the health supporting characteristic of facilitating and providing opportunities for physical activity. Relating to Supportive design theory, the current study findings suggest that the availability of attractive outdoor spaces (including greenspace), is an important factor for people to 'get out' during the workday and through this get more physical activity and stay less sedentary during the workday. Furthermore, well designed outdoor spaces around the workplace also serve to enhance the opportunities for a personal sense of control (i.e., providing more spaces to choose from), social relationships and support, as well as providing positive distraction (Ulrich, 1991, 1997; Jiang et al., 2019).

The overall challenge of planning and design would be how private, semi-private and public places, part of the cityscape in the surroundings of office buildings, can turn compatible with workers' multidimensional aspirations to good workspace, including diverse practical requirements in line with their work tasks. Shelters of wind, sun and eyesight from behind, are some of the basic requirements and if the sites in addition to this are lush, green and tranquil they might be able to create an "outward pull" in the daily life of the organization, making the staff motivated to make some effort to move some of their work-tasks outdoors.

What we know from earlier research is that there are combinations of green and built elements which together form the urban sites commonly preferred and housing the restorative qualities (Kaplan et al., 1998; Tenngart Ivarsson and Hagerhall, 2008) which people tend to look out for. Such "comfortable design" emphasizes the easy access to an outdoor environment containing enclosures, conveying feelings of safety and with good possibility to visual orientation (Bengtsson and Grahm, 2014).

However, the participants also pointed out the role of more active interaction with the built and green cityscape when they mentioned pleasant nature scents and noisy seagulls, while

having an “outdoor meeting” in the inner courtyard, or during active transport to destinations in other parts of town. This highlights the possibility of practicing a more place-responsive approach (Mannion et al., 2013) to outdoor office-work in the future, in which the surroundings are more actively used to stage an outdoor workday by drawing on the resources of people and places; for example, by arranging outdoor meetings, instead of or in combination with digital communication.

Participants’ feelings of vitality and being energized by outdoor office work may be associated with having contact with nature, but could also be due to being more active at large (Roe and Aspinall, 2010). The combination of physical outdoor agility and mental agility during outdoor stays might facilitate social, self, and emotional regulation processes in the transactions with place (Korpela et al., 2001; Mårtensson et al., 2009). A unique cityscape with its green, blue and built environment can contribute to attractive destinations and places in which people can stage meetings or find room for episodes of social or solitary work. This is well in line with the walkability literature discussing how urban temporal policies can be developed to get walks integrated into the everyday lives of urban dwellers by making the city, not only feasible to cross, but create routes that are safe, comfortable and even pleasurable (Lindelöw et al., 2014).

The compatibility of available outdoor spaces with the needs and current work task demands is a complex issue intertwined in a more general question of how to create livable urban environments. In accordance with the Urban Agenda Platform (2020) the planning for outdoor spaces needs to go hand in hand with the development of urban biodiversity and other ecosystem services (Gunnarsson et al., 2017; Hedblom et al., 2017).

## Limitations and Future Research

There are some limitations regarding the present research, such as the relatively limited number of participants involved in the testing of outdoor work possibilities. The participants came from several different departments, but they all worked in a municipality in southern Sweden. Future research needs to investigate whether the nine forms of outdoor work activities identified in this study need to be expanded in contexts with other cityscapes and weather conditions. Applying other approaches could give clues of the effects of outdoor office work. The experienced benefits of working outdoors should be corroborated systematically, to better understand their impact on the employees. Finally, research needs to further investigate the physical as well as sociocultural and structural organizational prerequisites of office work to better understand how outdoor work environment, leadership and culture may foster outdoor office work and overcome obstacles, such as indoor habits and norms.

## CONCLUSION

The present study contributes with new insights into how outdoor office work may be done—what works well versus less

well; how employees experience outdoor work – benefits and hinders; and what conditions are necessary to fulfill in order to make it happen.

According to participants’ experiences, outdoor office work appears to support wellbeing, recovery, autonomy, enhanced cognition and communication which in their turn might play a role in work productivity. It seems to offer employees a strategy to increase personal control and give support to different aspects of cognitive and mental health, functioning, and creativity as well as improving social relations. Outdoor office work can thus contribute to and support a more sustainable and innovative working life, provided that qualitatively suitable outdoor spaces are available near the workplaces. Some of the qualities sought for in an outdoor workspace were green and lush places to get tranquility for sedentary work and walkability for work in motion. The conditions also included facilitating sociocultural norms and structures to encourage outdoor work.

The results of the study indicate how outdoor office work, in many different ways and dimensions, can contribute to a more sustainable working life. Furthermore, the barriers to a more productive and health promoting outdoor work life appear to be more related to sociocultural factors, than to practical issues. It is therefore imperative that leaders, urban planners and policymakers collaborate and show the way out.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

CPT was in charge of the project, contributed to the conception and design of the work, arranged the learning modules, collected, analyzed, and interpreted the data for the work, and drafted and revised the manuscript. ELJ and ST contributed to conception and design of the project, participant lectures, drafted and revised the manuscript, and supervised the study. CS contributed to the conception and design of the work, held participant lecture, interpreted the data for the work, and drafted and revised the manuscript. CBD, EH, and FM contributed to the conception and design of the work, participant lectures, and drafted and revised the manuscript. All authors contributed to the article and approved the submitted version.



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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Influence of Perceived Environmental Quality on the Perceived Restorativeness of Public Spaces

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Parks and town squares can play an important role by offering spaces for cognitive restorativeness in urban contexts. Therefore, it is important that these spaces be designed in a way that encourages restorativeness. Indeed, their perceived quality should motivate users to stay and take advantage of them. Yet, it is not clear whether perceptions as to the quality of these spaces is relevant in promoting restorativeness. Thus, the aim of this study is to analyze whether elements of environmental quality perceived by users of public spaces favor restorativeness both in parks and squares. Environmental and social aspects are taken into consideration, since restorative experiences involve cognitive and physiological recovery, as well as a component of interaction with the environment. In this research, 519 users of 32 urban public spaces—town squares and parks—on the island of Tenerife (Spain) participated. Participants evaluated these spaces using four dimensions that focused on spaces' perceived environmental quality: design of spaces, care of spaces, social interaction, and presence of sensorial elements. Additionally, we evaluated the perceived restorativeness of each space. The results showed that the design of spaces, care of the spaces, social interaction, and presence of sensorial elements explain the variance in perceived restorativeness, although with different weights for parks and squares. We found that perceived quality of a space is a key predictor of its restorativeness. This means that maintaining parks and town squares is a relevant task given that they contribute to reducing cognitive overload, increasing sustainability, and facilitating health care in urban settings.

**Keywords:** restorativeness, public space, environmental quality, parks, town squares

## INTRODUCTION

Today, more than half of the world's population lives in cities, and forecasts point to an increase of three billion by 2050 (UNPE, 2018). However, this growth could lead to socio-environmental problems such as pollution, waste production, increasing inequality, and declining quality of life. It is therefore essential to increase the efficient use of resources, sustainable land distribution, and the protection of natural ecosystems in cities. In this context, urbanization has the potential to mark a new balance between economic growth, social welfare, and

environmental care; the pillars of sustainability (UNPF, 2014). Among the objectives of Agenda 2030 on Sustainable Development, the 11th is focused on actions in increasingly urbanized societies to guarantee a healthy life (physical, social, and mental) that promotes well-being and favors the development of more liveable cities. Promoting equal access to the benefits arising from the use of public resources is also among these objectives. These benefits include the cognitive restorativeness that occurs when we interact with natural elements.

In order to alleviate increasing inequality and enhance environmental quality in cities, it is necessary to maintain and improve public spaces. It is therefore vital to understand how users of parks or public squares value these physical environments to contribute to the improvement of urban policies, planning and design, as well as the architecture of urban green spaces. Romice et al. (2017) pointed out that the professionalization in design has generated a belief among the population that problems related to urban design should be resolved by policy, legislation, and management. Against this background, Dempsey and Burton (2012) indicated that community movements, supported by research programs on space maintenance, can connect citizen participation with the design and management of open spaces. Therefore, more evidence is needed on how environmental characteristics perceived by users can affect the restorative capacity of open urban spaces.

## Restorativeness in Public Spaces

The benefits of contact with nature have been repeatedly established in both natural and human-made settings (McMahan and Estes, 2015; Honold et al., 2016). There is a need to return to the natural and, failing that, to increase opportunities to access the benefits of nature in urban contexts (Staats et al., 2010; Emfield and Neider, 2014). Moreover, in perceptions of public spaces, there is great consensus that restorativeness is associated with certain psychological benefits (Hartig et al., 2003; Herzog et al., 2003; Galindo and Hidalgo, 2005).

Restorativeness is defined as a process by which diminished psychological resources, often caused by stress or emotional fatigue, are restored (Hartig et al., 2001). The restorative effect is evidenced by attention and specifically by directed attention, since it involves a greater demand of resources compared with involuntary attention, the latter being able to induce experiences of relaxation while not requiring effort. In order to reduce the wear and tear of directed attention, environments or tasks that imply a lower demand are required. The theory on restorative experience developed by Kaplan and Kaplan (1989) is based on the influence of natural environments and the cognitive benefits that these spaces can favor (Ulrich, 1983; Kaplan and Kaplan, 1989; Grinde and Patil, 2009). Korpela and Hartig (1996) developed a model in which a restorative environment must have the characteristics of (a) avoidance, allowing users of public spaces a cognitive and psychological distance from everyday life; (b) compatibility, so that users will be able to carry out actions or make decisions based on two aspects: individual

objectives or inclinations and actions required by the environment where the space is located; (c) fascination, which causes interest in users but without activating voluntary attention, so requiring a low attentional effort; (d) extension, which unifies sensations of connection and reach that spaces can have on users, making it easier for users to feel immersed in the environment and be predictable; and (e) coherence, referring to the impact that the physical arrangement of the elements causes on users.

Numerous studies have compared the restorative effect of natural spaces with urban spaces and have observed that urban spaces have a lower impact on cognitive and physiological restorativeness (Hartig and Evans, 1991; Franěk et al., 2018; Grassini et al., 2019; Ojala et al., 2019). Yet, to the extent that they have natural elements, urban spaces also contribute to cognitive restorativeness (Hernández and Hidalgo, 2005; San Juan et al., 2017). Urban environments can lead to an overload of stimulation and sustained attentional activation, which is why urban spaces with restorative capacity can be key to citizens' health, especially, considering that urban spaces with high capacities for restorativeness can be accessible every day and easy to visit for people who live in cities. Indeed, there is ample evidence of the potential of urban spaces for restorativeness, such as museums (Kaplan et al., 1993), houses (Scopelliti and Giuliani, 2004), gardens (Twedt et al., 2016), botanical gardens (Carrus et al., 2017), historical-artistic sites (Scopelliti et al., 2019), or urban landscapes (Karmanov and Hamel, 2008). In this sense, Staat et al. (2016) highlighted the importance of examining different types of spaces to make comparisons between urban and natural ones (for example, green paths vs. busy streets).

In summary, the impact of the presence of natural elements on the restorative capacity of spaces has been consistently demonstrated in various investigations. This restorative capacity has been shown in natural settings and in urban ones where natural elements are present, especially trees and plants. However, while in natural spaces, there is little or no presence of elements built by humans; urban spaces in addition to natural elements contain varying degrees of built elements. Therefore, two questions immediately arise: Is the restorative capacity of urban spaces an exclusive product of the presence or absence of natural elements? Or is restoration also related to the characteristics of built elements?

Analyzing the joint contributions of natural and built elements, which are characteristics of parks and squares, is of interest for promoting the restorative capacity of public spaces. Research in this area has combined the role of urban nature with other variables such as type of leisure activities, the environment in which spaces are located, and the social context (Staats et al., 2010). A multiple influence has been observed. However, there is not enough evidence on whether the specific characteristics of these spaces, the way in which people perceive or do not perceive these characteristics, have an impact on their restorative effect. Therefore, it is necessary to analyze to what extent the characteristics or attributes of built elements contribute to the restorative power of squares and parks.



## Perceived Environmental Quality

The analysis of spaces' characteristics and attributes and especially how they contribute to improving users' lives has been carried out fundamentally from the concept of perceived environmental quality. This is a concept that addresses the physical conditions necessary to make a space habitable and improve people's quality of life. However, it also involves linking psychological processes, as it can be approached from the evaluation that people make of a place. In short, environmental quality makes a tangible link between environments and people (Bonnes et al., 1997; Bonaiuto et al., 1999, 2003, 2006; Andrade et al., 2012; von-Breymann and Montenegro-Montenegro, 2019).

The impact of physical conditions, i.e., the quality of spaces, on various aspects of the interaction between human beings and their environment has been noted in evaluations of places related to residential satisfaction, place attachment, or habitability (Amérigo and Aragonés, 1990, 1997). Attributes such as noise level, neighborhood attractiveness, accessibility, and aspects related to maintenance explain satisfaction and attachment in neighborhoods (Amérigo and Aragonés, 1990, 1997; Ruiz and Hernández, 2014; Ruiz et al., 2019). In this direction, there is a frequent association between elements of environmental quality and well-being with several studies on the effects of urban design (Kleinert and Horton, 2016; Mangone, 2018), landscapes (Souter-Brown, 2015) or contact with nature (Corral-Verdugo et al., 2011; da Luz Reis et al., 2011). Other issues associated with environmental quality have been the perception of safety and security linked to the physical aspects of environments (Sautkina, 2007) or the emotional qualities associated with sound environments (Guillén and López-Barrio, 2007).

In summary, research into environmental quality and its effects on users' preferences and uses of public spaces have indicated that increases in quality are linked to increases in preference and satisfaction. However, little is known about the effect that the quality of built elements has on the restorative capacity of spaces, especially as it is in built urban spaces that people conduct their daily lives and where they really connect with the city in which they live. As indicated by Van den Berg et al. (2007), we should investigate design and urban planning solutions in cities and their green spaces that support restorativeness. Along these lines, Peschardt and Stigsdotter (2013) indicated a lack of knowledge about which specific characteristics of urban green spaces are associated with restorativeness. Therefore, this paper aims to provide new information on the effect that perceived environmental quality has on users' restorative experiences in these spaces.

One approach to the study of variables related to perceived environmental quality was carried out by Bonaiuto et al. (2019) based on the concept of urban reputation. This research shows that the evaluation of urban environments is multidimensional. The authors propose an assessment procedure made up of 27 subscales that are grouped into 12 dimensions. The results obtained show the importance of elements related to environmental quality in terms of design, care or maintenance, and social interaction.

Other research shows the importance of sensorial elements linked to hearing and smell. According to Emfield and Neider (2014), the images and sounds of nature are more relaxing than urban sounds. However, studies such as those by Krzywicka and Byrka (2017) and Payne et al. (2020) found a restorative potential of soundscapes in urban parks, despite the juxtaposition of nature sounds (such as birds) and urban sounds (such as traffic). Regarding the olfactory sense, some works go deeper into the role it can play in urban identity (Henshaw et al., 2016). In particular, Quercia et al. (2018) suggested the connection of odors with basic emotions and cognitive associations, specifically showing that unpleasant odors have a greater impact on autonomous activity, as well as participants' preference for hedonistic odors. In general, it is observed that research that has taken into consideration "non-visual" sensorial elements is inconclusive, as well as being scarce when linked to restorativeness.

## Promising Restorative Urban Areas: Parks and Town Squares

Interest in studying green spaces in cities is increasing (Peschardt and Stigsdotter, 2013; White et al., 2013; Wood et al., 2018). Parks in urban areas influence self-informed psychological restorativeness, and as Wood et al. (2018) pointed out, the facilities in these spaces and their biodiversity are influential features of self-informed psychological restorativeness. Tyrväinen et al. (2014) and Vander Berg et al. (2014) suggest that the size of green spaces and their physical characteristics are relevant aspects for restorativeness. In general, the use of parks is associated with benefits such as tranquility, solitude, beauty, health, recreation, public life, and identity with the community (Kocs, 2013). Similarly, views from windows, which include views of natural environments also have restorative effects (Masoudinejad and Hartig, 2020). The experimental study presented by Honold et al. (2016) also showed the positive effect that urban nature has on health. Likewise, Hernández and Hidalgo (2005) verified the restorative effect of the presence of nature in photographed urban scenes. For all these reasons, it can be concluded that introducing natural elements in public spaces such as parks or squares is a way of enriching urban environments and increasing their restorative potential.

While parks play an important role in improving restorativeness and health in general, squares can be equally important. San Juan et al. (2017) carried out a study focused on urban squares where the presence of natural elements (grass, trees, water), architecture (variation of the surrounding buildings), coherence, and mystery were considered. The results of the work supported the restorative effect of squares, improving people's psychological state after passing through an urban square. However, results showed no restorative differences according to the greenery. The authors argued that it is possible that, in urban environments, elements such as greenery or water may have less influence.

By contrast, in another study on urban squares, Lorenzo et al. (2016) confirm the relationship between users' preferences and amount of vegetation. However, in this study,

the role that the physical structures or the activities of the users of squares can play was not considered. Another aspect corroborated by previous studies (Purcell et al., 2001; Galindo and Hidalgo, 2005; Tenngart Ivarsson and Hagerhall, 2008) is that expected restorativeness from these spaces will influence users' preferences.

Based on a literature review, the general aim of this study is to check whether elements of environmental quality perceived by users of public open spaces favor restorativeness. Specifically, we first hypothesize that the perceived quality of physical elements of parks and squares is positively related to perceived restorativeness. A second hypothesis is that parks generate higher levels of perceived restorativeness than squares.

## MATERIALS AND METHODS

### Participants

This research involved 519 users of 32 urban public spaces—squares and parks—with free use. All participants were residents on the Island of Tenerife (Spain). This sample had an age range from 18 to 87 years old, with an average of 42.6 years old ( $SD = 15.75$ ). **Table 1** presents the sociodemographic data of the study participants.

### Spaces Included in the Study

The public spaces evaluated are located in urban areas with populations of at least 3,000 inhabitants on the island of Tenerife (Spain). **Figure 1** shows, through photographs, the various parks and squares under study (three squares and three parks).

The 32 spaces that were the subject of this research were evaluated by an expert observer using a validated tool (Rosales et al., 2019). This tool makes it possible to check the quantity and quality of the physical elements present in a public space according to 23 indicators, which are grouped into three main dimensions: architectural, functional, and contextual. In addition to an evaluation of each dimension, it is possible to obtain an overall evaluation combining all three dimensions.

The overall result of the evaluation of urban sites included in this work showed no differences [ $t(30) = -1.04$ ,  $p > 0.05$ ]

between the two types of spaces—20 squares and 12 parks. Also, it was tested whether there were significant differences between squares and parks for each of the dimensions. No significant differences were found for the functional and contextual dimensions with both types of spaces showing a similar evaluation in functional and contextual elements. Thus, at the functional level, the squares and parks in this study were characterized by a shortage of toilets, the presence of traditional waste collection bins, the presence of some sculptures in the interior, having mostly shared benches and outdoor seating, and including prominent signage on regulations and flora. On a contextual level, both spaces had a good level of lighting at night, an adequate level of security due to the presence of surveillance signs, visibility from the outside, access for security vehicles and the absence of mostly dark areas, and a good level of cleanliness and physical order. However, in the architectural dimension, there were differences between squares and parks [ $t(30) = -5.11$ ,  $p > 0.001$ ]. In **Table 2**, a detailed description of the architectural elements for each type of urban space is presented. We tested whether each architectural feature was different depending on the type of public space and found that green and/or landscaped areas were larger in parks than in squares [ $t(30) = -4.63$ ,  $p < 0.001$ ], the type of vegetation was also larger [ $t(30) = -2.63$ ,  $p < 0.05$ ], and the size distribution of areas for children, for sports, and for animals was significantly larger in parks than in squares [ $t(30) = -7.28$ ,  $p < 0.001$ ] as well (**Table 2**).

Based on these findings, analyses were carried out according to the type of space. Thus, in the results of this research, a subsection is presented for squares and another for parks.

### Study Design

The design of this study is predictive (Ato et al., 2013) as its purpose is to analyze the existence or not of a relationship between variables in order to determine or explain behavior. For this purpose, a survey methodology was used by which participants evaluated the spaces. We used four variables focused on perceived environmental quality: design of spaces, care of spaces, social interaction, and presence of sensorial elements (predictive variables). Additionally, the perceived restorativeness was evaluated (criterion variable).

### Materials and Instruments

A questionnaire was developed in three parts: (1) scale of perceived environmental quality, (2) scale of perceived restorativeness, and (3) sociodemographic variables.

The scale of perceived environmental quality is an adaptation based on the scales proposed by Ruiz and Hernández (2014), Bonaiuto et al. (2019), and Ruiz et al. (2019). It is composed of four dimensions with 21 items in total, with a Likert-type response scale from one to five, with 1 “Totally disagree” and 5 “Totally agree.” Specifically, this scale included the following variables:

- *Design of spaces subscale* is composed of seven items and whose internal consistency, measured with Cronbach's  $\alpha$ , was 0.72. This evaluation includes aspects related to signposting, accessibility, and waste disposal, as well as the presence of

**TABLE 1 |** Percentage of sociodemographic variables.

Gender	Men	44.3%
	Women	55.7%
Educational level	No studies	2.7%
	Primary education	16.7%
	Secondary education or vocational training	36.3%
	Studying at university	7.2%
	Completed university studies	37.1%
Current work	Working	64.2%
	Unemployed	13.1%
	Studying in some way	11.6%
	Retired	11.1%
	Married or living with their partner	64.2%
Marital status	Single and/or not living with a partner	24.1%
	Separated or divorced	8.1%
	Widowed	3.6%



## Parks

## Squares



**FIGURE 1 |** Photographs of parks and squares.

green spaces, places for free use, and aspects of the layout. For example, on this scale, the following items are used: “The different areas of this space are well signposted and connected” or “The transit or passage areas and interior paths of this place are wide enough.”

- *Care of space subscale* consists of six items and with an internal consistency of 0.84. Care of space is understood as the general conditions of maintenance and cleanliness of the place, both green areas and architectural elements, and is related to the external appearance of public spaces. Among the items included in this scale are, for example: “The maintenance of green and nature areas is correct” or “The level of cleanliness of this place, in general, is adequate.”
- *Social interaction subscale* is composed of four items with an internal consistency of 0.77. Social interaction is defined as the perceived quality of relationships with other users

in public spaces and the possibilities of contact that these spaces promote. An example of the issues raised on this scale is “The attitude of users of this place makes me feel comfortable.”

- *Presence of sensorial element subscale* has four items and with an internal consistency of 0.75 This instrument includes aspects related to auditory and olfactory senses. Some examples of the items used are: “In this place, you can appreciate pleasant sounds” or “In this place, you can perceive pleasant smells.”

The Restorative Capacity scale, translated into Spanish and used by Ruiz and Hernández (2014) and Negrín et al. (2017) from the original scale proposed by Berto (2005), which, in turn, was developed as a reduced version of Korpela and Hartig’s (1996) Perceived Restorativeness Scale (PRS), is composed of five items whose response scale is Likert type from one to five, with 1

**TABLE 2** | Description of evaluated architectural elements of squares and parks through the observation tool.

Architectural features	Architectural elements	Square		Parks	
		Description	M*	Description	M*
Green and/or landscaped areas	Size	Small (<100 m <sup>2</sup> )	3.83	Large (>500 m <sup>2</sup> )	7.22
Type of vegetation	Lawn—grass	Small variety of different vegetation types	7.0	Wide variety of different vegetation types	9.38
	Flowers—plants				
	Shrubs				
	Trees				
Children's, sports and animal areas	Size	Small (<100 m <sup>2</sup> )	1.78	Medium (100—500 m <sup>2</sup> ) and Large (>500 m <sup>2</sup> )	6.8
Accessibility	Open/closed enclosure	Open spaces, 100% walkable, with stairs and few limitations for people with reduced mobility	5.98	Open spaces, with impassable areas, no steps, and some limitations for people with reduced mobility	6.78
	Presence of private/transitable areas				
	Presence of steps				
	Access and transit for persons with reduced mobility				
Perspective—sense of spaciousness	Enclosed by:	Mixed enclosure	5	Enclosed by natural elements	4.2
	Natural elements				
	Buildings				
Pedestrian circuit in the public space	Mixed	Adequate pavement with no major walking difficulties. Visually unattractive with some protective elements	6.25	Pavement could be improved with some walking difficulties. Very visually attractive with numerous protective elements	5.7
	Pavement condition				
	Visually attractive for walking				
	Difficulty of walking				
	Weather protection elements (e.g., high-canopy trees, pergolas, etc.)				

\*Average rating of architectural features (scale of 1–10).

The first column presents the general architectural features included in the validated tool (Rosales et al., 2019), and the second column presents the architectural elements assessed for each of the architectural features. The next two columns—squares and parks—show, on the one hand, the description for both types of space for each architectural feature evaluated and the average score obtained for each architectural feature.

being “Totally disagree” and 5 “Totally agree.” The internal consistency was 0.82. For example, this scale includes the following items: “This place lets me forget my everyday responsibilities, feel relaxed, and lose myself in my own thoughts” or “I feel comfortable here because it’s easy to find my way around this place.”

With respect to sociodemographic variables, information was collected from participants on their gender, educational level, current work, and marital status.

## Procedure

Participants answered the questionnaire inside or near the public space that was to be evaluated. A group of five experienced interviewers were responsible for collecting the data. For this, the interviewers collected the data, in public spaces (squares and parks) at different times of the week (weekday vs. weekend) and at different time slots (morning/evening). Data were collected from January to early March 2020. For this work, interviewers used both the paper and pencil and the digital version of the questionnaire, using their own phone or tablet for the latter.

Before completing the questionnaire, the interviewers informed participants of the objective of the research and explained to them why their collaboration was essential. They also guaranteed the anonymity of participants’ responses and confidentiality

of the information provided. To complete the questionnaire, the interviewer first read out the various items to the participant. Second, based on their responses, the interviewer marked the answers in the printed or digital version of the questionnaire. Finally, participants were thanked for their collaboration, and each participant was asked to indicate if he or she consented to the use of his or her answers for research purposes. The completion time ranged from approximately 20–40 min.

## Data Analysis

Data analysis was carried out using IBM SPSS Statistics software, version 21. In this study, the internal consistency of the different scales was calculated. Moreover, the average for each variable was calculated from the different items that make up the various subscales used. In addition, the descriptive statistics (mean, standard deviation, and response range) of all the variables and the correlations between them were calculated. Several one-factor analyses of variance (ANOVA) were conducted to examine whether there were differences among participants based on sociodemographic data. Finally, it was checked, through a regression analysis, if the elements of perceived environmental quality favored perceived restorativeness.



## RESULTS

We analyze normality based on typical scores and multivariate outliers with the Mahalanobis distance, eliminating five outliers. The remaining analyses were carried out with 514 valid cases, of which 331 participants were interviewed inside or near squares and 183 participants inside or near parks.

First, we compared the scores of parks and squares on the predictor variables and on the criterion variable. **Table 3** shows the differences between the two types of public spaces in three of the predictor variables (design of spaces, care of spaces, and presence of sensory elements) and in the criterion variable (perceived restorativeness) of the research.

### Sociodemographic Variables and Predictors: Squares

We analyzed the descriptive statistics for the different study variables focused on perceived environmental quality: design of spaces, care of spaces, social interaction, and presence of sensorial elements. The correlation between the variables in this study are also calculated. In **Table 4**, we present the descriptive statistics and the correlations between the predictor variables.

**Table 4** shows how the design of spaces is significantly and positively related to the care of spaces, social interaction, and presence of sensorial elements. The care of spaces is also significantly and positively related to social interaction and presence of sensorial elements. Social interaction is significantly and positively related to the presence of sensorial elements.

Likewise, we analyzed whether there were differences in the predictor variables (design of spaces, care of spaces, social interaction, and presence of sensorial elements) according to the sociodemographic data collected in the questionnaire (gender, educational level, current work, and marital status).

- *Gender*: No differences were identified for design of spaces, care of spaces, and social interaction. However, there were differences in the predictor variable presence of sensorial elements [ $F(1,329) = 9.26$ ;  $p < 0.01$ ]. Specifically, men have a higher valuation for sensorial elements (3.40) in one type of spaces—squares—compared with women (3.11).

**TABLE 3 |** ANOVAs PV and CV.

		<i>M</i>	<i>df</i>	<i>F</i>
Design of spaces	Squares	3.56	(1,513)	90.39***
	Parks	4.14		
Care of spaces	Squares	3.26	(1,513)	19.09***
	Parks	3.64		
Social interaction	Squares	3.63	(1,513)	3.71
	Parks	3.78		
Presence of sensorial elements	Squares	3.23	(1,513)	56.67***
	Parks	3.85		
Perceived restorativeness	Squares	3.47	(1,513)	45.08***
	Parks	4.02		

\*\*\* $p < 0.001$ .

- *Educational level*: No differences were identified for care of spaces and presence of sensorial elements. However, for the predictor variables design of spaces [ $F(4,326) = 2.43$ ;  $p < 0.05$ ] and social interaction [ $F(4,326) = 2.71$ ;  $p < 0.05$ ], significant differences were observed. In this sense, when analyzing these in greater depth by means of tests with Tukey's HSD adjustment, it is observed that for the design of spaces, the differences disappear, while for social interaction, differences are observed between users with primary education (3.79) and those with university studies (3.44).
- *Current work*: No differences were identified for the design and care of spaces. Differences were found for social interaction [ $F(3,327) = 7.89$ ;  $p < 0.001$ ] and presence of sensorial elements [ $F(3,327) = 5.09$ ;  $p < 0.01$ ]. Specifically, from tests with Tukey's HSD adjustment, differences are observed in the perception of social interaction in squares between retired participants (4.11) and the rest of the groups (working, 3.55; unemployed, 3.64; studying in some way, 3.4, in terms of the presence of sensorial elements). Using Tukey's HSD adjustment test, differences are observed, on the one hand, between those who are retired (3.54) compared with those who are working (3.19) and those who are studying (2.92) and, on the other hand, between those who are unemployed (3.45) and those who are studying (2.92).
- *Marital status*: no differences were identified for design of spaces, care of spaces, and presence of sensorial elements. However, there are differences in social interaction [ $F(3,327) = 4.09$ ;  $p < 0.01$ ]. In particular, from Tukey's HSD adjustment test, it is observed that widowed participants (4.07) rate the social interaction of the spaces more highly than single users and/or those not living with a partner (3.40).

### Sociodemographic Variables and Predictors: Parks

We calculated the descriptive statistics for design of spaces, care of spaces, social interaction, and presence of sensorial elements. Furthermore, the correlations between the independent variables in this study were calculated. In **Table 5**, we present the descriptive statistics and the correlations among the predictor variables.

**Table 5** shows that, in parks, the study's predictor variables are significantly and positively related to each other, just as they are in squares.

Additionally, the same as for the squares, we analyzed whether there were differences in the predictor variables (design of space, care of spaces, social interaction, and presence of sensorial elements) based on the sociodemographic data (gender, educational level, current work, and marital status).

- *Gender*: No differences were observed in the variable design of spaces, care of spaces, social interaction, and presence of sensorial elements.
- *Educational level*: No differences were identified for design of spaces, care of spaces and social interaction. By contrast, for the presence of sensorial elements [ $F(3,179) = 4.24$ ;

**TABLE 4** | Descriptive statistics and correlations of predictor variables for squares.

	<i>M</i>	Standard deviation (SD)	1	2	3	4
1. Design of spaces	3.56	0.68	-			
2. Care of spaces	3.26	0.89	0.45**	-		
3. Social interaction	3.63	0.80	0.44**	0.22**	-	
4. Presence of sensorial elements	3.24	0.86	0.40**	0.29**	0.47**	-

\*\* $p < 0.01$ .**TABLE 5** | Descriptive statistics and correlations of predictor variables for parks.

	<i>M</i>	Standard deviation (SD)	1	2	3	4
1. Design of spaces	4.14	0.64	-			
2. Care of spaces	3.64	1.01	0.65**	-		
3. Social interaction	3.77	0.78	0.40**	0.33**	-	
4. Presence of sensorial elements	3.86	0.94	0.53**	0.48**	0.37**	-

\*\* $p < 0.01$ .

$p < 0.01$ ] significant differences were observed. Specifically, when analyzing these differences in greater depth by means of Tukey's HSD test, it is observed that there are differences for the presence of sensorial elements between participants who are studying at university (3.08) compared with those who have secondary education or vocational training (4.03) and those who have completed university studies (3.89).

- *Current work*: As with the squares, no differences were identified for the design of spaces and care of spaces. However, there are differences in social interaction [ $F(3,179) = 3.19$ ;  $p < 0.05$ ] and the presence of sensorial elements [ $F(3,179) = 3.47$ ;  $p < 0.05$ ]. Specifically, based on Tukey's HSD test, it is observed, on the one hand, that the differences in social interaction disappear. On the other hand, regarding the presence of sensory elements, the group of participants who are studying (3.25) has a lower perception of this type of elements compared with those users who are working (3.92) or unemployed (4.01).
- *Marital status*: No differences were identified for the variables of design of space, care of spaces, social interaction, and presence of sensorial elements.

## Perceived Restorativeness: Squares and Parks

We calculate the descriptive statistics for the perceived restorativeness. Moreover, we calculate the correlation between the variables (predictors and criterion) in this study. In **Table 6**, we present the descriptive statistics and the correlations between the dependent variable and the predictor variables.

**Table 6** shows that the perceived restorativeness for both squares and parks are significantly and positively related to

the predictor variables (design of spaces, care of spaces, social interaction, presence of sensorial elements).

Furthermore, we examined whether there were differences in the criterion variable (perceived restorativeness) based on the sociodemographic data (gender, educational level, current work, and marital status).

- *Gender*: No gender differences were identified in either of the two types of spaces—squares and parks.
- *Educational level*: No differences were identified for perceived restorativeness between participants surveyed inside or near the squares. However, significant differences were found in parks [ $F(3,179) = 2.93$ ;  $p < 0.05$ ]. When analyzing these differences in greater depth by means of Tukey's HSD test, it is observed that they disappear.
- *Current work*: No differences were identified for either squares or parks.
- *Marital status*: There are no differences in perceived restorativeness between the participants surveyed in either type of space, squares, or parks.

Likewise, based on the correlations observed between predictor variables (design of space, care of spaces, social interaction, presence of sensorial elements) and the perceived restorativeness, we performed a multiple linear regression with the stepwise method for both types of urban public spaces.

With respect to the squares, we assessed whether the sociodemographic variables (gender, educational level, current work, and marital status) as well as the predictor variables explain perceived restorativeness. This analysis yields three models where, in the third one, social interaction, design of spaces, and care of spaces predict the perception of restorativeness significantly [ $F(3,327) = 87.01$ ;  $p < 0.001$ ]. Thus, neither the presence of sensorial elements nor the

**TABLE 6** | Descriptive statistics and correlations of the dependent variable for squares and parks.

		<i>M</i>	Standard deviation ( <i>SD</i> )	1	2	3	4
Perceived restorativeness	Squares	3.47	0.90	0.55**	0.33**	0.57**	0.39**
	Parks	4.02	0.87	0.65**	0.65**	0.48**	0.52**

1. Design of spaces; 2. Care of spaces; 3. Social interaction; 4. Presence of sensorial elements.

\*\* $p < 0.001$ .

sociodemographic variables predict the value of our criterion variable.

This final model complies with the assumptions of normality, non-colinearity and independence of the residual. Specifically, the assumption of normality has been checked from an analytical study of the normality of the residuals by means of the nonparametric Kolmogorov-Smirnov test ( $Z$  of  $K-S = 0.76$ ;  $p > 0.05$ ). Regarding the assumption of noncolinearity, both the tolerance statistic and the variance inflation factor (VIF) statistic were used as the procedure for detecting multicollinearity. The results of these are presented in **Table 7**, observing that for the three independent variables of the model (design of spaces, care of spaces, and social interaction), the tolerance statistic is greater than 0.10, and the variance inflation factor (VIF) is less than 10. Furthermore, in the definitive model, through the Durbin-Watson statistic test, the assumption of independence of the residual is fulfilled, as a value between 1.5 and 2.5 (1.78) is obtained.

Once the assumptions of the regression analysis were verified, we observed that three of the four independent variables showed a statistically significant weight. **Table 5** also includes the standardized coefficients ( $\beta$ ),  $p$ -values and partial correlations.

In short, in the final model, social interaction, design of spaces, and care of spaces explain 44% of the variance in the restorative capacity perceived by participants interviewed inside or near the squares.

In relation to the parks, we analyzed whether sociodemographic variables (gender, educational level, current work, and marital status) and the predictor variables explain perceived restorativeness. This analysis yields six models where, in the last one, the level of studies studied at university, completed university studies, the design of spaces, the care of spaces, the social interaction, and the presence of sensory elements predict significantly the dependent variable [ $F(6,177) = 41.27$ ;  $p < 0.001$ ]. On the contrary, the rest of the sociodemographic variables do not predict the value of our criterion variable.

This final model, as with the squares, complies with the assumption of normality of the residuals ( $Z$  of  $K-S = 1.11$ ;  $p > 0.05$ ), the assumption of independence of the residual (Durbin-Watson statistic test = 1.97), and the assumption of noncolinearity (**Table 8**). Once the assumptions of the regression analysis were verified, we observed that two groups of users according to their level of education and all the independent variables showed a statistically significant weight. **Table 8** also includes the standardized coefficients ( $\beta$ ),  $p$ -values, and partial correlations.

In summary, completed university studies, studying at university, design of spaces, care of spaces, social interaction, and

presence of sensorial elements explain 57% of the variance in the restorative capacity perceived by participants interviewed inside or near the parks.

## DISCUSSION

This paper contributes to research into the effects that the perceived quality of public spaces can have on perceived restorativeness. The results obtained confirm our first hypothesis that the perceived quality of the physical elements of parks and squares is positively related to their restorative capacity perceived.

The results of the study show that the design and care of spaces, as well as the presence of sensorial elements are more present in parks than in squares. Valera et al. (2018) point out that the quality and good functioning of a public space can be assessed according to the diversity of uses it allows. In this sense, squares are wide, open public spaces, where we find elements such as benches, statues, monuments, etc. They usually serve as a cultural representation of cities, as well as a meeting place for people. In these spaces, users sit, stroll, or spend time, making them functional places that favor social contact. As for parks, they fulfill a recreational function, and this is reflected in their layout and elements. They generally have green areas (gardens and trees, water fountains, etc.) and offer a greater number of services and possibilities of use than squares (sports practice, playgrounds, etc.). This distinction means that the elements that make up parks are greater in number and more diverse. It is not surprising that the scores in the dimensions of design, care, and presence of sensorial elements are higher for parks. However, no differences are found in social interaction, concluding that both parks and squares offer equivalent possibilities to develop social life.

There are also differences according to the sociodemographic variables on the quality elements evaluated (design, care, social interaction, and presence of sensorial elements). However, when introducing the sociodemographic variables in a first step of the regression model on perceived restorativeness, the variance explained is low, if not null. The hypothesis of a greater perceived restorativeness capacity in parks than in squares is also confirmed. This result is attributed to the greater presence of green areas in parks. Tyrväinen et al. (2014) reported that even in short visits, urban forests (with a greater presence of nature) provide greater psychological benefits than large urban parks. Moreover, the perceived availability of nearby green spaces on their own is associated with improvements in self-reported quality of life (Hipp and Ogunseitan, 2011).

**TABLE 7** | Output of the perceived environmental quality regression on perceived restorativeness—squares.

	Non-standardized coefficients		Standardized coefficients and <i>p</i> -value	95% confidence Interval		Partial correlations	Collinearity statistics	
	<i>B</i>	<i>SE</i>		Lower limit	Higher limit		Tolerance	VIF
Constant	−0.33	0.22						
Social interaction	0.46	0.05	0.41***	0.35	0.56	0.44	0.81	1.24
Design of spaces	0.43	0.06	0.33***	0.30	0.56	0.34	0.68	1.48
Care of spaces	0.09	0.05	0.09*	0.01	0.19	0.11	0.80	1.25
Adj R <sup>2</sup>	0.44							

\**p* < 0.05; \*\*\**p* < 0.001.**TABLE 8** | Output of the perceived environmental quality regression on perceived restorativeness—parks.

	Non-standardized coefficients		Standardized coefficients and <i>p</i> -value	95% confidence Interval		Partial correlations	Collinearity statistics	
	<i>B</i>	<i>SE</i>		Lower limit	Higher limit		Tolerance	VIF
Constant	0.13	0.31						
Completed university studies	−0.18	0.16	−0.06	−0.50	0.15	−0.08	0.91	1.10
Studying at university	−0.30	0.10	−0.16**	−0.49	−0.11	−0.23	0.91	1.10
Design of spaces	0.38	0.10	0.27***	0.19	0.56	0.29	0.49	2.02
Care of spaces	0.26	0.06	0.30***	0.15	0.37	0.32	0.53	1.89
Social interaction	0.26	0.06	0.23***	0.14	0.38	0.30	0.79	1.27
Presence of sensorial elements	0.14	0.06	0.15*	0.03	0.25	0.18	0.63	1.59
Adj R <sup>2</sup>	0.57							

\**p* < 0.05; \*\**p* < 0.01; \*\*\**p* < 0.001.

Additionally, studies in immersive virtual environments have shown differences between parks and squares when manipulating physical aspects of the environment such as the enclosure of these areas. In the case of squares, an enclosed spatial layout positively affects restorativeness. However, in parks, this same condition is inversely related to restorative capacity (Tabrizian et al., 2018). In line with this work, it is worth noting that our results revealed that there are differences in the impact that environmental quality conditions have on perceived restorativeness. To test this effect, stepwise regression models were applied to control for the effect of sociodemographic variables. Specifically, we obtained two models in which different dimensions of environmental quality explain perceived restorativeness in urban open-use spaces. For squares, we observed that higher scores in social interaction and spaces design and care, predict higher perceived restorativeness level. The coefficients indicate a higher weight mainly of social interaction and design of spaces. Regarding parks, we observed that higher scores in spaces' care and design, social interaction, and presence of sensorial elements lead to higher levels of perceived restorativeness. In this case, the greatest weight is given to the importance of park maintenance as the first factor. The comparison of the two models shows that there is a

relationship between the elements of environmental quality and perceived restorativeness. The question that arises is to analyze whether these models are comparable. Both squares and parks have in common a significant weight in the design of spaces. These data are relevant if we consider other research on the role that the design of squares and parks plays on users' preferences (Korpela and Hartig, 1996; Korpela et al., 2008, 2010) as well as on variables such as vitality (Anderson et al., 2017). This finding is in line with other studies that highlight that aspects related to design, such as the layout of urban streets, are associated with social interaction and a sense of community (Wood et al., 2008).

Regarding differences, it was observed that care of spaces is more important in parks than in squares. Given that parks have a greater presence of natural elements, whether lawns, gardens, or trees, it is assumed that the maintenance of these areas should be continuous over time. To the contrary, a lack of conservation is evident in a shorter period of time than in the case of built elements. In addition, recreational areas, such as a playground or a sports field, also require supervision to be kept in optimal conditions. These aspects of care are closely related to the perception of hazards and risks. In this sense, Valera et al. (2018) point out the effect



that spaces' care factors (vandalism, inadequate lighting, or the presence of litter, for example) have on perceptions of insecurity and a subsequent reduced use of parks and squares. In this same study, the authors allude to the fact that the self-perceived most vulnerable groups (the elderly and women) may be less present in order to avoid risks or dangers. On the other hand, it is concluded that maintaining parks in optimal conditions invites the use of these spaces, favoring a more democratic use, as well as the enjoyment of more restorative experiences.

Another difference observed between the regression models was that the presence of sensorial elements only contributes to explained variance in parks. We associate this result with the fact that sounds associated with nature tend to be perceived more favorably than urban sounds (Krzywicka and Byrka, 2017), as well as the association that certain "natural" smells (bees wax, summer air) have with basic hedonic emotions (Glass et al., 2014). In this case, we consider that the presence of green areas intensifies the sensorial experience, and therefore, it could explain why it has a greater weight in the predictive model of parks. Since the presence of sensorial elements has been less studied, it would be advisable to analyze in greater depth what contributions sensorial elements make to restorativeness, including perceptive and objective measures with respect to dimensions such as noise or air quality. Enhancing the positive effects of public spaces includes favoring opportunities like the enjoyment of a good climate in the region, the aesthetic experience, and generation of sensorial enjoyment (Gehl, 2014).

Finally, with regard to the differences between the predictive models for parks and squares, it was observed that in the case of squares, the dimension of social interaction is emphasized. On the one hand, this indicates that the function of exchange and social encounter contributes significant value to the perceived restorativeness. On the other hand, squares can be representative of a higher quality of urbanism, in that they reflect a greater experience of social life. All this makes the role of social interaction more relevant to urban life in squares, which is consistent with other works (Galindo and Hidalgo, 2005; Peschardt et al., 2012). However, despite the social dimension being relevant in the perceived restorativeness experience, it has been an issue scarcely addressed in previous studies (Collado et al., 2017). In addition to this effect on perceived restorativeness, the literature emphasizes that superficial contacts between neighbors and perceived cohesion within neighborhoods are influenced by the availability of green and public spaces (Kaczynski and Henderson, 2007; Hayley et al., 2014).

In conclusion, it is necessary to provide some indications regarding interventions to improve parks and squares. In this sense, a commitment to urban design is useful for both spaces. This type of intervention can produce, among other effects, facilitation of welfare activities, promotion of community life, increased perceptions of vitality, connection with others, and greater use of public spaces (Anderson et al., 2017). Regarding the promotion of physical activity, the impact of urban design has also been verified.

Branas et al. (2011) and Cohen et al. (2014) pointed out that the inclusion of green areas or small parks in empty spaces is a facilitator of physical exercise. Another element of design that is suggested by these results is the inclusion of green areas. In accordance with other works, the presence of plants, water or trees provide restorative benefits (Hunter and Askarinejad, 2015). This measure would help urban squares to gain a greater restorative potential. Focusing, therefore, on the improvement of squares, it is also concluded that the inclusion of natural elements could favor sensorial elements that broaden the perceived restorativeness. Specifically, more effort should be invested in considering the sociopetal properties that tend to keep people together and encourage social interaction. This distinctive feature of squares favors urban vitality, a quality that places people at the center of the design of public spaces and can be associated with benefits such as an increased sense of belonging, neighborhood identity, or a sense of community.

These findings on spatial design and interaction go in the direction of the new urban planning strategies catalogued as New Urbanism (Calthorpe and Fulton, 2001). Public and pedestrian traffic, the size of neighborhoods, the proportion and distribution of housing and commercial areas, and the inclusion of green spaces and the preservation of trees are strategies that influence the development and maintenance of a sense of neighborhood (Youngentob and Hostetler, 2005). As well as fostering a sense of community, these strategies adopt a conservation role for the environment in building practices. As Gehl (2014) argues, public spaces must be vital places, and the presence of other people is a promise of social interaction. A dynamic city offers urban life where recreational and social activities take place, but also pedestrian traffic, so that it feeds back by attracting flows of people.

This study is not without its limitations. First, although data collection was carried out at similar times of the day to avoid fluctuations, collecting data at different times of the week (weekday vs. weekend), different time slots (morning/evening/night), and the time spent by interviewers at the sites (1–3 h) would have offered a more representative range of responses. Second, this is a transversal work that provides descriptive knowledge of the relationship between environmental quality and perceived restorativeness. However, longitudinal analysis would complement the results, allowing us to assess whether the frequency of attendance or use of public spaces has any effect on restorativeness.

Regarding future research lines, social interaction is associated with perceived restorativeness. Therefore, the role of place attachment, which implies the development of affective ties with public spaces, should be taken into account. It would also be valuable to note the differences according to the cultural framework in which studies take place. Likewise, it would be interesting to check the effect of the size of the public space on the restorative experience. In this sense, the works of Hunter and Askarinejad (2015) and Mayne et al. (2015) stand out, as they point out greater effects on physical and mental well-being in smaller parks than in larger ones. Furthermore, within the challenges of sustainability, in cities

where atmospheric pollution, waste generation, and the greater demand for natural resources are more present, the intervention and integration of restorative spaces makes more sense. Therefore, it would be relevant to see to what extent small interventions in parks and squares have on the restorativeness of these spaces.

Our findings argue that cities offer opportunities for restorativeness through their public spaces. Specifically, it is verified that parks and squares with suitable designs and offering possibilities of social interaction can contribute experiences of perceived restorativeness to users. These perceived restorative experiences will promote the recovery of psychological resources such as attention, positive moods, and stress reduction, enabling a healthier life in cities.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation

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## AUTHOR CONTRIBUTIONS

MR-R participated in the design of the instruments, supervision of data collection, data analysis, writing and revision of the text, and author of correspondence. CR participated in the design of the instruments, data collection and supervision, data analysis, and text writing and review. ML participated in the collection of data and the revision of the text. GM participated in the elaboration of the research project, supervision of data collection, and the writing of the text and its revision. BH participated in the whole process of elaboration and writing of the paper. All authors contributed to the article and approved the submitted version.

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# The Effects of Contact With Nature During Outdoor Environmental Education on Students' Wellbeing, Connectedness to Nature and Pro-sociality

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Experiences of contact with nature in school education might be beneficial for promoting ecological lifestyles and the wellbeing of children, families, and teachers. Many theories and empirical evidence on restorative environments, as well as on the foundations of classical pedagogical approaches, recognize the value of the direct experience with natural elements, and the related psychological and educational outcomes (e.g., positive emotions, autonomy, self-efficacy, empathy). In this work we present two studies focusing on the contact with nature in outdoor education interventions with primary and secondary school students in Italy. A questionnaire measuring connectedness to nature, psycho-physical wellbeing, pro-environmental attitudes, students' life satisfaction, pro-social behavior, empathy and anxiety was completed before and after the education program by the participants to the intervention group and by students of a control group. The students in the intervention groups (154 in study 1 and 170 in study 2) participated in environmental education programs consisting in guided activities in contact with the nature during four visits in one of two natural protected areas. The students in the control groups (253 in study 1 and 168 in study 2) attended the same schools as the intervention group but they were not involved in the environmental education program. The students in both the groups completed the questionnaire in the same weeks of the year. Findings show that taking part to the outdoor education program has positive outcomes on psycho-physical wellbeing, on connectedness to nature and on pro-social behavior of students in the intervention group, compared to the control group. The implications related to the effectiveness of outdoor education interventions and future directions of research and practice in environmental psychology and education are discussed.

**Keywords:** environmental education, outdoor, wellbeing, connectedness to nature, pro-sociality

## INTRODUCTION

Outdoor environmental education programs are a crucial tool for promoting children's and adolescents' pro-environmental attitudes and behaviors, as well as their feelings of connection to nature, and pursuing the goal of reducing human impact on the environment and natural resources therein (Passafaro et al., 2010; Pirchio et al., 2020). In the last 30 years, many different approaches have been used and tested to this aim, such as educational programs focusing on the acquisition of knowledge about the environment and how human activities impact on its quality. Other approaches focused on educational experiences where the contact with natural settings and outdoor activities are proposed as a mean for promoting positive emotional reactions among students and facilitating conceptual knowledge of major environmental issues (Rickinson, 2001). Indeed, several studies showed that, to the purpose of an effective behavioral change, educational approaches that are capable to generate an emotional involvement in environmental problems may be more effective than those focusing on the mere knowledge of environmental facts (e.g., Passafaro et al., 2010).

The present study assesses the psychological outcomes of an outdoor environmental education program for primary and lower secondary school students in Italy. Given the extended literature and the solid empirical evidence of the benefits of contact with nature for human psychophysical health and wellbeing, we test the hypothesis that outdoor environmental education programs might not only impact on pro-environmental variables, but also on students' wellbeing.

In fact, the experience of natural environments has been shown to promote recovery from stressful experiences, allowing individuals to recover their cognitive and emotional resources depleted in the course of daily life tasks, thus helping human adaptation to the environment and promotes subjective wellbeing, as well as physical and mental health (e.g., Hartig, 2004; Nilsson et al., 2010; Marselle et al., 2020, 2021).

Thus, in the present study we explore the impact of contact with nature during an outdoor environmental education program on outcomes relative to both subjective wellbeing (e.g., perceived wellbeing, empathy, anxiety, pro-sociality, and life satisfaction) and to pro-environmental psychological variables (e.g., connectedness to nature, pro-environmental attitudes, and behaviors).

## Outdoor Education and Pro-environmental Outcomes

An important construct to understand the relationship between humans and nature is connectedness to nature, which can be defined as the individuals' perception of their connection to the non-human natural world (e.g., Mayer and Frantz, 2004; Amerigo et al., 2012; Capaldi et al., 2014). Many studies showed that the perceiving oneself as "connected" to nature is a main predictor of pro-environmental attitudes and behaviors (Mayer and Frantz, 2004; Nisbet et al., 2009; Olivos et al., 2011; Frantz

and Mayer, 2014; Pasca et al., 2017); connectedness to nature has therefore been proposed also as a relevant measure for assessing environmental education programs (Frantz and Mayer, 2014; Barrable and Booth, 2020). In fact, contact with nature plays a key role in developing nature connectedness (Nisbet et al., 2009), and those environmental education interventions providing a sustained and emotionally significant contact with nature may increase the perception of being connected to, and part of, the wider natural world among children and adolescents (Barrable and Booth, 2020).

A major aim of outdoor environmental education interventions is to provide students with the opportunity of knowing relevant facts about the ecological processes of natural environments, and to develop positive attitudes and behaviors toward environmental preservation. Most of the studies in the last decades, aiming to explore the outcomes of outdoor environmental education programs, found an effect on environmental knowledge and attitudes (Bogner, 2002; Bogner and Wiseman, 2004; Olivos-Jara et al., 2013; Liefänder and Bogner, 2014; Schmitz and Da Rocha, 2018). Yet, while the role of knowledge in promoting ecological behaviors has been considered as controversial (Vicente-Molina et al., 2013; Moss et al., 2017; Otto and Pensini, 2017), the link between pro-environmental attitudes and ecological behaviors has received greater empirical corroboration (see Kaiser et al., 1999). Outdoor visits to natural spaces, as long as they can provide students with an intense and prolonged positive experience in nature, might thus have an impact on ecological behaviors, together with factual knowledge of, and positive attitudes toward, the natural environment (Bogner, 1998; Dillon et al., 2006; Braun et al., 2018).

## The Impact of Outdoor Education on Well-Being

Starting from the concept of restorative environments, many studies showed the benefits of contact with nature (e.g., in green residential areas, botanical gardens, urban forests, etc.) on human subjective well-being, focusing in particular on adults (Hartig, 2004; Laforteza et al., 2009; Hartig et al., 2011; Carrus et al., 2015b, 2017; Wassenberg et al., 2015).

Fewer studies have dealt specifically with the experience of restorative environments among children (e.g., Bagot et al., 2015; Carrus et al., 2015a; Collado and Staats, 2016). Children's activity in natural environments has been associated with cognitive, physical, affective, and moral developmental positive outcomes and with children's levels of independence and autonomy (Adams and Savahl, 2017). Also, the experience of contact with nature may play a role in attentional processes (Taylor et al., 2001; Johnson et al., 2019; Federico, 2020) and in cognition and emotion functioning among pre-school and school children (Wells and Evans, 2003; Corraliza et al., 2012; Collado et al., 2013; Carrus et al., 2015a). School garden activities and outdoor play have shown a positive effect on children's self-esteem, wellbeing, and empathy (Dyg and Wistoft, 2018; Sando, 2019). Green life environments (school and residential) may also moderate the impact of stressful life events on children, and

improve their physical and mental health (Bell and Dymont, 2008).

In particular, connectedness to nature seems to play an important role in these benefits of contact with nature, being significantly linked to both hedonic and eudaimonic well-being (Bowler et al., 2010; Capaldi et al., 2014; Warber et al., 2015; Whitten et al., 2018).

The main aim of the two studies presented here is to analyze the outcomes of an experience of contact with nature on psycho-physical wellbeing, during a non-residential outdoor environmental education program conducted for children of Primary and Secondary schools in Italy. Students participating in an outdoor environmental education program were matched with students of the same schools which did not take part in the program, as a control group. Thus, both studies analyze the effects of nature experience on an intervention (participating students) and a control (non-participating students) group, before and after the outdoor education program.

The program was composed of several outdoor workshop activities proposed and designed by experts and teachers, involving both the students and their parents during the Spring season. The activities took place during school time, and children were always supervised by their main classroom teachers. The program was supported by the Italian Ministry of Health; the present study received additional support from CURSA (University Consortium for Socio-Economic Research and for the Environment) and from Sapienza and Roma Tre universities.

All students (intervention and control groups) filled out a questionnaire before and after the education program. Data were collected with the agreement of the head teachers, without interfering with the normal organization of the school activities and teachers commitments. For both studies, written informed consent to participation was provided by parents, prior to the data collection.

## STUDY 1

Study 1 was conducted in the Pantanello natural reserve located in the Lazio Region (about 100 km south of Rome), an area owned and managed by the Fondazione Roffredo Caetani<sup>1</sup>. The environmental education program included three outdoor visits to Pantanello in March, April, and May 2018 for the students and their teachers, plus a fourth final visit where also the parents were involved; the fourth visit was designed with the purpose of letting the parents learn about the workshop experiences directly from the children.

The visits were structured in several educational activities, according to four main workshops carried out in the natural area. The workshops were titled as follows.

- (1) *"The plant landscape of the Park: orient yourself among the ancient knowledge on the use of medicinal herbs"*; the children discovered the use of medicinal herbs through the explanations and stories provided by the educators, as well as directly through their sensorial experiences (e.g.,

colors, smells, tactile experiences). A connection between the experience in nature and school activities was also activated (e.g., children studied in depth the medicinal plants and shared their knowledge with the classmates, created a medicinal plants cookbook, etc.).

- (2) *"Healthy as a fish: paths in the Park, to feel good"*; the children were led to discover the park through their own movements, and bodily and motor experiences. The educators designed different psychomotor paths to activate children's gross and fine motor skills in contact with nature (e.g., jumps, somersaults, etc.). In the class activities, children worked on the connection with the experience in nature; they also designed the paths on paper by exercising their memory and their visual-spatial skills.
- (3) *"Biodiverse and... unbalanced: a path to accessibility"*; in this workshop, the activities were designed to accompany children on the search for traces left by wild animals, and to the discovering and recognition of signs of different plant species. Children observed footprints and signs, dens and nests, leaves and seeds, colors and shapes; the skills related to the experience of sounds in nature were also stimulated, in line with many studies pointing on the importance of soundscapes as key component of positive human experiences of nature (e.g., Aletta et al., 2019; Ratcliffe, 2021): children listened to songs, sounds, and noises, to stimulate a wider sensorial perception and understanding of the ecosystems they were experiencing. Moreover, they reasoned with the educators on how humans have transformed the environment. In class, the children discovered with their teachers the natural features and the characteristics of their territory and discussed interventions to safeguard the environment and the pursuit of a more sustainable lifestyle.
- (4) *"EcoArt and Map of Emotions"*; the main goal of this workshop was to make the children aware of how they feel and what they think during the experience of nature. Children were led to explore some specific and iconic places of the park, and then asked to report on a map their emotions experienced in these specific places. The work on emotions continued in class. Children studied the characteristics of the emotions, how these can be shared with others, how these can be represented by drawings or by other forms of expression. They were also guided in the realization of art products, which were exposed and shared with the other participants during the outdoor experience.

## Aims and Hypothesis

Our main aim was to analyze the effect of the experience of contact with nature on several variables, during the outdoor program in the intervention group and compare it with the control group, across T1 (March 2018) and T2 (June 2018), and to examine the relations among these variables. Students completed a questionnaire measuring pro-environmental attitudes and behaviors, connectedness to nature, psycho-physical wellbeing, pro-social behaviors, empathy, and student's life satisfaction before and after the educational program.

<sup>1</sup><https://www.frcaetani.it/en/pantanello-park/>

We hypothesized that:

- H1: connectedness to nature is positively related to pro-environmental attitudes, psycho-physical wellbeing, pro-social behaviors, empathy, and student's life satisfaction;
- H2: the experience of contact with nature during the outdoor education program positively influences connectedness to nature, pro-environmental attitudes, psycho-physical wellbeing, pro-social behaviors, empathy, student's life satisfaction at T2 (after intervention): we expect differences between the scores at T1 and T2 among students in the intervention group compared to the control group.

## Participants

A total of 407 students of six different schools (located near the Pantanello area) participated in the study (54.1% males); 246 students attended the fourth and the last (5th) year of Primary School (age ranged from 9 to 10 years old), and 161 students attended the first year of Junior High School (11 years old). The intervention group was composed by 154 students and the control group by 253 students.

## Instruments

The questionnaire was composed by six scales, measuring the following variables:

1. *Connectedness to nature*: nine items (e.g., "Human beings are part of the natural world"), adapted and translated from the CNS scale (Mayer and Frantz, 2004), to be rated on a 4-steps Likert scale from "completely disagree" (1) to "completely agree" (4).
2. *Psycho-physical wellbeing*: five items with the "how did you feel in the last month" format (e.g., "I felt happy and in a good mood"), to be rated on a 4-steps scale from "never" (1) to "always" (4), taken from the World Health Organization-Five Well-Being Index (WHO-5; Topp et al., 2015).
3. *Pro-social behaviors*: four items regarding individuals' self-efficacy beliefs, feelings and management of interpersonal relationships (e.g., "if I see someone who is sad, I go to console him"), to be rated on a 3-steps scale from "never" (1) to "many times" (3), taken from the Perceived Social Self-Efficacy Scale (Di Giunta et al., 2010).
4. *Empathy*: three items regarding beliefs on abilities to recognize feelings, emotions and needs of others (e.g., "I understand if my friend needs help even if he doesn't ask me"), taken from the Perceived Empathic Self-efficacy Scale (Di Giunta et al., 2010), to be rated on a 4-steps scale from "not at all" (1) to "completely" (4).
5. *Student's life satisfaction*: seven items (e.g., "I like the activities offered at school"), regarding the students' satisfaction for their school (three items), their living environment (two items), and their self (two items), adapted from Huebner et al. (2012), to be rated on a 4-steps Likert scale from "completely disagree" (1) to "completely agree" (4).
6. *Pro-environmental attitudes and behaviors*: four items adapted and translated from the CATES – Children's Attitudes Toward the Environment scale

by Musser and Malkus (1994) related to children's pro-environmental action (e.g., "I turn off the water when I brush my teeth"), to be rated on a 4-steps Likert scale from "agree" (1) to "disagree" (4).

## Statistical Analysis

Correlation analysis and repeated measures ANOVA were conducted to test our hypotheses.

## Results

As predicted, (H1), connectedness to nature scores measured at T1 and T2 (as displayed in **Table 1**) show a positive and significant relation with pro-environmental attitudes and behaviors, with psycho-physical wellbeing, with pro-social behaviors, with empathy and with students' life satisfaction. Descriptive statistics for all the measures are reported in **Table 2**.

The ANOVA results show a positive and significant effect of the experience of contact with nature during the outdoor education program for the intervention group, at T2, for connectedness to nature [ $F_{(311,1)} = 5.545$ ;  $p = 0.019$ ] (**Figure 1**) and psycho-physical wellbeing [ $F_{(318,1)} = 16.7$ ;  $p = 0.000$ ] (**Figure 2**), as a 2-way interaction effect of group (intervention vs. control) by time (pre-post).

No significant interaction effects were observed for pro-environmental attitudes and behaviors, [ $F_{(315,1)} = 2.434$ ;  $p = 0.120$ ], pro-social behaviors [ $F_{(317,1)} = 0.306$ ;  $p = 0.581$ ], empathy [ $F_{(317,1)} = 2.22$ ;  $p = 0.137$ ], and student's life satisfaction [ $F_{(306,1)} = 0.001$ ;  $p = 0.961$ ].

## STUDY 2

Study 2 was conducted in part in the same location of study 1 (the Pantanello natural preserve), and in part in a different location: the "Sughereta" of Pomezia, a natural area also located in the Lazio region, about 30 km South of Rome.

The organization of the contact with nature experience during the outdoor education program and the research design was the same as in study 1, and took place from March to May 2019.

The specific activities of the workshops were inspired by the theory of "multiple intelligences" proposed by Gardner (1983). The educational program aimed at stimulating a wide range of capacities in students (such as logic, musical, visual, etc.), through different activities to be carried out in the outdoor green space. The activities were organized around five main workshops, dedicated to the following themes, always designed to improve the students' mastery and awareness of their own personal skills and competencies in the natural environment: (1) emotions and use of sensorial skills; (2) orienting oneself into the natural setting; (3) narratives and myths related to the natural site and natural elements; (4) biodiversity in the park; (5) psychomotor paths in the park and motor skills through the natural elements. The main principle of the intervention was using the natural setting as a "field laboratory," promoting the exploration and the physical movement in the park and following the learning goals chosen by the educators and the teachers during the training phase of the project.



**TABLE 1 |** Bivariate correlations between connectedness to nature and pro-environmental attitudes (PEA), psycho-physical wellbeing (PPW), pro-social behaviors (PSB), empathy (EMP), and student's life satisfaction (SLS) at T1 (1) and T2 (2).

	PEA1	PPW1	PSB1	EMP1	SLS1	PEA2	PPW2	PSB2	EMP2	SLS2
CN1	0.543*	0.367*	0.361*	0.318*	0.549*	0.519*	0.363*	0.197*	0.228*	0.453*
CN2	0.473*	0.261*	0.268*	0.163*	0.469*	0.507*	0.371*	0.369*	0.375*	0.538*

\* $p < 0.001$ .

**TABLE 2 |** Descriptive statistics (means and standard deviations) in the intervention and control groups at pre (T1) and post (T2) test, Study #1.

Variable	Group		Tot
	Intervention	Control	
CNS T1	3.44 (0.39)	3.24 (0.51)	3.31 (0.48)
CNS T2	3.49 (0.39)	3.18 (0.56)	3.29 (0.53)
Wellbeing T1	2.98 (0.61)	2.78 (0.52)	2.85 (0.56)
Wellbeing T2	3.21 (0.51)	2.75 (0.58)	2.91 (0.60)
Pro-sociality T1	2.59 (0.28)	2.50 (0.41)	2.53 (0.37)
Pro-sociality T2	2.59 (0.35)	2.51 (0.39)	2.54 (0.37)
Empathy T1	3.14 (0.53)	3.22 (0.57)	3.19 (0.56)
Empathy T2	3.19 (0.51)	3.17 (0.60)	3.18 (0.57)
Life satisfaction T1	3.50 (0.39)	3.24 (0.53)	3.33 (0.50)
Life satisfaction T2	3.46 (0.42)	3.20 (0.53)	3.29 (0.51)
Pro-environmental T1	3.54 (0.48)	3.19 (0.64)	3.31 (0.61)
Pro-environmental T2	3.49 (0.50)	3.23 (0.61)	3.32 (0.59)

Standard deviations are reported in brackets. CNS, Connectedness to nature scale; Pro-environmental, Pro-environmental attitudes and behaviors.

## Participants

A total of 338 students of six different schools participated in the study (48.8% males). 171 students attended the fourth and the last year of Primary School (range age from 9 to 10 years old) and 167 students in the first year of Junior High School (11 years old), 170 students were in the intervention group and 168 in the control group. Three schools were located in the area of Pantanello reserve (same as Study 1), and three schools in the area of the Sughereta of Pomezia.

## Instruments and Hypotheses

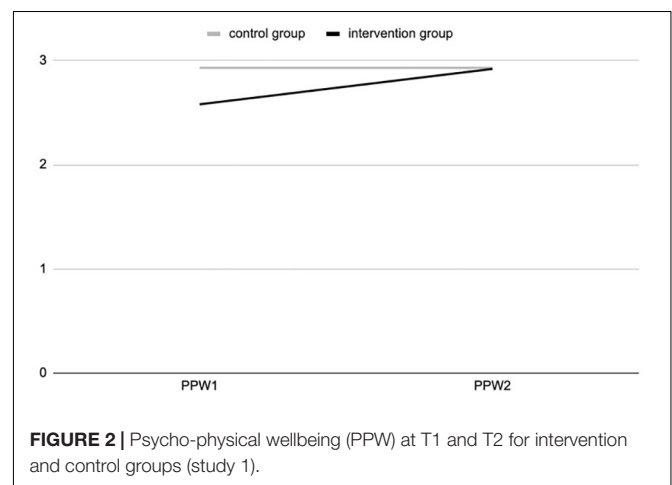
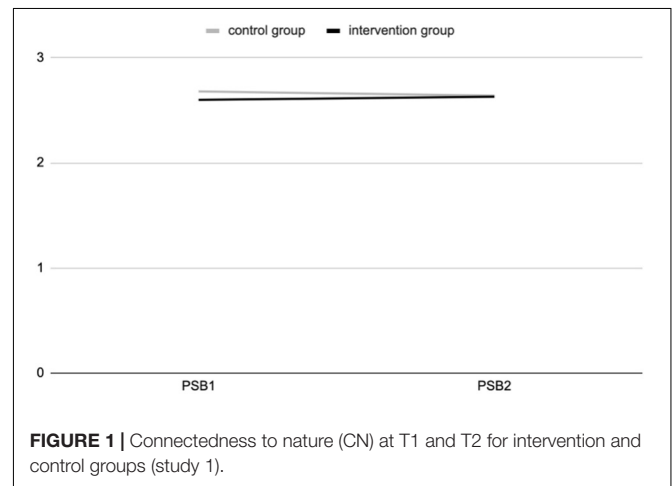
We used the same questionnaire as in study 1, adding the following measure:

7. **Anxiety:** four items of the SAFA-A (Cianchetti and Sannio Fancello, 2001), assessing self-reported anxiety (e.g., "I worry about the things I have to do"), to be rated on a 4-steps Likert scale from "agree" (1) to "disagree" (4).

The hypotheses were the same as in Study 1, with the addition of anxiety (we expected contact with nature to be negatively linked to anxiety).

## Results

Correlation analyses show a positive significant association of connectedness to nature at T1 and T2 with pro-environmental attitudes, psycho-physical wellbeing, pro-social behaviors,



empathy, student's life satisfaction, and anxiety measured at T1 and T2 (see **Table 3**). Descriptive statistics for all the measures are reported in **Table 4**.

The ANOVA analyses (see **Figure 3**) show a positive and significant effect of the contact with nature during the outdoor education program for the intervention group, at T2, on psycho-physical wellbeing [ $F_{(319,1)} = 24.428$ ;  $p = 0.000$ ], as a 2-way interaction effect of group (intervention vs. control) by time (pre-post).

A positive interaction effect, with a tendency to statistical significance, was also observed on pro-social behaviors, increasing at T2 in the intervention group, compared to the control group [ $F_{(314,1)} = 3.225$ ;  $p = 0.073$ ], as reported in **Figure 4**.

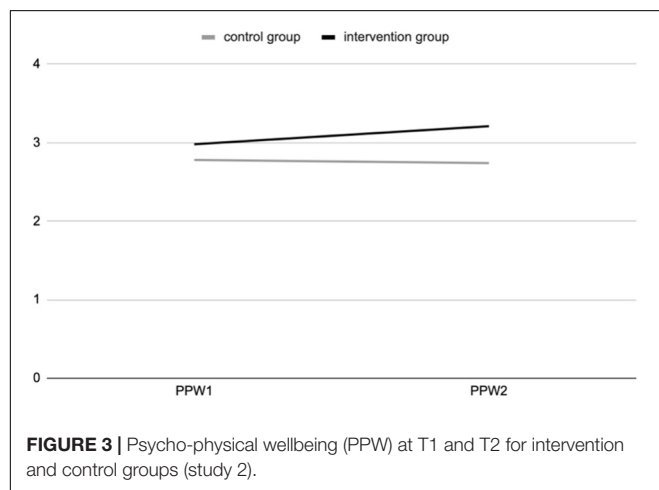
**TABLE 3 |** Bivariate correlations between connectedness to nature and pro-environmental attitudes (PEA), psycho-physical wellbeing (PPW), pro-social behaviors (PSB), empathy (EMP), school life satisfaction (SLS), and anxiety (ANX) at T1 (1) and T2 (2).

	PEA1	PPW1	PSB1	EMP1	SLS1	ANX1	PEA2	PPW2	PSB2	EMP2	SLS2	ANX2
CN1	0.491*	0.270*	0.335*	0.437*	0.461*	0.104	0.322*	0.212*	0.296*	0.335*	0.349*	0.115*
CN2	0.395*	0.227*	0.315*	0.312*	0.403*	0.109	0.418*	0.327*	0.406*	0.400*	0.471*	0.158*

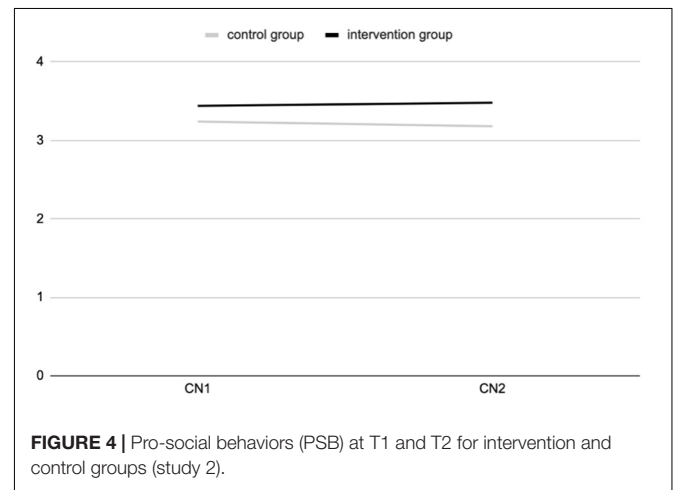
\* $p < 0.001$ .**TABLE 4 |** Descriptive statistics (means and standard deviations) in the intervention and control groups at pre (T1) and post (T2) test, Study #1.

Variable	Group		Tot
	Intervention	Control	
CNS T1	3.27 (0.46)	3.29 (0.46)	3.28 (0.46)
CNS T2	3.28 (0.46)	3.36 (0.48)	3.32 (0.47)
Wellbeing T1	2.59 (0.57)	2.93 (0.51)	2.76 (0.57)
Wellbeing T2	2.92 (0.60)	2.93 (0.56)	2.93 (0.58)
Pro-sociality T1	2.60 (0.40)	2.68 (0.28)	2.64 (0.34)
Pro-sociality T2	2.63 (0.38)	2.64 (0.32)	2.64 (0.35)
Empathy T1	3.10 (0.53)	3.29 (0.47)	3.20 (0.51)
Empathy T2	3.19 (0.53)	3.33 (0.50)	3.26 (0.52)
Life satisfaction T1	3.27 (0.45)	3.36 (0.44)	3.31 (0.45)
Life satisfaction T2	3.22 (0.50)	3.28 (0.51)	3.25 (0.50)
Pro-environmental T1	3.41 (0.48)	3.53 (0.50)	3.47 (0.49)
Pro-environmental T2	3.41 (0.57)	3.50 (0.54)	3.45 (0.55)
Anxiety T1	2.74 (0.70)	2.64 (0.67)	2.69 (0.69)
Anxiety T2	2.80 (0.72)	2.68 (0.76)	2.74 (0.74)

Standard deviations are reported in brackets. CNS, Connectedness to nature scale; Pro-environmental, Pro-environmental attitudes and behaviors.



No significant interaction effects were observed on connectedness to nature [ $F_{(312,1)} = 1.738$ ;  $p = 0.188$ ], pro-environmental attitudes [ $F_{(309,1)} = 0.409$ ;  $p = 0.523$ ], empathy [ $F_{(314,1)} = 0.129$ ;  $p = 0.720$ ], student's life satisfaction [ $F_{(310,1)} = 0.636$ ;  $p = 0.426$ ], and anxiety [ $F_{(311,1)} = 0.316$ ;  $p = 0.462$ ].



## DISCUSSION

This research aimed at describing the outcomes of an experience of contact with nature during school based outdoor environmental education programs, both in terms of students' pro-environmental orientations (e.g., sense of connection to nature and ecological attitudes and behaviors) and in terms of psychological wellbeing and socio-emotional factors.

Our findings are promising in showing that the participation in the outdoor program, providing contact with natural environments, is associated with higher connectedness to nature, psycho-physical wellbeing, and pro-social behavior in the students of the intervention group, compared to a control group. This is consistent with previous research findings outlining the impact of outdoor educational programs on connectedness to nature (Passafaro et al., 2010; Olivos-Jara et al., 2013; Frantz and Mayer, 2014; Otto and Pensini, 2017; Barrable and Arvanitis, 2018; Barrable, 2019a,b). Also, we observed an association between connectedness to nature and pro-environmental attitudes and behavior, confirming previous findings about the role of connectedness to nature for the development of ecological attitudes and behaviors (Mayer and Frantz, 2004; Nisbet et al., 2009; Frantz and Mayer, 2014). The nature-based interventions investigated in our studies had an impact on subjective wellbeing as well, in both studies, plus on connectedness to nature in the first study, and on pro-sociality in the second study.

We could speculate here on a possible explanation for this differential pattern of findings emerged across studies 1 and 2. In fact, it is interesting to point out the commonalities and

differences between the activities performed in the two outdoor educational interventions carried out in the two studies, in line with previous works (Rickinson, 2001). Both the interventions that were assessed in our research targeted factors such as the exploration and motor activities in the natural settings which could have played a role in increasing the students' perception of wellbeing (e.g., describing the natural landscape or specific plants or animals; making graphic representations of the landscape; performing gross motor actions such as running, climbing, moving using natural elements as tools or barriers, etc.). There were, however, some differences between the two interventions. The educational intervention reported in the first study had a somehow stronger focus on the relations between human beings and nature, strengthening the reflection on how the human activity may modify the natural environment and how nature could be a resource for human activity: in fact, the workshops were designed to guide students in the discovery of activities that can be made with the natural elements, such as the use of medicinal herbs for cooking or coloring, or using natural elements for producing art pieces, or learning how the natural features of the environment can stimulate a wider sensorial perception and understanding of the ecosystems. This could have worked for increasing the students' reflection on their relation to nature and their sense of connectedness to the natural environment.

These issues were also addressed in the intervention described in study 2, but with a somehow less salient focus. Rather, the intervention conducted in the second study was more related to the development of personal and social skills, based on the general framework provided by the model of multiple intelligences (Gardner, 1983; Gardner and Hatch, 1989). One could argue that that the theoretical framework of the multiple intelligences used for designing the workshops in Study 2 might have led the students to focus more on other aspects of the environmental education experience: for example, the activities in the "social intelligence" domain could be an explanation of the increased pro-sociality scores in the participant students.

Our findings do not show an impact of the outdoor educational program on other hypothesized factors, such as empathy, life satisfaction or anxiety. Even if these variables are correlated with connectedness to nature, suggesting that a sense of belonging to the natural world may in general be linked with positive emotional states and capacities, their scores did not differentiate the intervention and control groups as a direct effect of the contact with nature. This unexpected finding could be explained by the organization of the interventions. In fact, there is evidence of the role of the timing and intensity of the experience of contact with nature for its impact on connectedness to nature and wellbeing. Residential educational programs may have a stronger impact, and longer interventions may be more powerful than shorter ones (Rickinson, 2001; Passafaro et al., 2010; Warber et al., 2015; Barrable and Booth, 2020). The interventions described in this paper included only four visits to the natural settings, lasting a maximum of 4 hours each (which corresponds to a school time morning), about once a month from March to June: such a schedule may not allow for an intense and deep enough experience in nature, capable of making a difference

in the intrapersonal variables that were measured here. Clearly, it must be underlined the speculative nature of our explanation: thus, this aspects could be subject to further investigation in the future, by planning and implementing interventions with different levels of length and intensity, in order to involve schools and students in an optimal exposition to natural stimuli.

Finally, the association between connectedness to nature and socio-emotional variables and wellbeing offers interesting indications about the role of contact with nature and outdoor activities in the psychological and subjective wellbeing. As noted in previous studies, a strong sense of connection to nature has the power to increase the positive effect of contact with nature on psychological wellbeing and stress resilience (Mayer et al., 2009), also contributing to increased pro-sociality and empathy (e.g., Whitten et al., 2018). Again, the role of specific outdoor education experiences could be an interesting issue to be addressed by future studies in this field.

In conclusion, in these times where the ecological crisis, the climate emergency and the uncertain and unequal access to natural resources demand a radical change in human behaviors toward the environment and the adoption of more sustainable lifestyles, outdoor education programs targeting the new generations' environmental knowledge have a major importance (Pugnetti, 2020). Environmental educators need theoretically sound and empirically grounded knowledge, to design effective and efficient intervention programs, in order to impact on participants' sustainable lifestyles, resilience, and wellbeing (e.g., Warber et al., 2015; Varela-Candamio et al., 2018; Carrus and Panno, 2019; Steinebach and Langer, 2019).

The possibility of promoting more sustainable lifestyles and promoting human resilience by increasing connectedness to nature also through effective education practices is thus a crucial goal and challenge for the advancement of current education systems at the global level.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for this study on human participants in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

## AUTHOR CONTRIBUTIONS

SP and YP planned and implemented the research and wrote and revised the manuscript. SP planned and supervised the data collection. YP performed the statistical analyses and conducted the data collection. GC wrote and revised the manuscript and planned and supervised the data collection. AP supervised

the statistical analyses of study 1 and the research design and selection of the instruments. MC was responsible of the organization, planning, and implementation of the educational intervention. All authors contributed to the article and approved the submitted version.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Understanding the Factors Affecting Sustainable Energy Action Plan: A Case Study From the Covenant of Mayors Signatory Municipality in the Aegean Region of Turkey

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This study presents the case of a Metropolitan Municipality in the Aegean Region of Turkey, which undertook a series of initiatives to conduct projects on environmental protection and sustainability. This case study was conducted as two separate studies as a part of Horizon 2020-funded ECHOES project under Work Package 6, aiming to gain insight into the collective magnitudes of energy-related choices and behavior. The starting point of the process is marked, in 2015, by the municipality becoming a party to the Covenant of Mayors movement, joining around 8,000 signatories from over 50 countries. In line with European Union's (EU's) climate targets and associated energy-related policies, signatories of the Covenant of Mayors aim to decrease carbon emissions by 20% by 2020 and by 40% by 2030. In order to enhance the design and operationalization of policies for achieving these targets, each partner in the Covenant of Mayors is required to develop a Sustainable Energy Action Plan (SEAP). The SEAP is to be prepared within 2 years of becoming a party to the Covenant of Mayors and involves action plans and projects in order to operationalize the strategies for achieving the associated targets. To this end, this study analyzes the Metropolitan Municipality's SEAP and its components, which include zero-emission public transportation project, transformation of existing buildings to a more energy-efficient standard and related energy audit studies, a project for decreasing waiting periods in traffic via a Smart Traffic System, a pedestrianization project, and a project for increasing the use of geothermal energy for district heating. This study set out to identify the internal and external factors, as well as bottom-up and top-down mechanisms involved in various phases of the preparation and implementation of the SEAP. The research method was expert interviews, incorporating viewpoints and perceptions of stakeholders from different levels of the municipality. Among the key results are understanding the roles of enthusiasts and frontrunners in such initiative and the importance of top-management and central government support.

**Keywords:** Covenant of Mayors, municipality, sustainable energy action plan, energy transition, İzmir, Turkey

## INTRODUCTION

In the last decade, the significance and impacts of environmental concerns have become globally recognized. The adverse effects of global warming and climate change are increasingly visible as a result of globalization, growing industrial activity, and urbanization. Adding to these, the rapidly growing population poses risks to the availability of food, water, and energy resources including fossil fuels. These issues have serious consequences for the environment and humans (UN, 2018). One of the foremost responses to these challenges and risks is the adoption of sustainable development policies. These policies call for central and local governments to become parties to agreements that involve targets and commitments regarding environmental sustainability issues, such as considerably reduced carbon emissions and participation in environmental protection efforts. The Kyoto Protocol of 2005 depends on countries' commitments to decrease greenhouse gas emissions. Similarly, the countries that are the signatories of Paris Agreement, in effect as of 2016, committed to efforts to mitigate the effects of climate change and implement strategies that will help developing countries, as well as the signatory countries themselves, to adapt to the effects of climate change.

The signatories of the Paris agreement are the national governments themselves. However, climate change and adaptation efforts are not solely the domain of central governments; local governments, communities, non-governmental organizations (NGOs), and industry clearly have significant roles and responsibilities. Owing to their local power, and the development of leaner and more dynamic structures, local governments have implemented many initiatives regarding environmental issues and sustainability. One striking example is the Covenant of Mayors movement. The Covenant was established in 2008, and the local authorities in the movement share the ambitious goal of reaching, and even exceeding the climate and energy targets of the European Union (EU) (Covenant of Mayors Website, 2020). The Covenant of Mayors aims to harness local governments' effectiveness, rapid decision-making structures, and shorter lead times in implementing decisions to address climate change. In this respect, the Covenant of Mayors enhances the uptake of bottom-up approaches by local governments in decision-making processes and implementations (Energycities, 2018).

As of 2020, the Covenant of Mayors movement has around 8,000 signatories from over 50 countries. In line with EU's climate targets and associated energy-related policies, the signatories aim to decrease their carbon emissions by 20% by 2020 and 40% by 2030. In order to enhance the design and operationalization of policies for achieving these targets, the Covenant of Mayors involves each partner developing a Sustainable Energy Action Plan (SEAP). The SEAP needs to be prepared within 2 years of becoming a party to the Covenant of Mayors, and it involves action plans and projects to operationalize the strategies for achieving the associated targets (Covenant of Mayors Website, 2020).

The Metropolitan Municipality of Izmir, the major Aegean Region city, signed the Covenant of Mayors in 2015. The

municipality is among 16 signatories from Turkey, three of which are Metropolitan Municipalities (Covenant of Mayors Website, 2020). This case study focuses on the process of the SEAP for the Metropolitan Municipality (Izmir SEAP, 2016). The city was selected because the municipality demonstrated keen interest on this initiative, as well as similar initiatives in the past. The Metropolitan Municipality is also a member of World Health Organization's European Healthy Cities Network, which aims at emphasizing the role of health within local governments' strategies and operations, considering the social, economic, and political aspects of health-related issues. The municipality also established a separate department, the Branch Office of Healthy Cities and Clean Energy, responsible for coordinating the strategies and operations for environmental initiatives and mitigating climate change.

The effects of climate change and environmental issues are critical for Turkey, as for any country (Biresselioglu, 2012). However, considering the high share of fossil fuels in Turkey's energy mix and its great dependence on energy imports, initiatives to tackle climate change have multidimensional significance (Biresselioglu et al., 2017). The share of fossil fuels in Turkey's energy consumption is 85%, with a 74% dependence on energy imports (Republic of Turkey Ministry of Foreign Affairs, 2019), representing significant risks for energy security. Regarding the energy diversification and sustainability pillars of energy security, increasing the use of renewable energy resources is important in Turkey's energy strategy agenda (Republic of Turkey Ministry of Foreign Affairs, 2019). The share of renewable sources in Turkey's energy production is 49%, of which hydro contributes 17.9%; geothermal, 14.8%; biomass, 10.1%; and wind and solar, 3.1% each [International Energy Agency (IEA), 2017].

This perspective on climate change, reduction of carbon emissions, related initiatives, and energy security concerns highlights the role of the concept of energy self-sufficiency and associated initiatives in general, and in particular, for local communities. Such initiatives are also supported by developments in smart and green energy technologies (Biresselioglu et al., 2018a,b).

Municipalities have the responsibility for the planning and operation of public transportation, which is a critical component of overall transportation, especially with increasing population and population density. The transportation sector is responsible for around 25% of the greenhouse gas emissions in Europe, making it a major source of air pollution in cities. Of the various components of transportation, road transport alone is responsible for more than 70% of all Europe's transport-related greenhouse gas emissions [European Commission (EC), 2019].

To this end, this study analyzes the SEAP and its phases through data from in-depth interviews with expert participants in the SEAP process. In doing so, it identifies the drivers, motivators, and barriers affecting the process. The drivers in various phases of the preparation and implementation of the SEAP include the following: internal and external factors, bottom-up and top-down mechanisms, lower-level dynamics affecting energy choices, and energy-related behavior of the municipalities. The expert interviews reveal the viewpoints and perceptions of stakeholders

at different levels of the municipality. The deliberate choice of interviewees to include all decision-making levels enhances the analysis of the institutional and governance framework dynamics.

## LITERATURE REVIEW

The more visible environmental impacts of climate change include increased carbon emissions, resulting in declining air quality and greater noise pollution (Adamou et al., 2012; Colmenar-Santos et al., 2014; Kasten and Hacker, 2014; Da Silva and Moura, 2016; Mahmoud et al., 2013). However, the social attitude and response toward climate change have been affected by the generally gradual and difficult-to-perceive nature of its impacts. This leads to the perception of climate change as a phenomenon whose effects are uncertain and remote in time.

Therefore, in order to enhance the awareness and contribution of citizens for mitigating climate change, policies are needed that emphasize its immediate, local, and observable effects. In addition to increasing awareness, it is important to highlight the responsibilities of citizens regarding their energy consumption behaviors and to enhance individual norms (Steg et al., 2005). This can be achieved by implementing interventions to promote energy conservation and by using appropriate design for communications emphasizing citizens' roles and responsibilities about energy saving, making use of constructs from behavioral psychology and behavioral economics (Santin et al., 2009; Frederiks et al., 2015; Podgornik et al., 2016).

Lacroix and Gifford (2018) analyzed the relationship between psychological barriers and energy conservation behavior and identified a set of prevalent barriers. They also conclude that different cultural norms and worldviews influence individuals' perceptions of psychological barriers. In the case of Turkey, for instance, Dursun et al. (2019) conduct a survey with young consumers to investigate the role of environmental awareness in overcoming psychological barriers against energy conservation behaviors. They verify the effectiveness of objective environmental information in this aim.

In the context of behavioral economics, Sütterlin et al. (2011) aim at establishing a segmentation of consumers with respect to energy behaviors, and they propose tailoring efficient policies for specific consumer segments. Good (2019) investigates the potential of behavioral economic theory to provide insights to energy demand response, and he concludes that acknowledging social factors can enhance the management of demand response. Andor and Fels (2018) analyze four categories of non-price interventions aimed at households (social comparison, commitment devices, goal setting, and labeling), concluding that, to varying degrees, all can be effective in developing energy conservation behaviors.

In view of their specific advantages, local authorities emerge as actors and key stakeholders in this process. They are able to actively participate in formulating and implementing strategies toward increasing citizens' awareness and contributions (Biresselioglu et al., 2020). Sustainable urban development relies heavily on initiatives and actions at the local community level (Comodi et al., 2012; van

Doren et al., 2016; Tingey and Webb, 2020), and local governments are becoming increasingly involved in promoting urban sustainability strategies. Hence, the roles of municipalities are undergoing a transformation in their role from local-scale implementers of central government policy toward formulating and implementing their own policies on the local scale. At this point, it is important that local strategies and regulations developed by municipalities conform with the framework of the central governments (Häkkinen et al., 2016). Energy policy development and implementation at the local level requires close coordination with the central government authorities as well as with local stakeholders (Hoppe et al., 2011). However, even with such coordination, financial and regulatory barriers may pose challenges to local governments (Mey et al., 2016; Bergman and Foxon, 2020). Another serious barrier to local authority policies and initiatives is lack of citizens' awareness and support (Hong et al., 2015; Koirala et al., 2018; von Wirth et al., 2018).

When climate change is considered in the context of cities, the transportation sector is a major component. The transportation sector accounts for 25% of the greenhouse gas emissions of Europe (European Commission (EC), 2017; ICCT International Council on Clean Transportation Website, 2020). To this end, electric mobility (e-mobility) is one of the most important strategies for mitigation of climate change and the energy security of Europe. Advantages triggered by deployment of e-mobility include the improvement of air quality due to reduced use of fossil fuels for transportation, emergence of new business areas related with e-mobility technologies, and job creation (Haddadian et al., 2015; European Commission (EC), 2018). Thus, e-mobility establishes a contemporary sustainability concept in the field of transportation (Peters et al., 2011; Faria et al., 2014). Moreover, e-mobility is a major pillar of the 2030 target of European Commission regarding the achievement of zero-emission urban transportation for freight, and the 2050 target of zero-emission urban transportation for passengers. The increased use of e-mobility for public transportation is an encouraging development, which not only contributes to these future targets but also demonstrates immediate gains on air quality and awareness and support of citizens (Öko Institute, 2012; Barisa et al., 2016; Kaplan et al., 2016).

Clearly, e-mobility is not all without drawbacks. Electric mobility increases the demand for electricity generation, and thus, carbon emissions (Öko Institute, 2012; Kasten and Hacker, 2014). The recycling of electric vehicle batteries also poses environmental threats (Haddadian et al., 2015).

Owing to its economic, political, and environmental facets, energy emerged as an important item in the policies, strategic plans, and programs of many countries. The operationalization of the policymaking on the central government level requires the transposition of the elements of these policies to the local and individual scales; initiatives of local communities and their relationship with central policies and strategies are thus critical. Sperling et al. (2011) investigate to what extent local government initiatives are in line with government strategies, by focusing on the implementations of municipalities in Denmark. van der Schoora and Scholtens (2015) utilize the case study method to reveal how local-scale collective energy initiatives can promote



local self-sufficiency, emphasizing the role of the local network, a common vision, and organizational characteristics. Pablo-Romero et al. (2015) concentrate on the municipalities that have undersigned the Covenant of Mayors and identify factors that affect participation in the Covenant of Mayors: the availability of resources for renewable energy, financial considerations, environmental issues, political perspectives of citizens, and previous experience of implementations. Hoppe et al. (2015) analyze the cases of two successful implementations involving local administrations and energy initiatives from Germany and Netherlands. They highlight the importance of leadership, enhanced communication, trust, and process management. Brummer (2018) investigates positive and negative factors affecting community energy initiatives through a comprehensive analysis of implementations in the United Kingdom, Germany, and the United States. The positive factors are economic issues, awareness and acceptance, environmental concerns, achievement of targets, stakeholder participation, and innovation. The main barriers are identified as organizational problems, legal structure, insufficient institutional support, lack of political support, negative attitudes, and lack of organizational capacity. van Doren et al. (2016) consider barriers to general energy conservation initiatives, categorized in terms of under socio-cultural, market, political, and geographical features.

## MATERIALS AND METHODS

This research was undertaken as a part of Horizon 2020-funded ECHOES project's Work Package 6, coordinated by MEB (the lead author) and also contributed to D6.3 and D3.1 of the project ECHOES (2017, 2019), in which MEB was also the lead author.

Both authors in this study contributed to these deliverables and, more specifically, were responsible for the "Sustainable Energy Action Plan (Turkey)" and Zero Emission Public Transportation Project (Turkey)" case studies in D6.3 (ECHOES, 2019).

### Methodology

This study utilizes the case study methodology, chosen for its appropriateness, its capacity to explore real life, and contemporary case or cases over time. It relies on detailed, in-depth data from multiple sources, allowing the detailed report of a case description and case themes. This method allows us to study the unit in focus, in the context of a larger group, making the results more verifiable and representative (Creswell, 1998; Creswell, 2013).

The use of multiple sources of information allows for the uncovering of different aspects and various viewpoints of the focal concepts and topics (Baxter and Jack, 2008). Thus, a case study can provide a comprehensive analysis of the research subject (Stake, 1995; Yin, 2006).

This analysis is achieved through working with participants or stakeholders as sources. These sources are directly involved with the case topic, and their viewpoints allow detailed insight into the context and also facilitate understanding of participants' actions (Lather, 1992; Robottom and Hart, 1993).

A systematic approach to the case study and the presentation of results will enable the identification of similarities and differences among participants, managerial levels, and different perspectives. Hence, the scope of the case study must be carefully determined during the research design (Stake, 1995; Yin, 2003). The scope involves the identification of the definition of the case, the case framework, timeline, place, and activities involved within the case (Miles and Huberman, 1994; Stake, 1995; Creswell, 2003).

To maximize the possibility of generalizing the case level evidence, and providing adequate input for extrapolation, two methodological criteria are considered: representation and contrasting situations (Eisenhardt, 1989).

The case study is conducted through the implementation of qualitative inquiry, in this case, semi-structured in-depth interviews with the relevant stakeholders. In semi-structured in-depth interviews, open-ended questions provide the flexibility to capture respondents' perceptions and perspectives (DiCicco-Bloom and Crabtree, 2006; Kallio et al., 2016). In an in-depth interview, questions can be fine-tuned to previous contributions (Hardon et al., 2004; Rubin and Rubin, 2005; Polit and Beck, 2010). The method aims to explore the research topic by comparing different perspectives on similar aspects (Holloway and Wheeler, 2010), *via* a common interview template or guideline (Gill et al., 2008). Kvale (1996) lists the steps of the in-depth interview as follows: thematizing, designing, interviewing, transcribing, analyzing, verifying, and reporting. Interviewees were selected using a combination of purposive sampling and convenience sampling. Initially, representatives from each of the three managerial layers of the municipality were selected through purposive sampling according to the aims of the study. Then, convenience sampling method was utilized for the rest of the sample. This method ensured that at least two interviewees were selected from each managerial level for performing in-depth expert interviews, so that all phases of the SEAP process and all viewpoints are covered (Curtis et al., 2000; Taherdoost, 2016).

The choice of the sample, i.e., the number of interviews to conduct, was determined through the requirements of the selected methodology. The main aim of in-depth expert interviews was to obtain a comprehensive understanding of the SEAP and related processes and to identify categories of drivers, motivators, and barriers based on these data, focusing on the relationships between these variables through the experiences of the interviewees undergoing the SEAP process. Therefore, two main factors were considered in the selection of the sample size. The first was to select a sample size to assure that the whole timeline of the SEAP process was covered by the interviewees. The second was to achieve saturation, that is, collecting sufficient data, so that no new data concerning the SEAP process, its drivers, and the relationships between drivers would be contributed by further interviewees. Owing to the homogeneity of data provided by each managerial level, and the purposive sampling, the emergent findings started repeating after six interviews. At this point, sufficient data were obtained through the expert interviews (Morse, 2000; Mason, 2010; Baker et al., 2012).

#	Interview Code	Role in Organisation	Gender	Comments
1	11	Top level executive	Female	30+ years of experience in the organisation
2	12	Mid-level manager	Male	10+ years of experience in the organisation
3	13	Operational employee	Male	3 years in the organisation, previous experience in environmental projects
4	14	Top level manager	Male	35+ years of experience. Works for subsidiary of the Municipality
5	15	Mid-level manager	Male	15+ years of experience. Worked for several departments of the Municipality
6	16	Operations Manager	Male	10+ years of experience. Represents the implementation perspective

**FIGURE 1 |** A summary of interview characteristics.

Accordingly, the interview stage involved six different interviewees representing different levels of the municipality. Their profiles are presented in **Figure 1**. Interviews were conducted in 2017 and 2018.

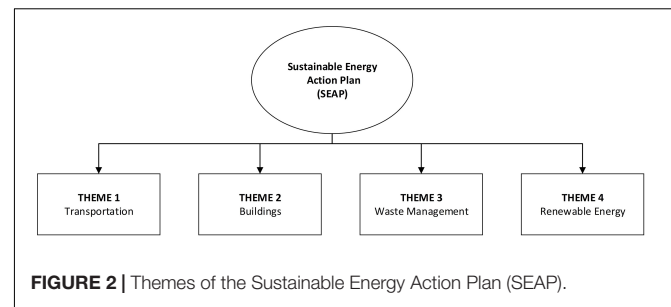
The interview protocol was prepared in sections covering all phases and all aspects of the SEAP (Hollway and Jefferson, 1997; McCormack, 2004). For this purpose, the interview questions guided interviewees toward a case study narrative, following the process phases in chronological order, focusing on the categories of drivers, motivators, and barriers at each step. The main sections of the interview protocol were as follows: descriptions of the case and the role of each stakeholder, analysis of the current approach and alternatives, planning and development of the roadmap, and implementation and implementation results from stakeholder perspectives. Finally, the interviewees were asked for general comments, suggestions, and recommendations.

The analysis of the transcripts of the in-depth interviews was conducted first using open coding as an initial analysis to identify and extract themes. The second step was the use of axial coding to establish the relationships and interactions between the themes identified *via* open coding. As the final step, selective coding was utilized to refine the findings of open and axial coding to determine the main themes for each phase, representative themes for key internal dynamics, and external factors affecting each phase, along with motivators and barriers (Flick et al., 2004; Shenton, 2004).

Triangulation, using different data sources and collection methods to reinforce the robustness and solidity of the analysis, is also crucial for a successful analysis. To achieve this, interviews were conducted with six interviewees in each organization, including a top-level executive, mid-level managers, and operational/field employees. This both enhances the analysis and contributes to successful triangulation through the collection of data from sources that reflected different aspects of the case, and through the independent analysis of data and results by multiple researchers (Flick, 1992).

## RESULTS

The SEAP of Izmir Metropolitan Municipality includes several components: zero-emission public transportation project,



transformation of buildings from the existing standard to a more energy-efficient standard and related energy audit studies, a project for decreasing waiting period in the traffic *via* a Smart Traffic System, pedestrianization project, and a project for increasing the use of geothermal energy for district heating (Izmir SEAP, 2016). Among these, zero-emission public transportation project is of particular importance, involving the increased use of renewable energy, decreased carbon emissions in transportation, and local communities' energy self-sufficiency implementations. Therefore, the following analysis places special emphasis on this project. The project involves the establishment of a fleet of 400 electric public buses, including the charging and maintenance infrastructure, and also a solar power production system for the required power.

The SEAP has four main themes (transportation, buildings, waste management, and renewable energy), as demonstrated in **Figure 2**.

The components of the SEAP are as follows: zero-emission public transportation project, transformation of existing buildings to a more energy-efficient standard and related energy audit studies, a project for reducing traffic wait time *via* a Smart Traffic System, a pedestrianization project, and a project for promoting geothermal energy for district heating.

In what follows, we track the footprints of the SEAP in order to identify the internal and external dynamics in operation during the process, *via* expert interviews designed to elicit different viewpoints and perceptions of stakeholders from different levels of the municipality. The scope starts with the decision to sign up to the Covenant of Mayors and is slightly extended to future projections regarding the SEAP and its sub-projects in order to identify the mechanisms, motivators, and barriers that influence the decision-making process under different circumstances and decision-making situations. An example of the different factors influencing these processes is the decision to become a signatory of the Covenant of Mayors. At first, this appeared to be a wholly top-management endeavor. It later emerged that mid-management was the initial origin, and the process was characterized by a bottom-up approach.

## Factors Affecting the Decision of Undertaking the Endeavor

### Internal Dynamics

The Covenant of Mayors is the most wide-ranging framework, including large-scale governments, and local authorities at the national scale; this was a factor in the decision to become a

signatory. It was also considered a means of increasing the domain of command for local governments and promoting improvement in their decision-making processes.

*"We became a party to the Covenant of Mayors since it was very common, and it had a lot of members. Moreover, it had a specific framework and constituted a better guideline for us [...] Many colleagues said that the Covenant of Mayors would ensure privilege and priority to take grant for EU projects."*

#### Interview I1

*"Consequently, the local authorities have more quick and efficient decision-making processes regarding environmental issues. Therefore, there is a bottom-up decision-making structure. The local authorities do not wait for any instruction from the top management. If every local authority fulfils its duty, the world will be able to find a proper solution for these environmental problems."*

#### Interview I2

*"In 2015, we attended the Paris Climate Conference. In the conference, it was revealed that the global problem caused by climate change could only be solved with the projects conducted by local authorities [...] As we believed that municipalities were highly effective in creating a climate-resistant city, we decided to launch the projects for the fight with climate change."*

#### Interview I1

Although local governments have experienced the benefits of a leaner organizational structure that encourages more active and well-organized decision-making processes, its hierarchical structure can occasionally slow the decision-making process. This structure includes bottom-up and top-down mechanisms; for example, decisions must have the approval of the Municipal Council, as an authority above the Mayor.

*"In 2015, the Municipality became a party to the Covenant. The decision was presented to the Municipal Council; the Mayor signed the document and approved it. The Municipal Council is above the authority of the Mayor [...] Similarly, the Municipal Council in the city is accepted as the representative of all the citizens living in this city. Therefore, the decision of the Council constitutes a great significance. Only the Mayor's decision is not sufficient to become a party to these kinds of agreements."*

#### Interview I2

*"Our commitment of a 20% emission reduction target was firstly approved by the Municipal Council. Then, the Council was convened and presented this issue to the Subcommittee of Environment. Currently, we have a policy document approved by the Municipal Council. This document became an official document approved by the top management. Therefore, our decision-making mechanism had a bottom-up structure, but the top management became conscious to a great extent."*

#### Interview I4

In general, the interviewees agreed on the vital role of both top-down and bottom-up mechanisms. This emphasizes the important influence of the internalization of the residents' voice, and also the mid-level managers' efforts. The top management had two roles: taking the final decision and fostering the implementation.

*"[...] our Mayor became a pioneer for the other 11 municipalities regarding the implementation of the Sustainable Energy Action Plan. Our Sustainable Energy Action Plan was a precondition*

*to participate in other European Union H2020 projects. These preconditions include the design of Action Plans, emission reduction targets, an inventory study to achieve these targets, declaration of intention and a comprehensive report regarding the actions to be taken."*

#### Interview I3

*"It was a project that came from the bottom of the structure of the firm. When the general manager accepted this, the Covenant of Mayors supported this project [...]. The project idea came from the bottom, but it was a good thing that we had an assistant general manager supporting us."*

#### Interview I5

## External Factors

### The role of central government

The perception of the overwhelming authority of the central government emerged as a crucial factor. In Turkey's management culture, the decision-making dynamics is usually considered to have a top-down structure, underlining the role of central government as a powerful actor both in decision making and in planning and implementation.

*"As there is a strong central government in our country, the decision-making mechanism has a top-down structure. This means the plans and projects are designed by top level executives. Therefore, we can achieve all plans with the support of external stakeholders such as the Ministry of Energy and the Ministry of Environment and Urbanization."*

#### Interview I3

*"The Covenant of Mayors offers an option for us regarding the decrease of carbon emission. Accordingly, there are sectors that are under the responsibility of Municipalities. However, the industrial sector is not under the responsibility of Municipalities."*

#### Interview I2

### Perception of side benefits

Municipality authorities expected membership in the Covenant of Mayors to have lateral benefits, for instance, supporting municipality's applications to further EU project grants.

*"Furthermore, we can get EU projects by way of the Covenant of Mayors. Many colleagues said that the Covenant of Mayors would ensure privilege and priority to take grant for EU projects."*

#### Interview I1

## Factors Affecting the Planning and Implementation Phases

The methodology for these Action Plans was initially established by the Covenant of Mayors itself. Succeeding the course of action as recommended by the Covenant of Mayors seemed candid.

*"Our Mayor became a party to the Covenant of Mayors and gave a commitment to reduce carbon emission by 20% until 2020. As a part of this commitment, we had to prepare a SEAP. Now, the Action Plan is in the implementation process."*

#### Interview I1

*"After we became a party to the Covenant of Mayors, we gave a commitment to prepare the Sustainable Energy Action Plan within 1 year. Therefore, we made an attempt for the preparation of the Plan. There is a methodology suggested by Covenant of Mayors for the preparation of this Plan. The Plan was designed according to this methodology."*



### Interview I2

However, various factors had noteworthy impacts on how these phases eventually evolved.

### Internal Dynamics

The organizational construction and organizational capacity were found to be key to the planning and implementation stages. In this specific case, the organizational structure was modified by the creation of a department responsible for the SEAP, followed by the creation of an auxiliary project team from members of other divisions. Workshops were organized to build and improve organizational capacity.

*"We are the first municipality that established a Directorate on this issue. As I said before, we determined the carbon emission values of the city. Then, we determined what we could do within the scope of the municipality's own responsibility for the reduction of carbon emission values, and we started to take actions."*

### Interview I1

*"All the departments in the municipality need a guidance for the implementation of these Action Plans. Therefore, we organized meetings to inform the employees in the municipality. We explained to them what the Sustainable Energy Action Plan is and why we conduct such a project."*

### Interview I3

*"The first thing to do was to encourage the stakeholders to adopt this plan. After the Sustainable Energy Action Plan was approved in the Municipal Council, we gathered only the top executives of all our companies and all our units in the assembly hall. The Mayor also mentioned the studies on the Sustainable Energy Action Plan and set some targets. In this way, all stakeholders started to focus on topics such as renewable energy and transportation."*

### Interview I6

The creation and development of bottom-up mechanisms by top-level managers were among the most substantial internal factors concerning implementation.

*"The key factor for the effectiveness of the Sustainable Energy Action Plan is the fact that decision-makers and top executives encourage and support the personnel. The decision-makers support and give importance to the ideas and suggestions put forward by the personnel in the bottom."*

### Interview I2

In as much as the SEAP is an effort linked to the municipality as a collective decision-making entity, the involvement of individuals and especially, of the Mayor, is vital in the introduction of this Action Plan.

*"The fact that Mayor was aware of the issue and supported us in the fight with climate change was the major effective factor. The city was a pioneer with respect to environmental issues and got a reward from the United Nations as the first environment friendly city. . . I think the key factor behind this success was based on high awareness level of the executives, their support and a competent technical team."*

### Interview I1

*"The Mayor made a speech on this issue and invited everyone to take charge of the implementation of this action plan. He also had an aim to encourage the municipality to generate its own electricity from renewable energy resources. In other words, the success of the*

*project is based on the initiatives of the Mayor and commitment of the personnel."*

### Interview I1

The employees' technical competence and self-assurance are likewise viewed as a significant factor in the implementation of the SEAP.

*"We work with employees that are technically self-conscious. They really have a high level of awareness; they like research and development; they want to improve themselves."*

### Interview I1

*"I think it is very useful in terms of raising awareness and developing a corporate perspective. . . I think SEAP is highly influential in terms of raising awareness of the technical personnel in the municipality. I believe that it will be quite successful in the end."*

### Interview I1

### External Factors

The planning and implementation phases involved challenges over which the authority of the central government was decisive. A number of sectors evidently within the scope of the SEAP were excluded from the planning and implementation phases, which were under jurisdiction of the central government. This encompassed the industrial sector, which produced the largest share of carbon emissions at 50% of the total.

*"[ . . . ] We also set a target regarding renewable energy. At this point, there are two different sets of categories consisting of targets. One is the targets within the Municipality, and the other one is the targets on the urban scale. The targets on the urban scale are more flexible, and the industrial and agricultural sectors were excluded as the municipalities could not intervene in these sectors. However, the inventory study included these two sectors."*

### Interview I4

The participation of external stakeholders is critical for the implementation of the SEAP. To this end, a workshop was organized for the participation of external stakeholders and capacity building.

*"A workshop was organized in the most critical stage of this project. All the related stakeholders including universities, trade associations, the Department of Transportation, the Chamber of Civil Engineers, the Chamber of Survey Engineers, and the Chamber of Architects were invited to the workshop. The most important aspect of organizing such a workshop was to see the projects of the external stakeholders."*

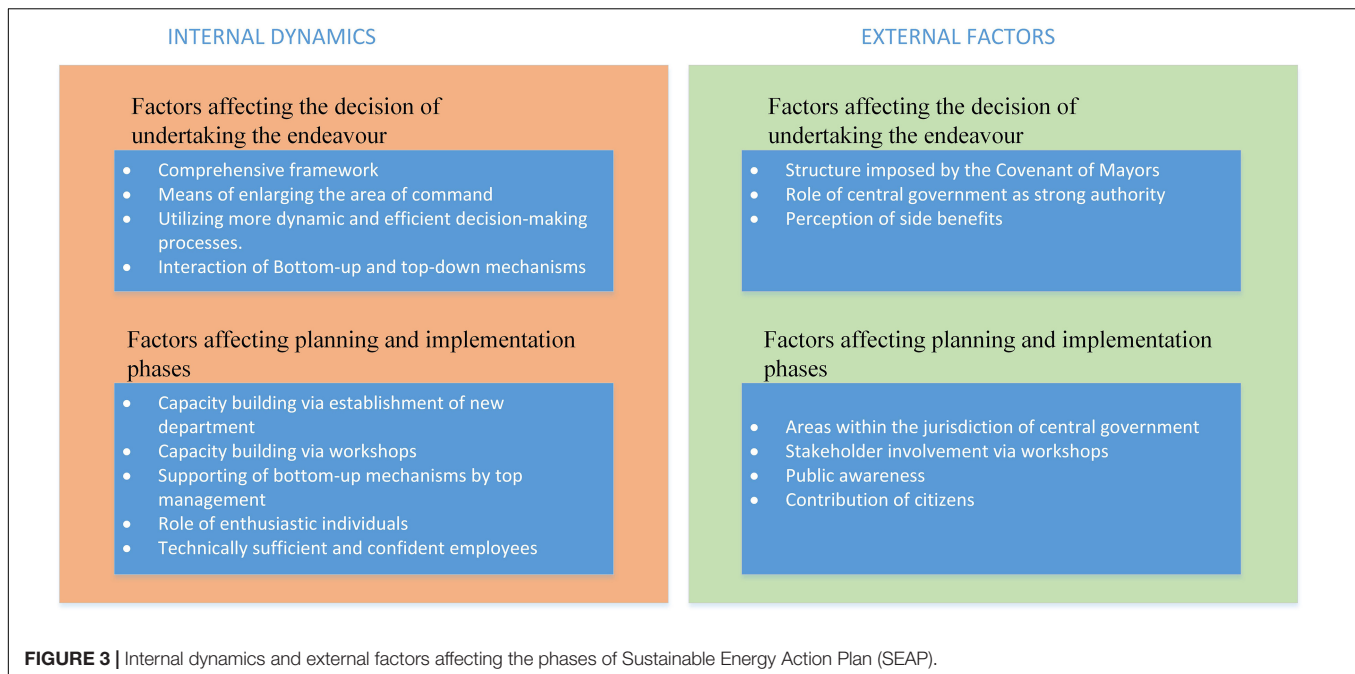
### Interview I3

Public awareness and contribution are critical for the implementation phase. To achieve carbon emission reduction targets, sections of the SEAP include policies directly targeting citizens.

*"[ . . . ] we designed projects to achieve [ . . . ] emission reduction targets. The projects included studies to raise awareness about solar energy projects, waste management, transportation, pedestrianization and use of bicycles, electric vehicles and electric buses."*

### Interview I3





*“One aim of transportation planning is to popularize the public transportation options such as the metro and tram, as well as pedestrian sidewalks and bicycle roads.”*

**Interview I6**

Figure 3 provides a summary of the internal dynamics and external factors affecting the decision to undertake the responsibility for planning and implementation of the SEAP in its various phases.

## Evidence From Implementation, Barriers, and Motivators

### Results of the Implementation

Considering the outcomes of the implementation of the SEAP, the key result is the achievement of energy savings and environmental targets.

*“Energy efficiency does not only provide a financial opportunity and saving but also provides a chance to reduce carbon emissions. Moreover, we decrease our energy consumption in this way.”*

**Interview I4**

*“It is possible to make energy saving by 5% only by informing people and raising their awareness.”*

**Interview I6**

*“In 2019, electric vehicles will be operating in 4 different cities. Interestingly, all the municipalities in these cities purchased 20 electric vehicles. I think they take this city as an example. We believe these projects will increase in local governments.”*

**Interview I5**

Stakeholders’ increasing awareness and support, and enthusiasm for further actions also boost energy-saving behavior.

*“Both the management and public are more aware of these issues. As the public awareness has increased regarding climate change-related issues, the popularity of Sustainable Energy Action Plan has*

*started to rise. These kinds of Action Plans constitute an umbrella for all other plans, programs and strategies of the municipalities.”*

**Interview I4**

*“As our effort is adopted by the top management, all stakeholders are more enthusiastic about developing these kinds of projects.”*

**Interview I3**

*“Now, we can see that all other departments try to take a step in this field without our intervention. This implies that every department in the municipality has started to give more importance to energy-related issues and energy systems.”*

**Interview I1**

Related impacts on a greater scale are anticipated. These projects are expected to increase the awareness of the notion of sustainability nationally.

*“I think that these plans will further increase the importance of the concept of sustainability in multiple fields: sustainable energy activities, sustainable growth, sustainable development and sustainable cities.”*

**Interview I6**

*“We achieved our target to create a sustainable city by minimizing the effects of environmental pollution without depleting the natural resources. I am also very hopeful in the national sense and I think that these efforts will not be in vain.”*

**Interview I1**

Throughout the project, design, operation, and organizational capabilities were enhanced. This heightened know-how will be available in comparable upcoming projects, and the process was also important in revealing issues requiring further enhancement. Furthermore, the encouraging outcomes of the implementation can also be observed in external stakeholders, particularly suppliers that serve as the industrial partners.

### Highlights from implementation results

- Achievement of energy savings targets
- Progress towards environment-related goals
- Increasing awareness and support of stakeholders
- Appetite for similar new endeavours
- Increased emphasis on the importance of sustainability on a national scale.
- Increase in design, operations and organizational capabilities and capacities
- Potential for utilization of the expertise for similar projects
- Identification of issues that need to be addressed for improvement
- Contribution to external stakeholders (e.g. suppliers) in terms of improving their capabilities and capacities

**FIGURE 4 |** Highlights from implementation results of the Sustainable Energy Action Plan (SEAP).

*"If you make a good example of an implementation, you can definitely apply it to the others. Other municipalities realized this implementation here [...] Our project was the major experience for us."*

**Interview I6**

Thus, the endeavor also provides avenues for further collaboration between public and private sectors for mutual benefits of the stakeholders.

*"We will probably have to focus more on battery management system... The infrastructure of these battery management systems will be firstly used applied in electric cars. Then, the buses and trucks will be supplied with the same system. Turkey is regarded as the commercial vehicle centre. We export many products to Europe from Turkey. This shows that our infrastructure is actually quite developed."*

**Interview I6**

Another important impact is greater public acceptance.

*"We don't have any hesitation regarding electric vehicles since we realized that they were quite economical. Our citizens use them and they have an experience regarding these vehicles. The only problem is the fact that they have started to normalize them. There is no obvious demand from the public regarding the increase of electric vehicles in public transportation."*

**Interview I5**

**Figure 4** reveals the key highlights from implementation outcomes of the SEAP.

### Barriers

The interviews pointed out a number of barriers that delay or adversely affect the general process of the SEAP.

#### Lack of awareness and acceptance

Citizens are not familiar with the notions and issues associated with climate change, thus hindering the Action Plan adaptation process. As one solution, the Operational Employee proposes publicity campaigns to raise citizens' awareness.

*"At the beginning, they had difficulty in conceptualizing carbon emission and the setting of emission reduction targets; however, they adopted this plan well after the public and non-governmental organizations became more aware of climate change-related issues."*

**Interview I3**

*"We also advertised our emission reduction targets on the television news."*

**Interview I3**

#### Resistance to change and slow social progress

Resistance to change is observed as additional key barrier to implementation, as it obstructs the social progress toward a low carbon city. NGO publicity campaigns and activities will be significant in reducing this resistance.

*"As a matter of fact, some of the people show resistance to the measures taken against climate change while some other accept the struggle with climate change as a facilitating trend. The civil society organizations are also quite successful in this regard. They organize campaigns and direct people to take an action against climate change."*

**Interview I4**

*"I don't feel very hopeless, but I see that our social progress is unfortunately very slow... We lost the enthusiasm of the citizens because of the problems caused by the citizens and the handicaps in the state administration."*

**Interview I1**

#### Bureaucratic issues

Three of the interviewees identified three main types of bureaucratic barriers: regulatory issues, administrative boundary problems, and the role of central administration.

The main difficulties concerning regulations in Turkey are their frequent amendments, the multifaceted legal structure, and long-established legal procedures, in addition to shifting political conditions. These factors present challenges in the implementation of the Action Plans.

*"The regulations restricted us regarding the implementations in renewable energy systems. They made their implementation difficult at the national level."*

**Interview I2**

*"As far as the legislation is concerned, it is seen that the legislation was the common problem, because it is constantly changing, and it has a complex structure."*

**Interview I3**

*"We improved our system in terms of regulations, because the regulations in Turkey are severe on this issue and the legal procedures take a long time."*

**Interview I3**

The comprehensive scope of the applied regulations denies any opportunity for privileges or exemptions for different types of organizations.

*"For example, we had a correspondence with General Directorate of Renewable Energy on this subject, but we did not get a positive result. We said that the regulations make it impossible to conduct such kinds of projects. We also asked whether there is any privilege for the municipalities and official institutions. As a municipality, we said that our buildings had a different position and offsetting was*

*very economical for us. However, they said there was no privilege on this issue."*

**Interview I1**

An additional regulatory problem concerns the administrative boundary; i.e., the provincial boundaries of the city were enlarged by central government regulations. These affected the size of the population and extended the control area, creating challenges for the Metropolitan Municipality in achieving targets.

*"The provincial borders of the city were changed as provincial administrative boundaries. Consequently, the responsibility of the district municipalities was transferred to the Metropolitan Municipality and the consumption level of the Metropolitan Municipality increased."*

**Interview I4**

*"We're having a hard time in explaining these facts to the citizens, because the population is quite high in large cities."*

**Interview I6**

Another challenge is the crucial role of central government, and particularly the Municipality's economic dependence on the central administration.

*"There is an engagement in the sense of economic commitment to central administrations and compliance with the decisions made. This might be the major challenge in practice."*

**Interview I1**

Despite the existence of incentive mechanisms in Turkey, a number of institutions have difficulty in making investments in renewable energy systems. Local authorities cannot fully benefit from these mechanisms due to the complexity of the procedures.

*"We were very disappointed, because while establishing the solar power plants, the central administration receives certain costs related to the transformer connections. These prices have been increased by 13 times. Therefore, installation of rooftop solar panel and offsetting of a different building was not a profitable and economical decision anymore. At this point, I lost my interest and enthusiasm to install solar panels on our buildings."*

**Interview I1**

### Issues with data collection

As stated in the roadmap, a full inventory study and precise data collection are important for effective implementation. Yet a noteworthy barrier remains in the form of challenges in the data-gathering process, together with the data's technical insufficiency and inarticulateness, in terms of both national and international standards.

*"In the urban scale, local electricity distribution companies became a stakeholder in the project. In this regard, the Mayor made several correspondences with these stakeholders. In fact, we had difficulty in collecting data from external sources [...] This is probably caused by the fact that electricity distribution companies have been privatized and this data can be collected from private companies. These challenges might stem from resistance, unwillingness, or commercial factors."*

**Interview I6**

*"Within the framework of the Sustainable Energy Action Plan, they asked us how many universities and personnel work for the*

*fight with climate change in the city. We don't have any data on this issue."*

**Interview I3**

*"Another challenge was the fact that the partners and stakeholders in the project did not have technical adequacy and they could not keep data regularly."*

**Interview I4**

### Financial issues

Costs and budget considerations cause great difficulty in the implementation of renewable energy developments. Currently, there are inadequate incentive mechanisms to boost domestic investment in renewable energy systems in Turkey.

*"The cost of generating energy from renewable energy resources is pretty high. We have one more problem: Who will cover the expenses of such a renewable energy project?"*

**Interview I3**

*"As the return on investment period is too long and costs are extremely high, some of these systems are no longer profitable and economical. Although some of our existing roof areas were available, we had to reduce the number of solar panels and started to use them only for meeting the consumption of the building."*

**Interview I1**

*"The price of one electric bus equals to the price of three conventional fossil fuel-based busses. At this point, the question is that whether we should provide a cleaner service to less people, or an environmental polluting service to more people."*

**Interview I2**

One further problem is associated with the difficulty in accessing sufficient financial resources. In the case of a developing country, exchange rate volatility and the lack of technological adaptation pose a vital challenge for sustainable energy projects at both local and national levels.

*"Especially Europeans question many things regarding their financial sources, and they have sufficient financial sources for renewable and sustainable energy projects. The financial issues are also extremely significant for us. Besides financial sources, they have the technology to successfully conduct these kinds of projects [...] In fact, increasing foreign exchange rate creates serious problems for us in terms of financing these kinds of projects. Turkey is a developing country and we need financial support and efficient financial sources."*

**Interview I3**

*"It was suggested that we could install solar panels on the rooftop in the urban scale, but we realized that these kinds of large-scale projects would require huge investments. Therefore, they were not feasible."*

**Interview I6**

### Motivators

As well as facing barriers, the SEAP process has also benefited from motivating factors regarding the implementation. The following section analyzes the major positive as identified in the interviews.

#### Advantages of being a local authority

In addition to the lean organizational structure and dynamic decision-making process, the municipality has advantages of a local authority's close relations with the public, and its

ability to foster cooperation with the Mayor and other municipal stakeholders.

*“As a local authority, we have many advantages. We can create close relations with the public. As we train our employees in the municipality, they can also convey their own experiences to the public.”*

**Interview I4**

*“The most important thing that makes our work easier is the importance given by our top management in this city to climate change-related issues.”*

**Interview I3**

### **The perceived goal of living in a cleaner city**

The implemented Action Plan allows a greener, cleaner, and more sustainable environment, providing citizens with prospects for healthier environmental conditions.

*“These projects may enable a cleaner and livable city. This is the major motivator for all citizens.”*

**Interview I6**

*“The citizens in the city are more sensitive. This is the most important point that differentiates the citizens of this city from the others... They say that it is much easier to spread an implementation to all other cities if it is firstly applied in this city.”*

**Interview I3**

### **Affiliation with international organizations**

As climate change is a global problem that affects all humans worldwide, it is of great importance to work within international organizations and simultaneously to consider national interests. These memberships stem from the motivation for joint action on climate change.

*“We are one of the members of World Healthy Cities Association. We believe that our membership is an encouraging attempt.”*

**Interview I1**

*“We decided that the Covenant of Mayors would be a good motivating factor for us in this process. We put forward a suggestion on this issue to our executives. The Municipality had already a positive attitude toward these kinds of initiatives.”*

**Interview I2**

### **Top-management vision and commitment**

*“Our executives have always highlighted that in the next 10 years, the electric vehicles will be on our agenda; especially in the next 20 years they will be seriously prioritized. We should make our research about this issue well; we should keep our data properly; as these things develop, there will be serious changes in our energy infrastructure. It was explained that we had to create units and departments that would follow this process. It is even planned to create other units such as a Directorate of Energy and a Department of Energy.”*

**Interview I5**

### **Teamwork and enthusiastic personnel**

*“Our assistant general manager was leading the project. There is an ongoing electric vehicle project in our company, and also a commission was established including young engineers dealing with the supply of electrical equipment from different branches.”*

**Interview I5**

### **Bottom-up mechanisms**

*“It was a project that came from the bottom of the structure of the firm. When the general manager accepted this, Covenant of Mayors supported this project. Then, it was asked why the project was not combined with solar energy plant project. The project idea came from the bottom, but it was a good thing that we had an assistant general manager supporting us.”*

**Interview I5**

**Figure 5** provides a listing of barriers and motivators of the process of SEAP.

## **CONCLUSION, DISCUSSION, AND RECOMMENDATIONS**

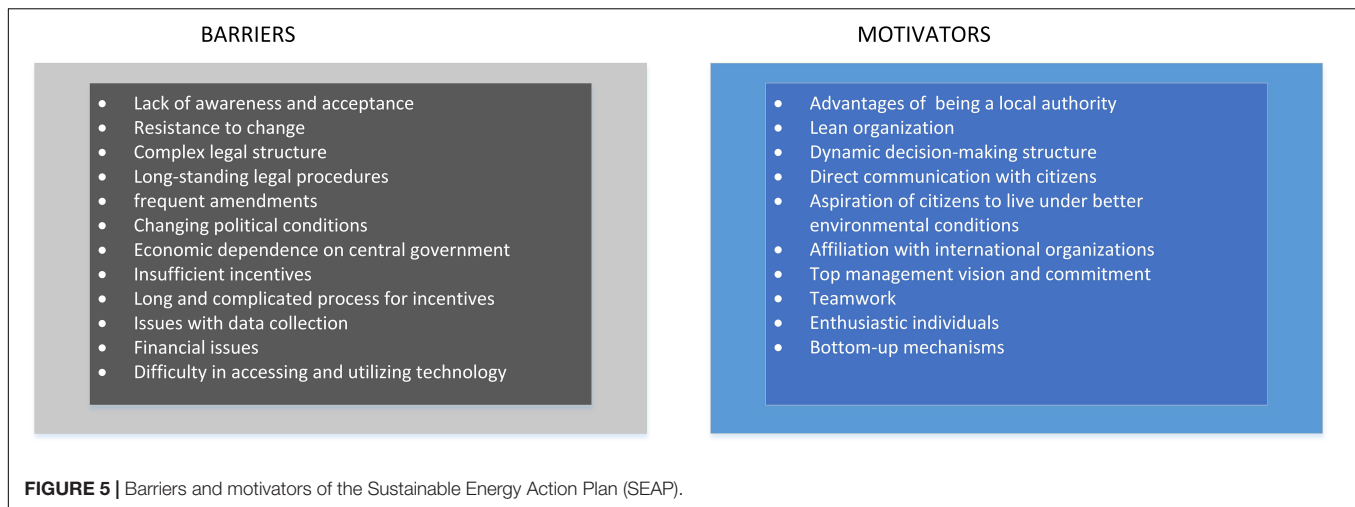
Izmir Metropolitan Municipality's environmental protection and sustainability initiatives provide an exemplary case that can guide other local administrations and collective decision-making units. The process is conducted in significant phases, each involving different aspects, from the initial idea to implementation, through post-implementation results. Although often perceived as a straightforward implementation of the Covenant of Mayors, in fact, each step demonstrates a complex interaction between mechanisms, influencing factors, barriers, and motivators. These parameters extend across a wide spectrum of themes, including infrastructural, organizational, social, administrative, individual, and financial aspects. The identification of these characteristics allows for the evaluation of the process, and this allows learning that can be applied in similar implementations. It also points out the multidimensional nature of such a process and highlights the need for a comprehensive approach.

Expert interviews and case study methodology were implemented for the analysis and identification of relevant factors. The involvement of interviewees from different backgrounds and managerial levels enhances representativeness and ensures the incorporation of a range of stakeholder viewpoints and perceptions.

As a result of the outputs of the interviews, several suggestions and recommendations can be identified for the success of the SEAP and similar endeavors.

An overview of the SEAP process marks the vital role of top-level management. In particular, the commitment of top-level management is crucial in the initial phases of the process and for ensuring organizational acceptance. In some cases, the top-management commitment is driven by environmental factors but in others by personal or corporate reputation, which can be perceived as a driver pertaining to Turkish culture. The top-level management also significantly contributed toward establishing the balance between the framework drawn by the central government and its application by local authority. In parallel with the evidence from the literature, the SEAP experience emphasizes that the central government's considerable jurisdiction is the determining factor in terms of legal and administrative restrictions and budget. Other outcomes of the government's prevalent power are the underutilization of the potential synergy between the local and central governments,





and the inability of local governments to develop and implement policies customized for the requirements of their communities. Such challenges are alleviated to some extent by memberships to initiatives such as the Covenant of Mayors.

The case also verifies findings from the literature revealing that such initiatives cannot be successful without encouraging and operationalizing bottom-up approaches. There are numerous factors affecting citizens' acceptance of energy initiatives and their contributions to these initiatives. The literature includes numerous studies emphasizing the importance of social and cultural aspects, such as lifestyle choices and habits, for such initiatives. Emphasis on the economic benefits for the city and individuals also contribute to increasing awareness and building trust. In the case of the SEAP, public awareness and contribution have only been addressed during the implementation phase; however, this study points to the need for policies and measures to increase citizens' awareness, trust, and contributions from the design phase.

The technical and administrative capacities of the organization also play a key role as a success factor. Qualified, competent professionals and experts are needed to further contribute to environmental initiatives.

Another component pertains to collaboration with external stakeholders such as industry and research institutions. A significant opportunity is provided by public-private partnership mechanisms, which can be effectively encouraged by cases similar to the zero-emission transportation component of the SEAP. In such cases, municipalities or governmental institutions should seek collaboration with local industries or startups through the development of new products, services, or technologies, such as battery management software for electric public transport vehicles. In return, the community receives custom solutions that fit their specific requirements. Public-private partnerships can be developed by not only local-scale initiatives but also subsidies and research and development (R&D) funding schemes. Additionally, trilateral cooperation between the university, industry, and public should be encouraged *via* mechanisms such as workshops or meetings.

This local collaboration, often overlooked in the existing literature, also promotes investment in R&D for technological improvement and domestic production.

Another finding from the analysis of the SEAP case is that countries that lag behind contemporary technological advances will inevitably depend on external sources, material, and expertise. This hinders the successful implementation of decisions due to greater costs and a narrower set of potential alternatives.

Existing studies in the literature suggest that, under the current paradigm, governments and local authorities focus on climate change mitigation rather than adaptation activities. However, there is a need for improvement in adaptation, based on future projections in terms of how countries, as well as cities and urban places, might react to these negative impacts. Accordingly, municipalities and local governments need to incorporate the regional climate model projections into their adaptation strategy and preparations. The SEAP also provides an example in which motivators, such as the Covenant of Mayors, encourage local governments to set goals more ambitious than those of central governments and then formulate and implement initiatives to achieve these.

The SEAP and similar plans involve action plans and projects. The success of the SEAP is highly dependent on how far these plans and projects are designed for and tailored to the needs of the local community. Equally important is the inclusion of well-defined follow-up and monitoring mechanisms to track the progress of implementation. The feedback process embedded in these mechanisms allows identification of issues and setbacks with implementation and facilitates the deployment of appropriate actions.

The implementation and success of initiatives such as the SEAP rely on several key factors, as emphasized in the interviews. To begin with, undertaking such an endeavor is more challenging without similar earlier implementations because supporting stakeholders, e.g., side industries, are not familiar with the requirements or specifications expected of them. Therefore, emphasis is placed on networking, experience sharing, learning

from best practices, and even from failures. *A priori* information on potential barriers may help cities and also industries in designing remedies, just as an understanding of the toolbox of motivators may provide opportunities for better exploitation.

## DATA AVAILABILITY STATEMENT

The data generated for this study are available on request to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by İzmir University of Economics' Ethics Committee for Social Sciences. The patients/participants provided their written informed consent to participate in this study.

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## AUTHOR CONTRIBUTIONS

MEB and MHD conceptualized the research methodology, interpreted the results together, and wrote the “Conclusion, Discussion, and Recommendations” section. MEB designed the manuscript, undertook fieldwork *via* contacting six municipality representatives, and conducted the interviews together with MHD. MHD performed the analysis and prepared the first draft. MEB revised the first draft, updating and writing the developing sections of the manuscript. Both authors have read and approved the final manuscript.

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# Altruism, Environmental Concerns, and Pro-environmental Behaviors of Urban Residents: A Case Study in a Typical Chinese City

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To investigate the relationships between altruism, environmental concerns, and ordinary people's pro-environmental behaviors that go beyond self-interested NIMBY-ism, we examined measurements of altruism and environmental concerns in a Chinese context and developed a scale that measured people's pro-environmental behaviors at the individual, organizational, and policy level. We then conducted a tailor-made, face-to-face survey ( $N = 603$ ) and found, first, that old age, gender (being a woman), party affiliation, and education level are positively associated with pro-environmental behaviors at the individual, organizational, and policy levels. We next found that human domination worldviews are negatively associated with individual- and organizational-level pro-environmental behaviors and that eco-centric worldviews are positively associated with individual-level pro-environmental behaviors. Third, we found that altruistic behaviors (prosocial behaviors and/or donations) are positively associated with pro-environmental behaviors. In short, awareness of the ecological crisis and altruism can stimulate people's pro-environmental behaviors in China. Meanwhile, it is doubtful that people care more for the environment after their living standards have improved, because socioeconomic status indicators are not statistically significant for individual-level pro-environmental behaviors.

**Keywords:** altruism, environmental concerns, environmental behaviors, individual participation, organizational participation, policy participation, China

## INTRODUCTION

While China's pollution levels continue to increase, people's environmental awareness has also increased over recent decades (Gilley, 2012; Lu et al., 2019). However, scholars have argued that people's environmental concerns may not correspond with their environmental behaviors (Harris, 2006; McGranahan and Tacoli, 2006). In other words, attitudinal questionnaires may be helpful in understanding how respondents believe they will act, but it cannot measure their "true" behavior (Dockery and Bedeian, 1989). For example, although the association between environmental attitudes and behaviors is generally positive (Soutter et al., 2020), empirical studies analyzing the direct relationship between environmental concern and behavior have consistently supported the conclusion that the relationship is low to moderate (e.g., Weigel and Weigel, 1978; Hines et al., 1986/87; Schultz and Oskamp, 1996; Diekmann and Preisendörfer, 1998). Moreover,

McGranahan and Tacoli (2006) found a negative correlation between environmental concerns and pro-environmental behaviors among urban dwellers and rural migrants.

From a theoretical standpoint, the literature suggests three major assumptions that can explain people's motivation to engage in pro-environmental behaviors: that such behaviors are performed to benefit oneself (i.e., assumption of egoism), to benefit unfamiliar others (i.e., assumption of altruism), or for the act in itself but not for oneself nor anyone else (i.e., assumption of a moral principle) (e.g., Hardin, 1977; Kahneman and Knetsch, 1992; Batson, 1994; Clark et al., 2003; Hong, 2006; Eom et al., 2019).

Of all three assumptions, the assumption of egoism has been dominant in research on environmental behavior. Many studies have revealed that gaining personal benefits (e.g., better living environment, health, and/or psychological gratification) ranks among the most important factors motivating pro-environmental behaviors (e.g., Kahneman and Knetsch, 1992; Nunes and Schokkaert, 2003; Daube and Ulph, 2016; Hartmann et al., 2017). In particular, of various pro-environmental organizational behaviors, so-called "not in my back yard" (NIMBY) activities in China have drawn great attention from scholars (Ho, 2001; Stalley and Yang, 2006; Lang and Xu, 2013; Wu, 2014; Gu, 2016).

Meanwhile, research has also verified that pro-environmental behaviors have inherent characteristics of altruism (Clark et al., 2003; Griskevicius et al., 2010; Bolderdijk et al., 2013) and pro-environmental principles such as concern for the environment (Dunlap et al., 2000; Hong, 2006; Halkos and Matsiori, 2017; Eom et al., 2019). Thus, self-interested individuals will behave in pro-environmental ways when their behavior benefits them personally but not when the benefit is exclusively environmental. By contrast, altruistic individuals and environmental ethics supporters will engage in pro-environmental behaviors when the benefits are personal and, critically, even if they are solely environmental (Passmore, 1974; De Dominicis et al., 2017).

It is worth noting, for ordinary people who are not involved in NIMBY activities, "The impact of an individual's pro-environmental behavior on its own marginal welfare is rather negligible" (Hartmann et al., 2017: 44). Therefore, ordinary people who engage in pro-environmental behaviors may act for the benefit of the common good (e.g., for future generations) and for the environment itself (e.g., to conserve nature for its own sake) instead of themselves. In that regard, the assumptions of altruism and a moral principle should be important drivers of pro-environmental behaviors. However, in the literature from China, only a few articles discuss the possible effects of altruism and environmental ethics on environmental behaviors at a conceptual level (Yan, 2009; Li, 2016), whereas the possible relationships between altruism, environmental ethics, and environmental behaviors in China have not yet been examined empirically.

This study aimed to fill this research gap. By using a survey developed especially for this study, we adopted the assumption of altruism and the assumption of a moral principle to investigate the pro-environmental behaviors of ordinary people in China

that go beyond self-interested NIMBY-ism. More specifically, we sought to:

- Measure a broad range of ordinary people's everyday pro-environmental behaviors;
- Measure altruism and environmental concerns in a Chinese context; and
- Assess how those pro-environmental behavioral patterns correspond to altruism, environmental concerns and demographic factors.

## LITERATURE REVIEW AND HYPOTHESES

### Revisiting Environmental Behaviors in China

People's environmental behaviors have been studied at the individual, organizational, and policy levels in China (Ru, 2004; Yang, 2005; Wang and Lin, 2010). At the individual level, although the specific findings vary, studies have shown that demographic characteristics (e.g., gender, age, and education) significantly impact people's pro-environmental behaviors, including making green purchases and donating to environmental protection organizations (Gong and Lei, 2007; Hong and Xiao, 2007; Chen et al., 2011; Zhang, 2012, 2016). For example, several studies have revealed that women in China express less environmental concern than men (Hong and Xiao, 2007), whereas others have shown that women display greater levels of environmentally friendly behaviors (Gong and Lei, 2007) and that women, older individuals, and people with higher levels of education have greater environmental concern than others (Li, 2003; Luo and Deng, 2008; Shen and Saijo, 2008; Zhang, 2012, 2016). Such controversial results are due to factors of social context. After all, China's borders contain areas with striking differences in not only climate and landscape but also in the people who live there. Such diversity urges researchers to be cautious when choosing instruments for measurement and when making inferences from results.

At the organizational level, Ru (2004) has identified 42 types of activities conducted by Chinese environmental non-profit organizations (ENPOs) (except for the international and student organizations); examples include holding elections, running board meetings, fundraising, interests-based activities (bird watching, tree planting, etc.), organizing exhibitions (such as photograph exhibitions), and street tabling/dissemination of information or souvenirs. Although several well-organized environment-related collective actions in China (e.g., protests against the paraxylene petrochemical plant in Xiamen and incinerators in Beijing, Wujiang, and Panyu) have drawn great attention from scholars (Lang and Xu, 2013; Wu, 2014; Gu, 2016), little research has been conducted to study ordinary people's participation in environmental protection at the organizational level. However, as scholars have revealed, such environmental movements, by taking aim at local projects that tend to prompt short-term concessions and that may prompt polluting companies to merely shift operations toward less-populated and/or investment-hungry provinces, are

unlikely to affect environmental protection in China at the policy level (Ho, 2001; Stalley and Yang, 2006; Li et al., 2012).

At the policy level, it is worth noting, regulations of the People's Republic of China on Open Government Information (OGI), which came into effect on May 1, 2008, empowered citizens' public participation at the policy level. According to OGI, officials are required to publicize information about land use, government spending, public health, food and drug safety—anything directly affecting citizens. Thus, by visiting the government or certain ENGOs' official websites, the ordinary people can get various information such as public hearings on environmental assessment, the latest related regulations, and so forth. Nevertheless, to date, studies have primarily focused on students and/or environmental leaders but not the main stream of people in China who have never engaged in any environmental movements. For instance, given the rapid growth of ENPOs, Yang (2005) has proposed that they could serve both as onsite schools and as agents of democratic social change in China. By comparison, Ho (2001) has argued that China's brand of environmentalism has a "female mildness," meaning going green as long as no conflicts arise and only at a safe distance from direct political action (p. 916). Stalley and Yang's (2006) case study also revealed that altruistic environmentalism among students was unlikely to become an independent movement or a source of pressure for changing policy in China. Beyond that, however, ordinary people's pro-environmental behaviors at the policy level (e.g., to visit the website to collect the related policies, to join a public hearing, etc.) are seldom discussed.

Based on above literature review, to gain a better understanding of the environmental behaviors of ordinary people in China who have never engaged in any environmental movements, we categorized pro-environmental behaviors as occurring at the individual, organizational, or policy level. Likewise, the impacts of demographic factors on the ordinary people's behaviors in relation to the environment were explored at the individual, organizational, and policy levels.

## Altruism and the First Hypothesis: The Assumption of Altruism

In general, altruism can be defined as an individual performing an action which is at a cost to themselves, but benefits, either directly or indirectly, another individual, without the expectation of reciprocity or compensation for that action (Batson, 1987, 2011; Johnson et al., 1989; Eckel and Grossman, 1996; Van Lange et al., 1997). Indeed, debate persists over whether individuals are ever truly altruistic, because people may perform so-called "good deeds" for egoistic reasons, including for public praise or to avoid guilt (Hardin, 1977; Batson, 1987; De Dominicis et al., 2017). Environmental behaviors can also be motivated by reasons of either altruism or self-interest (Guagnano, 2001). However, in research on altruism at the societal level, investigating observable behaviors is more appropriate than investigating internal motivations (Comte, 1875).

Altruism may also be a universal virtue across all societies (Johnson et al., 1989; Simon, 1990; Sober and Wilson, 1998;

Madsen et al., 2007; Eom et al., 2019). For instance, in Western thought, Hume (1896, 1902) and Smith (1759) discussed the possibility of human action based on unselfish motives, or what they termed benevolence. Comte (1875), who coined the term altruism, also believed that some social behavior was an expression of an unselfish desire to "live for others" (p. 556). In China, the ancient philosopher Mencius (370–286 BCE) elaborated upon the idea of benevolence and described altruistic actions in various texts that have since circulated for thousands of years:

Everyone has a heart which cannot bear the suffering of others ... If anyone sees a child about to fall into a well they will feel fear, not because they may impress the child's parents or their neighbors and friends. From this we can see that compassion is essential to humanity, along with shame, modesty and acceptance (Mencius, 2009 2A:6)

Expend the respect of the aged in one's family to that of other families; expend the love of the young ones in one's family to that of other families (Mencius, 2009 1A:7).

Because pro-environmental behaviors have been shown to positively relate to altruistic values (Clark et al., 2003), we hypothesized that altruism positively relates to environmental behaviors at the individual, the organizational, and the policy level (H1). Our sub-hypotheses were as follows:

H1a: Altruism positively relates to environmental behaviors at the individual level.

H1b: Altruism positively relates to environmental behaviors at the organizational level.

H1c: Altruism positively relates to environmental behaviors at the policy level.

## Environmental Concerns and the Second Hypothesis: The Assumption of a Moral Principle

The assumption of a moral principle, which suggests that environmental behaviors involve moral judgment, partly adheres to the Kantian rule of the supreme principle of morality, that "neither fear nor inclination to the law is the incentive which can give a moral worth to action; only respect for it can do so" (Kant, 1959, p. 440). Similarly, Xunzi ("Master Xun"), a renowned philosopher of China's Warring States Period (481–221 BCE), in his chapter titled "Discourse on Nature" states that nature acts as it always does and that its processes do not change from one epoch to the next (Goldin, 2005).

Considering the assumption of a moral principle, scholars have studied people's environmental attitudes and affirmed that environmental concern—that is, an attitude of seriousness toward environmental problems (Attfield, 1983; Benson, 2001; Dunlap and Jones, 2002)—may affect various pro-environmental behaviors, including responsible consumption and supporting environmentally friendly policies (Nisbet and Myers, 2007; Halkos and Matsiori, 2017; Hall et al., 2018; Eom et al., 2019). For example, environmentalists advocate banning waste incineration for energy, not because pollution occurs in their neighborhoods but because they believe that people in most cities are exposed to

toxic concentrations of nitrogen dioxide and particulates, among other pollutants.

Thus, we hypothesized that environmental concern positively relates to environmental behaviors at the individual, organizational, and policy levels (H2). Our sub-hypotheses were as follows:

H2a: Environmental concern positively relates to environmental behaviors at the individual level.

H2b: Environmental concern positively relates to environmental behaviors at the organizational level.

H2c: Environmental concern positively relates to environmental behaviors at the policy level.

## RESEARCH DESIGN

Because altruism is a virtue encouraged by various cultures (Johnson et al., 1989; Simon, 1990; Sober and Wilson, 1998; Madsen et al., 2007), researchers need to consider how differences in sociocultural factors, including language, social norms, and social structures, can impact the conduct and interpretation of their empirical research (Allison, 1992; Shiu-Thornton, 2003; Eom et al., 2019). Therefore, in this section, we carefully justify our selection of research setting, target population, and sample, as well as measurements for altruism, environmental concern, and environmental behaviors.

### The Research Site: A Typical Chinese City

Led by the research objectives, we conducted a survey ( $n = 603$ ) from May 9 to May 27, 2014, in a typical Chinese city, which is a cradle of traditional Chinese civilization. According to the city's bureau of statistics, the registered population (i.e., the *hukou* of the City) was 6,999,900 at the end of 2013. In contrast to the metropolises of Beijing, Hong Kong, and Shanghai, this city is more representative of all Chinese cities in its institutional system, size, and culture. To ensure the anonymization, we use "the city" or "the typical city" instead of the city's real name in this article.

The city is located at the juncture of low mountains and hills, such that its terrain is high in the south and low in the north. Dust and pollutants descend upon the city when the wind blows from the north, and due to air pollution, children in the city have often had to stay inside for physical exercise in the winter.

The city's environmental transparency, which can raise public awareness of environmental issues and give the public the tools that it needs to identify and mitigate environmental risks, improved in the 3 years before we conducted our survey. According to the Pollution Information Transparency Index (PITI), which aims to assess the disclosure of sources of pollution-related information, identify and promote good local practices, and encourage the disclosure of information about the environment in general, the city ranked 74th among 113 cities in China in 2011, 61st among 113 cities in 2012, and 24th among 120 cities in 2013 (IPE and NRDC, 2012, 2014).

For the above reasons, the research site, as a typical city in China that faces stress due to environmental problems and has begun to make efforts to reduce pollution, deserves an investigation.

## Research Ethics

This study was approved by the Survey and Behavioral Research Ethics Committee. We prepared and distributed the "Consent Form for an Anonymous Survey" that provided enough information for prospective respondents to decide whether or not to take the survey. The form briefly introduces the study, states that participating in the research is voluntary and that respondents are free to refuse to participate and may withdraw from the research at any time, states that the data would be anonymized and used only for academic purposes, and provides the principal investigator's name and contact information.

## Pilot Study

A pilot study was conducted from November 28 to December 5, 2013. Thirty questionnaires were collected in the aforementioned city to test the reliability of the Chinese Self-Report Altruism Scale (SRA, by Rushton et al., 1981) which was translated by us and New Ecological Paradigm Scale (NEP, by Dunlap et al., 2000) which was translated by Hong (2006). We applied IBM SPSS Statistics V22.0 to analyze the data. And found those values were acceptable (Cronbach's  $\alpha > 0.7$ ). Once several items were edited to correct minor grammatical errors, the questionnaire was finalized.

## Sampling and Data Collection

To ascertain the main patterns of ordinary people's environmental behaviors, we combined random sampling and purposive sampling to collect data in the city. The sampling procedure was conducted as follows.

First, we randomly selected three districts from among the six districts in the city. Next, we randomly selected a street office (*jiedaobanshichu*) in each district. Each sub-district is in charge of  $\sim 10$  neighborhoods (*Juweihui*), and the total population managed by a street office exceeds 50,000. At that point, in each sub-district street office, we randomly selected a neighborhood where no NIMBY activities had occurred in the previous 3 years. Although random sampling can be highly representative of the population, to avoid possible residential segregation and ensure that participants sampled represented variety in social background, we selected one high-end residential estate and one inexpensive residential estate in each neighborhood. Altogether, six estates were included in the study.

Next, we hired 12 field interviewers to conduct a face-to-face survey. The interviewers knocked on the doors with odd room numbers in the selected estates. People above 18 years old who opened the door were invited to answer the face-to-face questionnaire.

In total, 639 questionnaires were distributed, and 603 valid questionnaires were collected. It should be noted, we regret the unexpected missing data. This may be due to the mailing distance, which led to some answers being difficult to read. For example, there are 20 items of the SRA scale, however, if one item of the scale is missing, the information of the whole scale is missing. Therefore, there are only 325 valid samples after factor analysis of SRA. In regression analysis, due to the increase



of variables, the number of samples will continue to decrease, resulting in the minimum sample size of 216.

## Measuring Altruism, Environmental Concern, and Environmental Behaviors

### Altruism: Revised Self-Report Altruism Scale

A number of measures—such as prosocial values, social responsibility, moral judgment, and empathy—appear to be stable traits of altruism (Staub, 1974; Rest, 1979; Rushton et al., 1981; Ma, 2013). Scholars have designed a number of scales to measure altruism in various social contexts (Heist and Yonge, 1962; Mehrabian and Epstein, 1972; Ma and Leung, 1991; Khanna et al., 1993; Chou, 1996). Among the direct measurements of altruism, the SRA, developed by scholars in Canada (Rushton et al., 1981), is one of the most widely used scales, even in non-Western societies. For example, Khanna et al. (1993) modified the original SRA to develop a Hindi version of the scale.

Given that the Chinese language, culture, and social context can vary greatly from those in other countries, several scholars have translated and revised the SRA for research in China. For example, Chou (1996) translated the Hindi SRA into Traditional Chinese to assess the altruistic behaviors of adolescents in Hong Kong. More recently, Song and Chen (2012) and Tang et al. (2015) translated the original SRA into Simplified Chinese and revised the scale to measure altruism among college students in mainland China. However, because most people living in mainland China do not read Traditional Chinese and because our research's purposes required a sample including adults from all walks of life and with various levels of education, levels of income, ages, and occupations, none of the original or derived instruments were suitable for our research.

Thus, to confirm factors describing altruism in mainland China, we critically examined the Canadian and Hindi SRAs in light of the Chinese context. In turn, the first author translated both instruments into Simplified Chinese, and the translations were assessed by a professor of English linguistics whose native language is Mandarin. After that, we invited an expert in social psychology and an expert in social research methods to comment on the items of the Canadian and the Hindi SRA scales. The two experts agreed that both scales would need to be revised before they could be applied in China. At that point, we recruited 77 full-time postgraduate students majoring in social sciences who hailed from 31 provinces of China. The students were randomly divided into group A (38 students) and group B (39 students). Group A was asked to respond to the Canadian SRA, and group B was asked to respond to the Hindi SRA. At the same time, the students were asked to comment on each item of the scale by answering the following questions: Does the translation of the item match Chinese expressions/usage? Does the content of the item correspond to Chinese culture or social reality? Do you have any other opinions?

The opinions about the Canadian SRA included the following ideas. First, the situation of “I have helped push a stranger's car out of the snow” would seldom occur in many parts of China. Second, regarding “I have given a stranger a lift in my car,” more than 70% of the students expressed that due to the worry of

endangering their own safety, people would not give a ride to strangers, and they believed that other Chinese people would not do so either. They stated that this question may not reflect altruism well, given the low level of social trust in China. At the same time, three students said that they had given strangers a lift, two students had been given a lift by strangers, and 14 students stated that they might give others a lift.

The opinions about the Hindi SRA included the following ideas. First, the “scooter” or “motorbike” (frequently used in this scale) is not the major means of transportation in China and would need to be revised. Second, the use of assumed imagination in the scale should be discussed, as imagined behaviors may be different from behaviors in reality. Furthermore, self-enhancing bias is likely to occur when someone is invited to report their altruistic attitude, although the “imagined activities” and the real acts may be linked (Gosling et al., 1998; Baumeister, 1999).

Therefore, in line with the opinions collected, a Chinese SRA was developed by slightly modifying the Canadian SRA. After much deliberation, the item, “I have helped push a stranger's car out of the snow” in the Canadian SRA was replaced with “I have helped a stranger put his/her luggage in the luggage rack” in the Chinese version. This is for two reasons. First, pushing a car and putting luggage in a luggage rack are similar: both require a certain level of physical strength to help others. Second, most public transportation in China (such as planes, cars, trains, etc.) have a luggage rack, so it is more likely that most Chinese people will encounter someone who needs to put luggage on a luggage rack. Additionally, given the lack of consensus regarding the item, “I have given a stranger a lift in my car,” this item was included for further investigation.

The specific measurement items of the Chinese version of the SRA are shown in **Table 1**. Respondents are asked to rate their engagement in the activity in each item on a five-point Likert scale, where “1 = never,” “2 = once,” “3 = more than once,” “4 = often,” and “5 = very often.” A higher score represents a greater number of altruistic acts.

We adopted principal components analysis (PCA) to analyze the 20 items of the Chinese SRA. Factors with eigenvalues greater than one are subjected to a varimax rotation. It was found that two items had communalities of <0.3 (9 - “I have helped carry a stranger's belongings [books, parcels, etc.]” and 14 - “I have let a neighbor whom I didn't know well borrow an item of some value from me [e.g., a dish, tools, etc.]”). We excluded items 9 and 14, and then applied PCA to the 18 items of the scale. As the results shown in **Table 1**, seven items load most heavily on the first factor, which we named “prosocial behaviors” factor (1, 3, 5, 11, 17, 18, 20). It is not only because the items described the prosocial activities, but also because the relationship between altruism and prosocial attitude has been long discussed (Schwartz, 1972; Batson, 1987). Five items load most heavily on the second factor, which we named the “sympathetic behavior” factor (7, 8, 12, 15, 16). This is because these items embody sympathetic elements, and it was believed that sympathy could be one of the altruistic motivation (Krebs, 1975). Four items load most heavily on the third factor, which we named the “social responsibility” factor (2, 10, 13, 19). Though there is a debate that engaged

**TABLE 1 |** Factor analysis of altruism.

Item	Factor analysis				
	Prosocial behavior	Sympathetic behavior	Social responsibility	Social donation	Communalities
1. I have helped a stranger to put his/her luggage in the luggage rack.	<b>0.52</b>	−0.10	0.26	0.46	0.55
3. I have made change for a stranger.	<b>0.63</b>	0.10	0.17	0.28	0.50
5. I have given money to a stranger who needed it (or asked me for it).	<b>0.63</b>	0.07	0.02	0.18	0.44
11. I have allowed someone to go ahead of me in a line up (at photocopy machine, in the supermarket).	<b>0.54</b>	0.33	0.14	−0.21	0.47
17. I have, before being asked, voluntarily looked after a neighbor's pets or children without being paid for it.	<b>0.59</b>	0.28	0.13	0.22	0.48
18. I have offered to help a handicapped or elderly stranger across a street.	<b>0.47</b>	0.26	0.26	0.32	0.46
20. I have helped an acquaintance to move households.	<b>0.64</b>	0.13	0.28	0.13	0.51
7. I have done volunteer work for a charity.	0.10	<b>0.69</b>	0.02	0.32	0.59
8. I have donated blood.	0.37	<b>0.42</b>	−0.22	0.21	0.41
12. I have given a stranger a lift in my car.	0.52	<b>0.53</b>	−0.10	−0.20	0.61
15. I have bought "charity" Christmas cards deliberately because I knew it was a good cause.	0.16	<b>0.72</b>	0.07	0.16	0.57
16. I have helped a classmate who I did not know that well with a homework assignment when my knowledge was greater than his or hers.	0.10	<b>0.62</b>	0.30	0.12	0.50
2. I have given directions to a stranger.	0.05	−0.07	<b>0.66</b>	0.41	0.61
10. I have delayed an elevator and held the door open for a stranger.	0.22	0.13	<b>0.74</b>	0.03	0.61
13. I have pointed out a clerk's error (in a bank, at the supermarket) in undercharging me for an item.	0.16	0.47	<b>0.48</b>	−0.11	0.49
19. I have offered my seat on a bus or train to a stranger who was standing.	0.14	0.06	<b>0.80</b>	0.02	0.66
4. I have given money to a charity.	0.27	0.23	0.16	<b>0.68</b>	0.61
6. I have donated goods or clothes to a charity.	0.22	0.40	−0.06	<b>0.67</b>	0.65
Eigenvalues	2.99	2.58	2.31	1.83	9.71
Percentage of variance	16.62	14.34	12.81	10.19	53.96

*The bold values in one column means that the items load onto one factor.*

social responsibility not always being driven by altruism, scholars have suggested certain links between social responsibility and altruism (Tang et al., 2015). Two items load most heavily on the fourth factor, which we named the “social donation” factor (4, 6). As one of the most popular altruism behaviors in various cultures, donation could be an important dimension of altruism (Eckel and Grossman, 1996). The Cronbach’s alpha coefficient of the above mentioned factors were 0.78, 0.70, 0.71, and 0.50, respectively.

As we mentioned earlier, though a few studies have used the SRA scale, there is no consensus on the measurement in terms of translations and dimensions among Chinese scholars (Chou, 1996; Song and Chen, 2012; Tang et al., 2015). To facilitate a more direct analysis of the effect of each independent variable on the dependent variable in the regression model, we used a formula to convert these factors into an index between 1 and 100 (Table 2). Thus, the mean of people’s altruism in prosocial behavior, sympathetic behavior, social responsibility, and social donation of participants engaging in pro-environmental behaviors are 56.46, 41.20, 62.51, and 51.68, respectively (Table 2).

### Environmental Concern: A Chinese Version of the New Environmental Paradigm

Chinese scholars have translated major scales, including the New Environmental Paradigm (Dunlap and Van Liere, 1978), the Environmental Concern Scale (Schultz and Zelezny, 1998, 1999), and the NEP (Dunlap et al., 2000) and suggested modifying them

to better suit Chinese culture and society (Chung and Poon, 1999; Hong, 2006; Xiao and Hong, 2007; Liu and Wu, 2012; Hong et al., 2014). However, no consensus on the measurement of environmental concern in China has been reached. Some scholars have adopted a translated version of the original scale, whereas others have deleted several items, and still others have introduced new items (Luo and Deng, 2008; Duan, 2009; Luo et al., 2009; Feng, 2010; Zhou, 2011).

On the basis of a pilot study, we adopted the NEP scale (Dunlap et al., 2000) translated by Xiao and Hong (2007) for three reasons. First, Hong (2006) and several other scholars adopted the translated Chinese version of the NEP in the nationwide Chinese General Social Survey (CGSS) in 2003 and 2010, and they acknowledged that the scale can be an important instrument for measuring the general public’s environmental attitudes when properly altered (Xiao and Hong, 2007; Hong et al., 2014). Second, because no consensus exists on the revision of the NEP scale, applying the original NEP (i.e., the Chinese version) remains the most appropriate option. Beyond that, as Hong et al. (2014) have suggested, the scale can be further revised by deleting certain items with low resolution coefficients in data analysis. Third, because the NEP has become a widely used measure in pro-environmental research in more than 40 countries (Hawcroft and Milfont, 2010), using the scale may improve dialogue between research and benefit knowledge accumulation.

The specific measurement items of NEP are shown in Table 3; the answer options consist of five items, including “1 - strongly disagree,” “2 - disagree,” “3 - undefined,” “4 - agree,” and “5 -

**TABLE 2 |** Descriptive statistics of research variables.

Continuous variable	Mean	Standard deviation	Sample size	Category variable	Percent %	Sample size
<b>Dependent variable: Pro- Environmental behaviors</b>				<b>Age</b>	100	531
Individual participation factor	55.59	20.91	483	Young adults (18–44)	55.18	293
Organizational participation factor	13.95	15.30	483	Middle adults (45–59)	20.15	107
Policy participation factor	36.95	21.21	483	The elderly (60+)	24.67	131
<b>Independent variable: Environmental Concerns.</b>				<b>Political status</b>	100	500
Human domination factor	55.63	13.68	544	CPC Member	23.60	118
Eco-crisis factor	59.09	17.12	544	Non-CPC Member	76.40	382
Balance of natural factor	57.21	18.35	544	<b>Education level</b>	100	567
<b>Independent variable: Altruism</b>				Junior Secondary and Below	25.75	146
Prosocial behavior factor	56.46	18.25	325	Senior Secondary	25.93	147
Sympathetic behavior factor	41.20	18.20	325	College or University	44.78	254
Social responsibility factor	62.51	19.15	325	Postgraduate and above	3.53	20
Social donation factor	51.68	16.76	325	<b>Personal monthly income</b>	100	526
<b>Category variable</b>				0–1,999 ¥	34.03	179
<b>Gender</b>	100	558		2,000–3,999 ¥	46.01	242
Male	43.55	243		4,000–5,999 ¥	11.79	62
Female	56.45	315		6,000–7,999 ¥	4.37	23
				≥8,000 ¥	3.80	20

We used the following formula to convert these factors into an index between 1 and 100:

Convert factor = (factor + B) • A.

A = 99/(maximum factor - minimum factor).

B = (1/A) - minimum factor.

**TABLE 3 |** Factor analysis of environmental concerns.

Item	Factor analysis			
	Human domination	Eco-crisis	Balance of nature	Communalities
2. Humans have the right to modify the natural environmental to suit their needs.	<b>0.61</b>	0.04	−0.02	0.37
4. Human beings' ingenuity will ensure that we do NOT make the earth unlivable.	<b>0.56</b>	−0.05	−0.05	0.32
6. The earth has plenty of natural resources if we just learn how to develop them.	<b>0.60</b>	0.18	0.05	0.39
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.	<b>0.67</b>	0.15	0.13	0.49
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.	<b>0.55</b>	0.23	−0.07	0.36
12. Humans beings were meant to rule over the rest of nature.	<b>0.60</b>	0.09	0.22	0.41
14. Humans will eventually learn enough about how nature works to be able to control it.	<b>0.64</b>	0.03	0.22	0.45
3. When human beings destroy nature, it often produces disastrous consequences.	0.14	<b>0.65</b>	0.25	0.50
5. Human beings are abusing and destroying the environment.	0.11	<b>0.67</b>	0.20	0.50
7. Plants and animals have as much right as human beings to exist.	0.14	<b>0.69</b>	−0.10	0.51
13. The balance of nature is very delicate and easily upset.	0.04	<b>0.67</b>	0.23	0.50
15. If things continue on their present course, we will soon experience a major ecological catastrophe.	0.10	<b>0.58</b>	0.35	0.47
1. We are approaching the limit of the number of people the Earth can support.	0.06	0.07	<b>0.77</b>	0.61
9. Despite our special abilities, human beings are still subject to the laws of nature.	0.11	0.21	<b>0.58</b>	0.39
11. The earth is like a spaceship with very limited room and resources.	0.03	0.31	<b>0.60</b>	0.46
Eigenvalues	2.61	2.40	1.70	6.70
Percentage of variance	17.42	15.97	11.31	44.69

*The bold values in one column means that the items load onto one factor.*

strongly agree." A higher score represents a greater degree of environmental concern<sup>1</sup>.

We adopted PCA to analyze the 15 items measuring environmental concerns. Factors with eigenvalues greater than one are subjected to a varimax rotation. It is worth noting, as Chinese scholars indicated: our sample did not support the five dimensional structure of the NEP (Dunlap et al., 2000). Still, we used the broadly-used terms to name the factors to improve understanding between scholars (Dunlap et al., 2000; Hong, 2006). Of the results shown in **Table 3**, seven items load most heavily on the first factor, which we named, "Human Domination" factor (2, 4, 6, 8, 10, 12, 14). Five items load most heavily on the first factor, which we named, "Eco-Crisis" factor

(3, 5, 7, 13, 15). And three items load most heavily on the first factor, which we named, "Balance of nature" factor (1, 9, 11). Their Cronbach's alpha coefficients were 0.72, 0.73, and 0.50, respectively. The mean of human domination, eco-crisis, and balance of nature were 55.63, 17.12, and 57.21 (**Table 2**).

### Environmental Behaviors

With increased awareness of environmental degradation and anxiety over health, evidence has shown that Chinese citizens have begun to participate voluntarily in various pro-environmental activities, including: donating to environmental protection organizations, participating in environmental volunteering, conducting environmental research, establishing environmental organizations or groups, and conducting "not-in-my-backyard" (NIMBY)-style movements such as protesting against pollution (Ho, 2001; Ru, 2004).

<sup>1</sup>The double number of items was assigned for the negative score in the original questionnaire, but we made a corresponding adjustment in the analysis.



On the basis of a comprehensive literature review and previous research (Kaiser, 1998; Kaiser et al., 2003; Ru, 2004), we developed 20 questions to study the frequency and forms of pro-environmental behaviors, which covered the *individual* level (e.g., environmental consumption), the *organizational* level (e.g., establishing environmental organizations) and the *policy* level (e.g., make suggestions on environmental policies to the government). The specific measurement items are shown in **Table 4**: the answers are either “yes” or “no,” with values of 1 and 0, respectively. PCA was used to analyze the nine items measuring environmental behaviors. We employed varimax rotation to create orthogonal dimensions.

As the results shown in **Table 4**, the three factors with eigenvalues greater than one are subjected to a varimax rotation. Three items loading most heavily on the “policy participation” factor, consist of items (7, 8, 9) designed to tap the facet of pro-environmental behaviors at the policy level. Four items loading most heavily on the “individual participation” factor, consisted of items (1, 2, 3, 4), which were designed to tap the facet of pro-environmental behaviors at the individual level. It is worth noting, the formal volunteering, in general, is a kind of “organized volunteering,” organized by various organizations (Xu and Ngai, 2011; Xu, 2013). In this regard, the volunteer participation could be categorized into the action at the “organizational level.” However, clearly, the notion of volunteering embodies a set of values, such as altruism that emphasize an action taken by personal choice and without expectation of pay (Dunn, 1995; Xu, 2017). Seen in this light, volunteering can also be regarded as a behavior at the “individual level,” because it is a personal choice based on free will and it is not for remuneration. Of the remaining two items (5, 6), loading was most heavily on the “organizational participation” factor, which were designed to tap the facet of pro-environmental behaviors at the organizational level. The Cronbach’s coefficients of the three factors were 0.65, 0.55, and 0.71, respectively.

The mean of individual participation, policy participation, and organizational participation of participants engaging in pro-environmental behaviors were 55.59, 36.95, and 13.95, respectively (**Table 2**). This indicates that individual participation was highest, followed by policy participation and organization participation.

## Variables and Method

People’s pro-environmental behavior is the dependent variable. Independent variables include altruistic behaviors and environmental concerns.

Information on demographic and socioeconomic variables—such as gender, age, political status, education, income, and hometown—was also collected in this study. Demographic variables were used as control variables. These included gender, age, political status, education level, and personal monthly income.

The dependent variables in this study are continuous variables. Thus, a multiple linear regression Model was adopted. And the formula is as follows:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_j x_j + \mu \quad (1)$$

Among them, “y” refers to dependent variables, including the individual participation factor, organizational participation factor, and policy participation factor of the pro-environmental behaviors. And “x<sub>j</sub>” represents the j-th independent variables and control variables.

$\beta_j$  represents the regression coefficient corresponding to the j-th independent variables or control variables.  $\beta_0$  is a constant term, and  $\mu$  is a random error term.

To examine the impacts of altruism and environmental concerns on pro-environmental behaviors respectively, a separate regression has been run with altruism vs. environmental concerns. Shown in **Table 5**, Models A1, B1, and C1 only included demographic variables; Models A2, B2, and C2 included altruism variables on the basis of Model 1; and Models A3, B3, and C3 included environmental concern variables on the basis of Model 1. The dependent variable of Model A was individual participation, the dependent variable of Model B was organizational participation, and the dependent variable of Model C was policy participation. The explanatory power of altruism and environmental concerns to the dependent variables can be obtained by comparing change in R<sup>2</sup> values. Finally, Models A4, B4, and C4 were aggregate Models, which included all of the variables mentioned above.

## RESULTS AND DISCUSSION

As mentioned above, this study applied the multiple linear regression Model by taking the individual-level, the organizational-level, and the policy-level pro-environmental participation as the dependent variables; the dimensions of environmental concerns and altruism as the main predictor variables; and gender, age, political status, education level, and personal monthly income as the control variables. The descriptive statistics of the variables in this study are shown in **Table 2**. Through collinearity statistics, obtained VIF value of 1–2, it can be concluded that there is no multicollinearity symptoms. The regression results are shown in **Table 5**.

In terms of individual-level pro-environmental behaviors, gender, age, political status, and education level had a significant impact on individual pro-environmental behaviors. As shown in Model A1, the score of male participants in individual pro-environmental behaviors was lower than that of women, by a difference of 7.81. The scores of young adults and middle-aged participation in individual pro-environmental behaviors were lower than that of older adults, by differences of 9.31 and 6.93, respectively. Members of the Communist Party of China (CPC) displayed more participation in individual pro-environmental behaviors than party non-members. The score of participants who had achieved senior secondary school education was higher than that of participants who had achieved junior secondary school education or below in individual pro-environmental behaviors, by a difference of 7.46. No statistically significant difference was found for the indicator of socioeconomic status, measured by personal monthly income.

In terms of altruism and individual pro-environmental behaviors, the prosocial behavior and social donation factors had

**TABLE 4 |** Factor analysis of environmental behaviors.

Item	Factor analysis			
	Policy participation	Individual participation	Organizational participation	Communalities
7. Have you ever heard of the "environmental disclosure rules"?	<b>0.73</b>	0.07	0.05	0.54
8. Have you taken part in an environmental public hearing?	<b>0.65</b>	0.02	0.32	0.53
9. Do you know that the government has solicited public opinions on environmental protection?	<b>0.66</b>	0.16	−0.15	0.48
1. Do you have the habit of bringing your own shopping bags?	0.11	<b>0.62</b>	0.06	0.40
2. Do you sort your waste?	0.09	<b>0.71</b>	0.01	0.51
3. Do you buy phosphorus-free detergent?	−0.01	<b>0.62</b>	−0.08	0.39
4. Have you done any volunteer work relating to environmental protection?	0.23	<b>0.40</b>	0.32	0.32
5. Have you initiated/organized environmental protection activities?	−0.05	−0.01	<b>0.82</b>	0.67
6. Have you ever founded an environmental protection organization?	0.11	0.02	<b>0.72</b>	0.52
Eigenvalues	1.5	1.5	1.4	4.4
Percentage variance	16.4	16.3	15.7	48.4

The bold values in one column means that the items load onto one factor.

a significant positive impact on individual pro-environmental behaviors, and the sympathetic behavior and social responsibility factors had no statistically significant impact on individual pro-environmental behaviors. Compared with Model A1,  $R^2$  of Model A2 increased by 12%, indicating that altruism had a good explanatory power for individual participation. In Model A2, when the scores of prosocial behavior, social responsibility, and social donation increased by 1, the scores of individual pro-environmental behaviors increased by 0.38, 0.19, and by 0.36, respectively. In this regard, altruistic behaviors can promote the pro-environmental behaviors at the individual level. **H1a hypothesis is therefore supported.** However, as Model A4 shown, when the environmental concern variables were included, the effect of social responsibility dimension is non-significant, while the effect of other dimensions remains unchanged.

In terms of the relationship between environmental concern and individual pro-environmental behaviors, the factors of human domination, eco-crisis, and balance of nature were significant in the opposite direction; that is, the anthropocentric factor had a negative effect on individual participation in pro-environmental behaviors. In Model A3, if the score of the human domination factor increased by 1, the score of individual engagement of participants in pro-environmental behaviors decreased by 0.12. The eco-crisis factor and the balance of nature factor had positive effects on individual pro-environmental behaviors. In Model A3, when the scores of the ecological crisis factor and the natural balance factor increased by 1, the scores of individual pro-environmental behaviors increased by 0.22 and by 0.16, respectively. Residents who scored higher on the eco-crisis factors and/or the balance of nature factors engage in more

individual pro-environmental behaviors. In other words, human domination is a negative dimension on environmental concern, while the eco-crisis factor and the balance of nature factor are positive dimensions. Thus, in general, environmental concern has a positive effect on pro-environmental behaviors at the individual level. Therefore, **Hypothesis H2a is verified.** However, as Model A4 has shown, when the altruism variables were included, balance of nature dimension becomes non-significant, while the effect of other dimensions remains unchanged. In addition, comparing with Model A1,  $R^2$  of Model A3 increased by 2% only. This indicated that the explanatory power of environmental concerns on individual participation was less than altruism.

In terms of organizational pro-environmental behaviors, the young adults engaged in more pro-environmental behaviors than older people: in Model B1, for example, the score of participation in environmental organizations of the young adults was higher than 6.12. This finding is precisely the opposite of individual environmental behaviors. It can be seen that different age groups have significant differences in their pro-environmental behaviors. Furthermore, personal monthly income had a negative effect on participants' organizational pro-environmental behaviors. Other control variables were not statistically significant in their impact on participation in organizational environmental behavior.

In terms of altruism and organizational-level pro-environmental behaviors, the social donation factor had a significant positive effect on participation in environmental protection organizations. Compared with Model B1,  $R^2$  of Model B2 increased by 8%. This indicated that altruism had a good explanatory power for organizational participation. In

**TABLE 5 |** Environmental concern, altruism, and environmental behaviors.

	Individual participation				Organizational participation				Policy participation			
	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4
<b>Gender<sup>a</sup></b>	<b>−7.81***</b> (2.60)	<b>−9.20***</b> (3.28)	<b>−7.77***</b> (2.65)	<b>−8.70***</b> (3.31)	1.78 (1.89)	3.34 (2.84)	0.79 (1.93)	2.04 (2.90)	−0.55 (2.83)	−1.52 (3.32)	−0.68 (2.91)	−2.56 (3.44)
<b>Age<sup>b</sup></b>												
Young adults	<b>−9.31***</b> (3.42)	<b>−10.18**</b> (4.98)	<b>−9.63***</b> (3.56)	−7.44 (5.24)	<b>6.12**</b> (2.46)	6.56 (4.29)	<b>6.29**</b> (2.56)	<b>8.13*</b> (4.54)	<b>−7.13*</b> (3.75)	2.33 (5.03)	−4.50 (3.94)	3.12 (5.45)
Middle adults	<b>−6.93*</b> (3.91)	−9.61 (5.86)	−5.47 (4.00)	−5.88 (6.04)	1.16 (2.78)	−1.22 (5.06)	1.10 (2.87)	0.43 (5.28)	<b>−7.37*</b> (4.17)	−2.88 (5.83)	−4.17 (4.34)	−0.40 (6.22)
<b>Political status<sup>c</sup></b>	<b>7.34**</b> (3.13)	<b>8.23**</b> (4.11)	<b>6.50**</b> (3.20)	<b>8.79**</b> (4.22)	2.25 (2.25)	0.05 (3.57)	2.33 (2.30)	0.76 (3.69)	<b>11.90***</b> (3.47)	<b>6.95*</b> (4.19)	<b>12.09***</b> (3.59)	<b>9.00**</b> (4.40)
<b>Education level<sup>d</sup></b>												
Senior secondary	<b>7.46**</b> (3.66)	<b>10.60*</b> (5.58)	6.00 (3.77)	<b>11.32**</b> (5.70)	1.69 (2.62)	0.17 (4.84)	1.40 (2.71)	−0.33 (5.04)	−0.47 (3.97)	0.01 (5.62)	−2.40 (4.14)	−0.94 (6.00)
College or university	3.50 (3.62)	1.77 (5.32)	3.76 (3.74)	4.15 (5.43)	−1.42 (2.57)	−7.31 (4.65)	−0.65 (2.67)	−6.11 (4.82)	−2.17 (3.94)	2.99 (5.39)	−2.51 (4.13)	3.16 (5.70)
Postgraduate and above	8.62 (7.81)	13.20 (9.01)	7.30 (7.83)	13.67 (8.93)	1.14 (5.76)	−4.32 (8.04)	1.23 (5.78)	−4.23 (8.09)	3.60 (8.67)	11.90 (9.22)	1.74 (8.77)	11.09 (9.45)
<b>Personal monthly income</b>	1.20 (1.45)	0.76 (1.90)	1.52 (1.50)	0.94 (1.94)	<b>−1.74*</b> (1.05)	−0.72 (1.66)	−1.50 (1.09)	−0.55 (1.70)	<b>−2.82*</b> (1.67)	−1.43 (2.01)	−2.71 (1.75)	−2.30 (2.08)
<b>Altruism</b>												
Prosocial behavior		<b>0.38***</b> (0.09)		<b>0.33***</b> (0.09)		0.07 (0.08)		0.05 (0.08)		<b>0.19**</b> (0.09)		<b>0.18*</b> (0.10)
Sympathetic behavior		−0.08 (0.09)		−0.11 (0.10)		0.03 (0.08)		−0.05 (0.09)		0.16 (0.09)		0.11 (0.10)
Social responsibility		<b>0.19**</b> (0.08)		0.12 (0.09)		0.10 (0.07)		0.10 (0.08)		−0.00 (0.08)		−0.03 (0.09)
Social donation		<b>0.36***</b> (0.09)		<b>0.29***</b> (0.09)		<b>0.29***</b> (0.08)		<b>0.30***</b> (0.08)		<b>0.22**</b> (0.10)		<b>0.22**</b> (0.10)
<b>Environmental concerns</b>												
Human domination			<b>−0.12*</b> (0.07)	<b>−0.18*</b> (0.09)			<b>−0.09*</b> (0.05)	<b>−0.15*</b> (0.08)			−0.11 (0.08)	0.04 (0.10)
Eco-crisis			<b>0.22***</b> (0.08)	<b>0.27**</b> (0.10)			0.08 (0.05)	0.04 (0.09)			0.11 (0.08)	0.03 (0.11)
Balance of nature			<b>0.16*</b> (0.09)	0.18 (0.12)			0.08 (0.07)	0.05 (0.10)			0.12 (0.10)	0.14 (0.12)
<b>Constant</b>	55.31*** (3.81)	6.59 (9.81)	39.30*** (8.14)	−0.85 (12.71)	8.69*** (2.77)	−14.69* (8.67)	3.87 (5.89)	−8.38 (11.25)	34.96*** (4.16)	−8.21 (9.91)	26.86*** (8.86)	−14.76 (13.25)
N	410	242	388	229	407	237	384	224	399	230	376	216
F	3.723	5.349	3.900	4.770	1.689	2.236	1.600	2.045	2.890	2.017	2.335	1.693
R <sup>2</sup>	0.08	0.20	0.10	0.25	0.03	0.11	0.05	0.13	0.06	0.10	0.07	0.11
Adjusted R <sup>2</sup>	0.05	0.16	0.08	0.20	0.02	0.06	0.02	0.07	0.02	0.05	0.04	0.05
Change in R <sup>2</sup>	—	0.12***	0.02*	0.17***	—	0.08***	0.02*	0.10***	—	0.04**	0.01	0.05**

(1) The coefficient is a non-standardized regression coefficient, with a standard error in brackets.

(2) a represents "woman," b represents "elderly adult," c represents "non-CPC member," d represents "junior secondary or below."

(3) \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.1$ .

(4) change in R<sup>2</sup> refers to the change in R<sup>2</sup> compared to the baseline Model.

(5) Significant figures shown in bold.

Model B2, when the score of the social donation factor increased by 1, the score of organizational participation increased by 0.29. The effect is still significant when adding environmental concern variables. **Therefore, hypothesis 1b is partially verified.** The relationships between the other dimensions and organizational-level pro-environmental participation were not statistically significant.

In the context of environmental concerns and organizational-level pro-environmental behaviors, the human domination factor had a significant negative impact on organizational-level pro-environmental behaviors. Compared with model B1, the  $R^2$  of model B3 increased by 2%. This indicated that the explanatory power of environmental concerns on organizational participation was less than altruism. In Model B3, if the score of the human domination factor increased by 1, the score of residents' organizational-level pro-environmental participation decreased by 0.09. Thus, people with a human domination consciousness will not only negatively influence their individual participation in pro-environmental behaviors but will also reduce their organizational participations. The effect is still significant when adding altruism variables. **Therefore, hypothesis H2b is partially verified.** The other two dimensions were not statistically significant for organizational participation.

In terms of policy-level pro-environmental behaviors, age, political status, and personal monthly income had a significant impact. Young adults and middle-aged groups showed less participation in policy-level pro-environmental behaviors than the elderly group: for example, in Model C1, the young adults and middle-aged groups had lower scores than elderly people by differences of 7.37 and 7.13, respectively. Party members had a policy-level pro-environmental behavior score that was higher than that of non-party members by 11.9. As can be seen, party members are more actively involved in the revision of environmental protection policies. Like the effect on organizational pro-environmental behaviors, personal monthly income had a negative effect on participants' policy-level pro-environmental behaviors. The relationships between other control variables and participants' policy-level pro-environmental behaviors were not statistically significant.

In terms of altruism and policy-level pro-environmental participation, similar with the individual-level pro-environmental behaviors, the prosocial factor and social donation factor had a significant positive effect on participation in environmental protection organizations. Compared with Model C1,  $R^2$  of Model C2 increases by 4%. This indicated altruism had low explanatory power on policy participation. In Model C2, when the score of the prosocial factor and social donation factor increased by 1, the score of organizational participation increased by 0.19 and 0.22. The effect is still significant when adding environmental concern variables. **Therefore, hypothesis H1c is partially verified.**

In terms of environmental concerns and pro-environmental participation in policy, it was found that all dimensions of environmental concern had no statistically significant effect on policy-level pro-environmental behaviors. It can be seen that environmental concerns mainly affected individual and organizational pro-environmental participation, not

policy participation. Therefore, hypothesis H2c has not been supported.

## CONCLUSIONS AND FURTHER RESEARCH

### Summary and Implications

To investigate the relationships between altruism, environmental concerns, and ordinary people's pro-environmental behaviors performed in consideration of how their actions might affect others and that exceeds self-interested NIMBY-ism, we analyzed Chinese-language versions of the SRA and NEP scales before developing our own scale to measure a relatively broad range of people's everyday pro-environmental behaviors at the individual, organizational, and policy level in a Chinese context. Then, by using a tailor-made survey ( $n = 603$ ), we explored the factors that affect ordinary people's pro-environmental behaviors by analyzing the relationships between environmental concerns, altruism, and pro-environmental participation at the individual, the organizational, and the policy levels. The main findings are summarized below.

From a demographic perspective, we found that age, gender, and political status significantly impact people's pro-environmental behaviors. First, in contrast to men and the young adults, women and the elderly are more likely to participate in pro-environmental activities at the individual level. This finding is similar to other studies, which suggests that it may be related to the fact that women and the elderly are traditionally more involved in housework activities that are associated with environmental protection, such as purchasing washing materials, cleaning, classifying garbage/recycling, and so on (Greenbaum, 1995; Tindall et al., 2003; Gong, 2008; Li, 2011; Zhang, 2012).

Second, age groups differ in their pro-environmental behaviors. The young adults and middle-aged groups participate in more organizational pro-environmental behaviors but less on the individual and policy levels. This could possibly occur because younger people have more opportunities to join social group activities than elderly people. The elderly group displays more individual- and policy-level pro-environmental behaviors than the young adults groups, but less involvement in organizational-level pro-environmental behaviors. Such findings are in line with previous studies that have found that the elderly were enthusiastic about household recycling activities (Scott, 1999; Li, 2003) and that the elderly had more opportunities to give opinions at a policy level, due to their status and prestige (Dowd, 1984).

Third, CPC members demonstrate more environmental-friendly behaviors at the individual and policy levels than non-party people. This is consistent with previous studies (Cai et al., 2018) and may be due to the fact that the CPC, as the ruling party, not only often asks members to play a leading/exemplary role in their work and in society, but also holds regular party meetings to disseminate certain policies and information. Therefore, CPC members have a better understanding of environmental problems and related policies than non-members (Tang, 2016; Dong, 2017).



In addition, it is worth noting that we found that the personal monthly income is not statistically significant in relation to individual pro-environmental behaviors, while it has a negative effect on pro-environmental behaviors at the organizational and policy levels. Therefore, the views of “development is an absolute principle” or “treatment after pollution”—which are underpinned by the idea that people would naturally care for environment after the living standards and education levels are improved—are unreliable and even ecologically dangerous assumptions.

In terms of the impact of environmental concerns on people's environmental behaviors, we found that the human domination factor has a significant negative impact on individual- and organization-level pro-environmental behaviors, while the ecological crisis factor has a positive effect on individual pro-environmental behaviors. This is attributed to the idea that anthropocentrists believe that human beings can meet their needs at the cost of their ecological environment. In contrast, residents with an awareness of an ecological crisis worry about the current ecological environment; thus, they will participate in more pro-environmental activities. The dimensions of environmental concern are not statistically significant for policy-level participation; in other words, environmental concerns primarily affect pro-environmental behaviors at the individual and organizational levels, but not at a policy level. We propose two possibilities to explain this result: on the one hand, even though people are more concerned about environmental policy, ordinary people who have never engaged in any environmental movements might not have strong motives to influence policy. On the other hand, to promote environmental governance, policy makers and other stakeholders should provide more convenient channels (e.g., Bulletin Board System; Mobile Applications, etc.) for public participation and encourage people to contribute to environmental policy.

In terms of the relationship between altruism and people's environmental behaviors, we found that altruistic behavior has a positive impact on pro-environmental behaviors, seemingly reflected by the prosocial behavior and social donation factors. Specifically, these two factors have a significant positive impact on individual- and policy-level pro-environmental behaviors; for organizational-level pro-environmental behaviors, only the social donation factor has a significant positive effect, and other dimensions are not statistically significant. This may be due to the fact that social donations are the most easily-accessible environmental activities for people to participate in at the organizational level in mainland China.

In summary, although it seems that the self-interested NIMBY movement is more likely to attract attention (Yang, 2005; Li et al., 2012), our empirical research here shows that altruism and awareness of the ecological crisis can promote people's engagement in pro-environmental behaviors in China. Therefore, it is likely that ENPOs can reach wider audiences of potential supporters and convert more of them into active volunteers. In this way, more people would participate in various environmental activities as a result of education that deepens their awareness in environmental and ecological crises or that

advocates and encourages altruism. Meanwhile, the truth of the assumption that people care more for the environment after their living standards have improved is seriously thrown into doubt, because socioeconomic status indicators are not statistically significant for individual-level pro-environmental behaviors.

## Further Research and Limitations

The research that has been undertaken has highlighted a number of topics on which further research would be beneficial. First, though scholars have revealed that environmental knowledge could be an influential factor for environmental behaviors, for the following reasons we did not set out to measure environmental knowledge in this research and instead left the topic to further studies. Firstly, the Chinese scale currently only focuses on pure knowledge of human-ecology systems (e.g., the harm of car exhausts, acid rain, etc.) (Hong and Xiao, 2007). However, based on the literature, we believe that a feasible measurement for this study should also cover knowledge of ENPOs and environmental policies. Secondly, previous research has shown that environmental knowledge is usually highly related to education (Gong and Lei, 2007; Hong and Xiao, 2007; Chen et al., 2011), and demographic data like education is typically much easier to collect than environmental knowledge. Thirdly, we are afraid that it would be too ambitious for us to develop two new scales in one study. Therefore, future studies might, for example, develop a scale to evaluate people's environmental knowledge at scientific (pure knowledge) and social (ENGOs, related policies, etc.) levels, and then the relationships between environmental knowledge and people's environmental behaviors can be further explored.

Second, another interesting field of further research would be the relationships between altruism and donations. For example, as an altruistic behavior across human societies, would the social donation factor and pro-environmental behaviors share similar drives (i.e., motivation or underlying psychological mechanisms)? Moreover, the latest media revolution has led to the new separation between the state and the society; it is worth studying further through interdisciplinary approach to better understand online fundraising, e-donation, and related environmental participations (Xu, 2021).

Third, further exploration is needed into the factors that deter individuals of different groups—such as men, young adults, and the elderly—from engaging in various environmental activities. In particular, due to the higher individual levels of pro-environmental activity participation among women and the elderly, one direction of future study could examine the mediation effect of participating in housework.

Last, but not least, we should acknowledge that there are several research limitations in this study. First, in contrast to other methods such as online surveys, a face-to-face survey can assure a nice level of understanding of the questions. However, the face-to-face survey could possibly raise people's concern about being evaluated by others (e.g., the interviewer), which can, in turn, lead to artificial responses that are more “favorable.” Second, due to limited time

and resources, we collected the hardcopy questionnaires in the city in East China and mailed them to a university located thousands of miles away in South China to input the data. As we previously mentioned, the missing data occurred during this study. This may be due to the mailing distance, which led to some answers being difficult to read. In retrospect, it would be better to input the data while at the research site.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by The Chinese University of Hong Kong. The patients/participants provided their written informed consent to participate in this study.

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## AUTHOR CONTRIBUTIONS

YX conceptualized the theme, collected the data, and wrote the first manuscript draft. SC analyzed the data. WL reviewed and commented on the initial draft. All authors contributed to the article and approved the submitted version.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# The Efficacy of a Virtual Reality Exposure Therapy Treatment for Fear of Flying: A Retrospective Study

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**Background:** Fear of flying (FoF) is a phobia with 10–40% prevalence in the industrialized world. FoF is accompanied by severe economic, social, vocational, and emotional consequences. In recent years, virtual reality (VR)-based exposure therapy (VRET) for FoF has been introduced. Positive long-term efficacy of FoF-VRET has been reported by several studies, which, however, were limited by relatively small, non-representative samples and a lack of comparative pre/post functional efficacy outcome measures. Our objective was to evaluate the efficacy of a VRET treatment utilizing a large-scale VR system, experienced by a representative sample of self-referred individuals.

**Methods:** We conducted a retrospective survey. Of 274 individuals who received the treatment (over a period of 3 years), 209 met inclusion/criteria, and 98 agreed to participate. We mainly collected information regarding flight activity before and after treatment relying on evidence such as boarding passes and flight tickets. The primary outcome measures were (1) number of flights per month (FpM) and (2) number of flight hours per month (FHpM). For each participant, these outcomes were computed for the post-treatment period ( $\geq 6$  months after FoF-VRET) and the corresponding pre-treatment period.

**Results:** FpM (mean  $\pm$  SD) increased from  $0.04 \pm 0.06$  to  $0.16 \pm 0.14$  flights ( $p < 0.0001$ ). FHpM rose from  $0.19 \pm 0.35$  to  $0.79 \pm 0.87$  h per month ( $p < 0.0001$ ).

**Conclusion:** These results are indicative of FoF-VRET treatment efficacy. Future studies should evaluate long-term maintenance of the treatment effect and thus identify the optimal frequency for delivery of periodic booster treatments.

**Keywords:** anxiety disorders, empirical supported treatments, computer/internet technology, behavior therapy, phobia/phobic disorders

## INTRODUCTION

Airplanes are the safest, most common way to travel for long distance trips in the industrialized world (Transportation USD, 2017; IATA, 2018). Fear of flying (FoF) is a common anxiety disorder in western countries, and its prevalence is estimated at 10–40% (Dean and Whitaker, 1982; Van and Diekstra, 2000; Oakes and Bor, 2010). Among those who suffer from FoF, 14% have never flown on an airplane, 6% have flown and say they will not fly again, and 10% have

flown and say they will fly again only if there is no other choice (Ferrand et al., 2015). FoF may be secondary to phobias related to environmental conditions (e.g., altitude and severe weather) or situational phobias (e.g., claustrophobia) and may be comorbid to panic attacks and generalized anxiety disorder (Czerniak et al., 2016). Physiological and psychological anxiety symptoms of FoF may include panic attacks, fear, muscle tension, sweating, shortness of breath, heart palpitations, nausea, and dizziness (Kraaij et al., 2003). The costs of FoF for affected individuals, their families and society are substantial. FoF sufferers tend to avoid flying entirely, which may have serious social, vocational, and emotional consequences (Foreman et al., 2006). Societally, FoF results in significant cost to the airlines and incalculably reduced productivity and opportunity (Foreman et al., 2006).

Several pharmacological treatments exist for FoF including anti-anxiety medications like benzodiazepines (Greist and Greist, 1981). Other treatments are psychological interventions like exposure therapy (also called as systematic desensitization; Wiederhold et al., 2001). The most common treatment for FoF is cognitive behavioral therapy (CBT; da Costa et al., 2008), which focuses on creating neutral memories to replace the panic-inducing ones and may include relaxation techniques, psychoeducation, and exposure therapy. In exposure therapy, the FoF sufferer is exposed to the source of anxiety in a controlled manner, and this approach is considered as the most efficient treatment for FoF (Rothbaum et al., 2006; Rus-Calafell et al., 2013). Exposure therapy for FoF might involve simulating a flight or exposure to a stationary plane.

Over the last decade, virtual reality (VR) has become a viable method for administering exposure therapy for anxiety disorders. For example, several VR-based exposure treatments for post-traumatic stress disorder have been proposed (for review see Botella et al., 2015). As applied to FoF, virtual reality exposure therapy (VRET) involves creating a virtual airplane environment that simulates various aspects of flying using dynamic visual, auditory, and motion stimuli (Czerniak et al., 2016). Unlike exposure therapy using a real flight, this VR-based method allows the therapist to systematically control the level of the exposure intensity to a variety of elements (Schultheis and Rizzo, 2001). Notably, VRET for FoF (FoF-VRET) is most often implemented with a VR head mount display (e.g., Muhlberger et al., 2003; Tortella-Feliu et al., 2011) and thus lacks the ability to simulate motion. Large-scale VR systems that incorporate motion can be used to address this limitation and better simulate the flight experience.

There are few reports evaluating the clinical efficacy of FoF-VRET (e.g., Rothbaum et al., 2000, 2006; Maltby et al., 2002; Wiederhold et al., 2002; Muhlberger et al., 2003; Krijn et al., 2007; Tortella-Feliu et al., 2011). In a recent meta-analysis of 11 randomized trials, Cardoso et al. (2017) found FoF-VRET to be superior to control/standard FoF treatments. Only a few randomized trials have assessed efficacy in the months following treatment. For example, Rothbaum et al. (2000) reported the maintenance or enhancement of self-reported post-treatment improvements after 6 months for both VRET and standard exposure therapy groups. Further, at 6 months post-treatment,

79% of VRET participants and 69% of standard exposure therapy participants reported that they had flown (voluntarily) since completing the treatment. In another study, Muhlberger et al. (2003) found that 62% of VRET participants reported flying during the 6-month follow-up period. However, Maltby et al. (2002) reported that differences between VRET and an attention-placebo group observed immediately following treatment had disappeared after 6 months. In a randomized controlled trial, Rothbaum et al. (2002) found that 92% of VRET and 91% of standard exposure participants had flown 1-year post-treatment. Tortella-Feliu et al. (2011) found that 66% of VRET participants reported flying during the 1-year follow-up period. Finally, in a long-term follow-up study, Wiederhold and Wiederhold (2003) found that 85% of their 30 participants reported flying in the 3 years after completing several different VRET treatments.

Taken together, sample sizes in these studies were relatively small, and it is apparent that there is great variability (62–92%) in the prevalence of (voluntary) flying in the period following the conclusion of VRET treatment (Rothbaum et al., 2002; Muhlberger et al., 2003). Further, participants in such studies are not considered as representative of the general population as they have consented to an experimental treatment and are thus particularly motivated and amenable to the treatment. Most importantly, existing studies lack comparative pre/post functional efficacy outcome measures. To address these issues, better controlled studies with larger, more representative clinical samples are needed.

The research Center of Advanced Technologies in Rehabilitation (CATR) at Sheba Medical Center (Ramat Gan, Israel) has developed a FoF-VRET using a large-scale VR system (see Czerniak et al., 2016 for a full description of the setup; see also *Methods*). The FoF-VRET is provided as a personalized, flexible treatment; there are a number of variations that the therapist can apply to the treatment at his/her discretion in accord with professional experience. Until January 2019, more than 274 individuals have been treated.

The aim of the present study was to evaluate the efficacy of our FoF-VRET by retrospectively surveying individuals who received the treatment as a paid clinical service. Our primary objective was to evaluate whether flying habits changed after completion of the treatment.

## MATERIALS AND METHODS

### Rationale

Between 2014 and 2018, 274 individuals were self-referred to receive FoF-VRET at the clinical virtual reality facilities in the virtual reality facilities of the rehabilitation hospital at Sheba Medical Center. We emailed 209 individuals who had completed the treatment and for whom we had an email address on file. In the email, we asked if they would be willing to participate in a phone survey regarding the FoF treatment they received (see section “Procedure” for more details). Among the benefits of this methodology are reduced bias associated with willingness to participate in experimental research, reduced bias associated

with an onsite office interview by a clinician, and reduced “gratitude effect” consequent to pro bono research participation since participants in the present study paid out-of-pocket to obtain a clinical service.

## Participants

The Inclusion criteria were completion of the FoF-VRET treatment regimen at the clinical virtual reality facilities in the virtual reality facilities of the rehabilitation hospital at Sheba Medical Center and having an email address on file (to facilitate emailing of consent at initial contact). The Exclusion criteria were non-responsive to email, refusal to participate or <6 months after treatment completion.

Six months was set as the minimum time from treatment completion to allow a reasonable amount of time for participants to fly and for comparability to the literature (see section “Main Outcome Measures”). Of the 209 individuals we contacted, 98 actually participated. Individuals were excluded for the following reasons: 50 were non-responsive, 53 refused to participate, and eight were questioned <6 months from treatment completion. The majority of the participants were female (54%); mean age  $\pm$  SD was  $43.9 \pm 13.3$ , and the range was 17–77 years. For technical reasons, age was not available for 15 participants, and gender was unavailable from one participant.

## Procedure

First, potential participants were emailed for their consent to participate; those who agreed were then contacted by phone to confirm their informed consent. Next, a structured phone interview was conducted. The interview consisted of three parts:

1. Confirmation of FoF-VRET treatment dates and recording the reason or reasons for self-referral.
2. Information on flight activity for the period following treatment completion and a corresponding period of identical length of time prior to treatment initiation. For each flight, participants reported their destination and flight duration. For verification purposes, participants were asked to furnish supporting material including boarding passes and passport stamps.
3. Questions about the FoF-VRET treatment experience, including whether they underwent other FoF treatments  $\pm 1$  year before/after the FoF-VRET treatments.

## Main Outcome Measures

The primary measure of FoF-VRET efficacy was number of flights per month (FpM). The secondary outcome measure was number of flight hours per month (FHpM). For example, a participant interviewed 18 months after VRET completion reported the following flight information: to New York (11 h) in month +2, to London (5.5 h) in month +7, and to Eilat (1 h) in month +17. His/her outcome measures were thus  $FpM = (3/18)$  and  $FHpM = (17.5/18)$ . Corresponding pre-treatment measures were calculated from data for the identical period of pre-treatment time.

## FoF-VRET Treatment

Refer to the **Supplementary Material** for a brief description of the FoF-VRET treatment (for a full description see Czerniak et al., 2016).

## Statistical Analyses

Non-parametric within-participant analyses (Wilcoxon signed-rank tests) were used to compare pre- and post-treatment FpM and FHpM levels as Kolmogorov-Smirnov tests indicated that these outcome measures do not follow a normal distribution (all  $p < 0.05$ ). Alpha level was set at  $p < 0.05$ , two-tailed.

## RESULTS

### Flight Activity Before and After FoF-VRET Treatment

Participants showed a clear increase in flight activity post-treatment as compared to pre-treatment (**Figure 1**).

Regarding flight activity outcomes before and after treatment, within-participant analyses revealed a significant difference for FpM and FHpM before [FpM: median = 0, Interquartile Range (IQR) = 0.07, FHpM: median = 0, IQR = 0.28] and after (FpM: median = 0.13, IQR = 0.19, FHpM: median = 0.56, IQR = 1.05) treatment (Wilcoxon signed-rank tests,  $Z = 6.71$ ,  $p < 0.0001$ ,  $Z = 5.8$ ,  $p < 0.0001$ , respectively).

**Figure 2** shows FpM and FHpM across participants in the months before and after treatment.

### Reasons for Seeking FoF-VRET and Other FoF Treatments

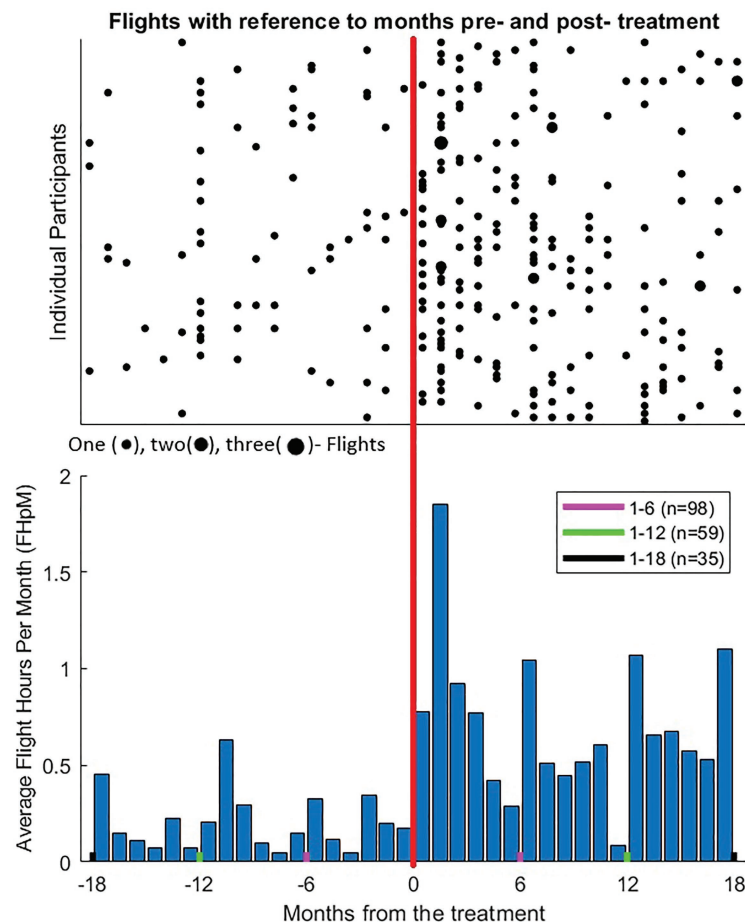
To provide additional clinical background, **Figure 3** shows the distribution of reasons for seeking FoF-VRET across participants, as reported during the phone interview.

**Figure 4** shows the distribution of other treatments for FoF within approx.  $\pm 1$  year of FoF-VRET reported by participants. The distribution indicates that nearly half (48%) of participants did not engage in any other treatment. Among the other participants, psychological treatment (18%) and FoF workshops (12%) were most common; hypnosis (4%) and CBT (3%) were least common.

To confirm that our findings regarding FoF-VRET efficacy were not unduly affected by the additional treatments, we conducted a *post-hoc* analysis. Briefly, we split participants into “no other treatment” (49%) and “other treatment” groups. For each participant, we computed pre/post change (post-treatment minus pre-treatment;  $\Delta$ ) in FpM and FHpM, respectively. Man-Whitney tests revealed no significant differences between the groups ( $\Delta FpM$ :  $U = 1237.0$ ,  $p = 0.75$ ,  $\Delta FHpM$ :  $U = 1200.0$ ,  $p = 0.95$ ), suggesting that other treatments did not appreciably affect the increased flight activity we attribute to FoF-VRET.

## DISCUSSION

This study aimed to determine the efficacy of FoF-VRET treatment using a retrospective follow-up questionnaire conducted



**FIGURE 1 |** Flight activity 18 months before and after FoF-VRET treatment for individual participants. **(Top)** Each point represents at least one flight for the given month (see key below panel). Negative values on the abscissa reflect months pre-treatment, and positive values reflect months post-treatment, vertical orange line represents the month during which the treatment took place. Each horizontal row represents data from one participant. Data from 17 participants who did not fly before or after the treatment (i.e., reciprocal 18 months periods pre- and post-treatment) are not shown, yet these data were included in statistical analyses. Following treatment, mean  $\pm$  SD FpM increased from  $0.04 \pm 0.06$  to  $0.16 \pm 0.14$  flights ( $n = 98$ ; see also text for non-parametric comparisons). **(Bottom)** Mean flights hours per month (FHpM) across participants. Following treatment, mean FHpM raised from  $0.19 \pm 0.35$  to  $0.79 \pm 0.87$  h per month. Note that, for each participant, pre-treatment data were analyzed for the identical length of time as the post-treatment period at the time of data collection (see text). Thus, for all 98 participants, data were analyzed for 6 months pre/post treatment (red lines), for 64 participants data were analyzed for 12 months pre/post treatment (green lines), and for 35 participants data were analyzed for 18 months pre/post treatment (black lines). *Pre-hoc* analyses confirmed uniformity of distributions during overlapping periods for all three groups.

over the phone. Our study is novel in that we evaluated individuals who voluntarily paid for and received treatment in our virtual reality center.

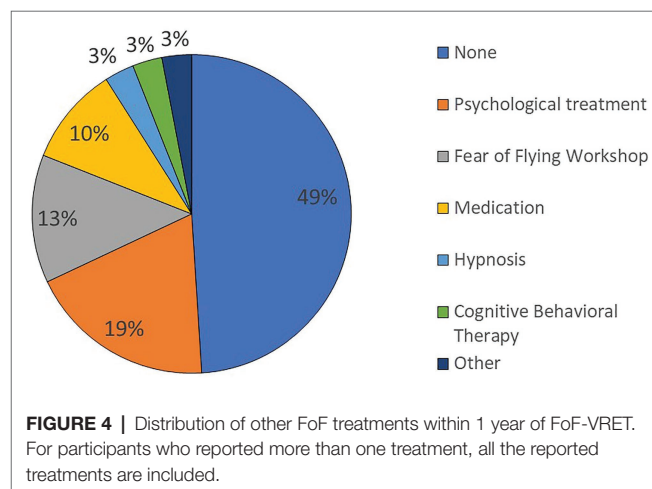
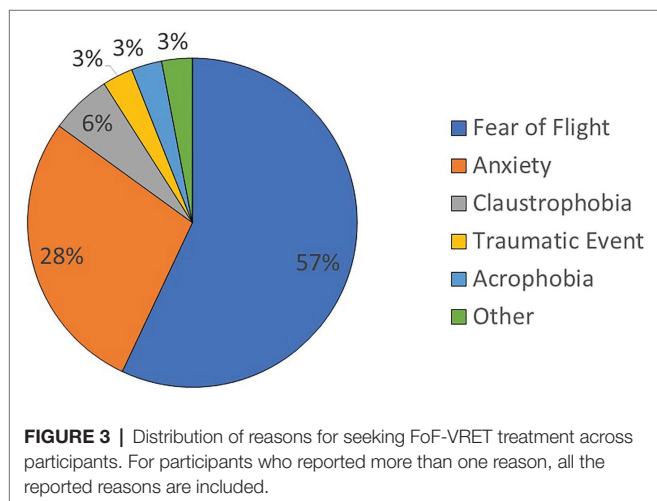
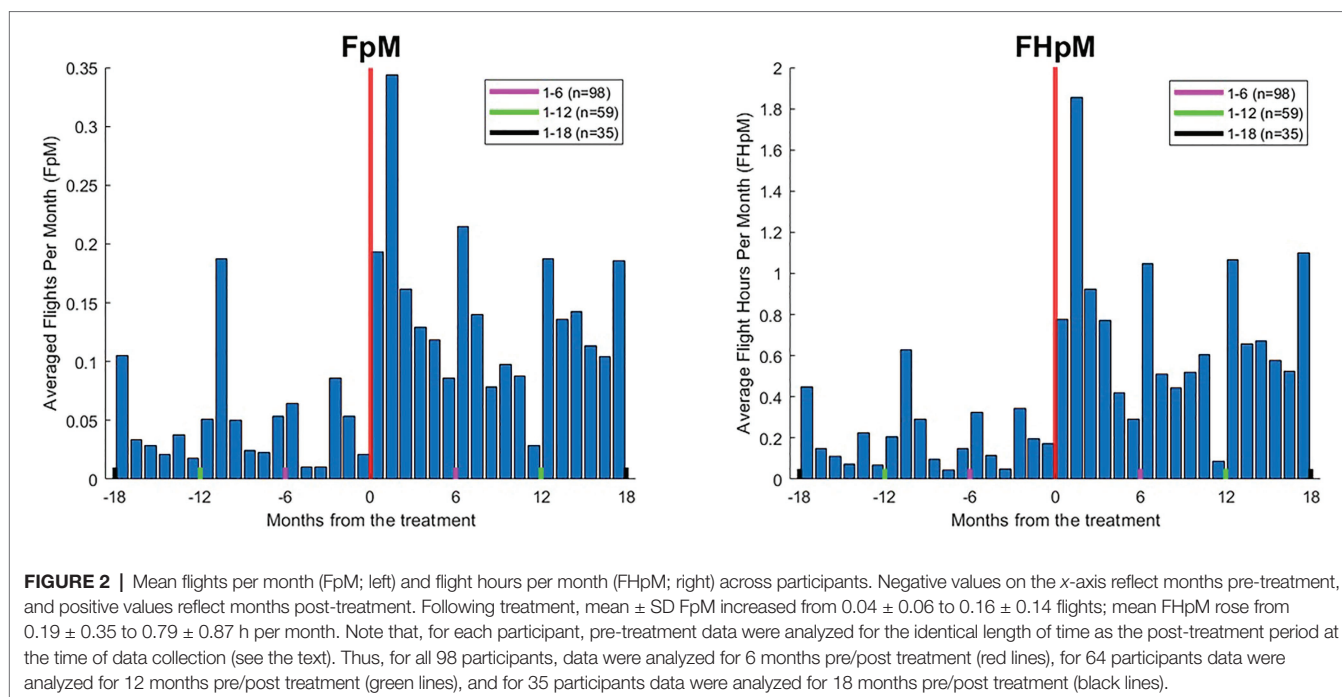
This FoF-VRET has several advantages over standard FoF exposure treatments. Firstly, it provides a safe, controlled environment that can be continuously monitored and manipulated by professional therapists and technicians. Secondly, it provides a highly detailed visual, auditory, and motion simulation of an actual flight experience rather than a static airplane. This provides better exposure to the fear-triggering factors, potentially inducing participant responses more similar to those elicited by real air travel. Finally, other measures like heart rate and blood pressure can be recorded during VR exposure therapy to provide therapists with more comprehensive clinical information.

## Efficacy

The current results show that number of flights and flight hours post-treatment significantly increased, reflecting treatment efficacy. These results are in line with other retrospective follow-up studies assessing the efficacy of other virtual reality-based FoF treatments (Rothbaum et al., 2000, 2002; Maltby et al., 2002; Muhlberger et al., 2003; Wiederhold and Wiederhold, 2003; Tortella-Feliu et al., 2011). The results of this study corroborate these prior studies and provide new evidence that those who benefited from the treatment continue to fly as long as 18 months after FoF-VRET treatment initiation.

While previous studies evaluating the efficacy of FoF-VRET used air travel in the post-treatment period (i.e., yes/no) as the sole (binary) outcome (e.g., Rothbaum et al., 2002; Wiederhold and Wiederhold, 2003), the current study introduces additional





measures: flight frequency (i.e., number of flights per month) and flight hours per month in the post-treatment period. We believe that with the addition of these measures, we are able to provide the better evidence of treatment efficacy, as we show that treated participants not only fly more often, but also that they fly for longer durations. These results suggest that engaging in FoF-VRET leads participants to take flights they would not have been prepared to take prior to treatment.

In a recent meta-analysis of 11 randomized controlled trials, Cardoso et al. (2017) reported significant overall efficacy of a FoF-VRET intervention ( $G = 0.592$ ) and a significant increase in flight activity at follow-up ( $G = 0.588$ ), demonstrating the advantage of FoF-VRET treatment over control/traditional FoF treatments. However, their results also reveal the limitations of these trials due to poor study quality and small sample

size. The authors suggest that reported effects may have been overestimated as a result of these issues. In contrast, our findings are based on a larger sample size and a more true-to-life (ecological) environment than those of the aforementioned studies.

## Other Results

Some of our results elucidate clinical aspects of FoF and its treatment. While most participants reported suffering specifically from FoF (acrophobia), a significant number of participants reported suffering from general anxiety. Furthermore, almost half (48%) of the individuals receiving FoF-VRET treatment reported that they did not engage in any other treatments at least 1 year prior to treatment, suggesting that half of those suffering from FoF are untreated and may avoid air travel.

## Limitations and Future Work

The current study is limited in several important ways. Firstly, to maximize sample size, we did not collect data at a fixed length of time from treatment (e.g., 1 year). Consequently, some adjustments to the data were required (e.g., standardizing the primary outcome measures to permit within-subject statistical comparisons). Secondly, the attrition rate was relatively high (51.8%), which may have affected the results. Although this level of attrition was higher than in other retrospective follow-up studies (13% in Rothbaum et al., 2002; 10% in Muhlberger et al., 2003; 10% in Wiederhold and Wiederhold, 2003; and 29.3% in Tortella-Feliu et al., 2011), a higher attrition rate may be expected for participants solicited to participate in a phone survey following receipt of a clinical treatment they paid for as compared to participants volunteering in research studies. A further limitation is that we interviewed many participants soon after treatment end and a smaller number of participants after an extended period post-treatment. Assuming attenuation of treatment effect with longer post-treatment duration, overall efficacy may thus have been inflated. However, in comparing FPM and FHPM for 0–9 and 9–18 months among the 22 participants with at least 1 flight in the 9 months post-treatment, we found no difference (see **Supplementary Material**). This issue should be further evaluated in a prospective, longitudinal study.

Finally, due to the nature of the study, only participants who actively sought the FoF-VRET were included. This sample of participants may have been biased as they likely had greater motivation to treat their FoF and fewer psychological barriers relative to others with fear of flying. Future studies may attempt to address this limitation by evaluating a broader sample.

As FoF severity was not assessed during treatment, future studies should examine the relation between FoF severity and FoF-VRET treatment outcome.

## CONCLUSION

Current results are indicative of FoF-VRET treatment efficacy. Air travel is an integral part of modern life in the industrialized world, and its prevalence is expected to grow as airfares continue to decrease and global economics entails more business travel (IATA, 2018). We can therefore expect a heightened awareness of FoF and an increase in referrals for suitable

treatments including VRETs. Future studies should evaluate long-term maintenance of the treatment effect and consequently identify the ideal frequency for delivery of subsequent booster treatments.

## DATA AVAILABILITY STATEMENT

Unidentified data supporting the conclusions of this article will be made available by the authors upon reasonable request.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Sheba Medical Center Local IRB Committee. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

AG performed some of the phone surveys, analyzed the data, and drafted the manuscript. GD drafted the manuscript. YH performed some of the phone surveys and analyzed the data. SN designed the study. MP designed the study, analyzed the data, and drafted the manuscript. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.641393/full#supplementary-material>

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# Psychological Predictors of Energy Saving Behavior: A Meta-Analytic Approach

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Understanding how psychological processes drive human energy choices is an urgent, and yet relatively under-investigated, need for contemporary society. A knowledge gap still persists on the links between psychological factors identified in earlier studies and people's behaviors in the energy domain. This research applies a meta-analytical procedure to assess the strength of the associations between five different classes of individual variables (i.e., attitudes, intentions, values, awareness, and emotions) and energy-saving behavioral intentions and behaviors (self-reported and actual). Based on a systematic review of studies published between 2007 and 2017, we estimate the average effect size of predictor-criterion relations, and we assess relevant moderators and publication bias, drawing on data obtained from 102 independent samples reported in 67 published studies ( $N = 59,948$ ). Results from a series of five single meta-analyses reveal a pattern of significant positive associations between the selected psychological determinants and energy-saving indicators: associations between individual-level predictors and energy-saving outcomes are positive and moderate in size, ranging from large effects for emotions to small-moderate effects for pro-environmental values. Interestingly, moderation analysis reveals, among other things, that attitude-behavior links are not statistically significant when actual behavior is considered as an outcome. Implications for policy interventions are discussed.

**Keywords:** meta-analysis, energy saving behaviors, attitudes, intentions, values, awareness, emotions

## INTRODUCTION

Climate change is currently a central part of the global energy debate and public discourse. Climate scientists agree that climate change is caused by the considerable increase in the concentration of greenhouse gases in the atmosphere, directly or indirectly attributable to humans' use of fossil fuels. It is therefore necessary to underline the need to change our energy consumption behaviors not only individually, but also collectively. From the point of view of environmental psychological science, addressing climate change is considered as a fundamental challenge, which requires a deep understanding of the psychological processes involved in both pro-environmental behaviors and lifestyles in general, and human energy consumption in particular (e.g., Clayton, 2020; Hartig, 2020; Bouman and Steg, 2020).



The purpose of this paper is to present an overarching view of published empirical research on the relation between psychological factors and energy-related choices and behaviors. We argue here that a meta-analytical study of this kind could be useful for both scientists and decision makers in the energy domain and contribute to build on the currently available knowledge on the human dimension of the sustainable energy transition (e.g., Steg et al., 2015; Tiberio et al., 2020). Some interesting systematic reviews and meta-analyses on these issues have recently appeared, highlighting for example the role of identity variables on a wide range of pro-environmental behaviors, which include, but are not limited to, energy-related ones (e.g., Fritsche et al., 2018). Other works have attempted to focus more specifically on energy-saving behaviors, mostly through systematic literature reviews, in order to identify the general factors that might influence them (including psychological determinants: see for example Steg, 2008; Yang et al., 2016). Other contributions assessed the effects of behavioral intervention strategies (e.g., Abrahamse et al., 2005; Abrahamse and Steg, 2013; Delmas et al., 2013; Karlin et al., 2015; Andor and Fels, 2018; Bergquist et al., 2019; Nisa et al., 2019; Buckley, 2020). However, apart from some notable comprehensive overviews (e.g., Steg et al., 2015) or broader contributions (van Valkengoed and Steg, 2019), to our knowledge, there are no recent meta-analyses or systematic reviews that have focused on the direct psychological predictors of energy-related behaviors. Therefore, drawing on literature from a broad spectrum of studies across psychological sciences, in this paper we identify five categories of psychological variables that have been acknowledged in previous studies as key factors for explaining variability in energy-saving behavior. Individual level factors such as ecological attitudes, pro-environmental values, awareness of consequences of one's behavior and beliefs in climate change, emotions, and intentions to adopt energy-saving solutions have been frequently considered as potential antecedents of energy-saving behaviors. In this paper, we use a meta-analytical procedure to assess the strength of the associations between five different classes of individual psychological variables (i.e.: attitudes, values, intentions, awareness, and emotions) and energy-saving behavioral behaviors (self-reported and actual). To conduct such a meta-analysis, the goal of our literature search was to identify published empirical studies that examined the links between attitudes, intentions, values, awareness and emotions on the one hand, and people's observed and actual behaviors in the energy domain, on the other hand. In this work, the intention to adopt energy-saving solutions has been considered both as predictor of self-reported and actual energy-saving behavior, or as an outcome, when either self-reported or actual behavior were not available in the primary studies considered. Indeed, a large number of studies use intentions as their only outcome of antecedent factors aimed to explain the adoption of energy-saving solutions, assuming that it can be considered as a reliable proxy of behavior in the energy domain.

In the next sections we briefly review the literature behind each of these classes of predictors, and we present and discuss the results of the meta-analytical tests conducted.

## THEORETICAL BACKGROUND

### Attitudes

The main reason for studying environmental attitudes in the field of energy saving behavior is related to the well-known attitude-behavior link in social psychology. Positive attitudes toward a specific environmental issue (e.g., climate change) were found to be associated to behavioral intention in that same domain (e.g., Poortinga et al., 2004). Widely used theories and models, such as the Theory of Planned Behavior (TPB; Ajzen, 1991) have explained the attitude-behavior link, and the circumstances under which it occurs, both in general (Manstead, 1996) and in the environmental domain in particular (Staats, 2003). In the specific energy-related domain, the TPB framework has been applied to analyse both individual's energy saving behaviors as well as the acceptance of renewable energy technologies (Abrahamse and Steg, 2011; Wang et al., 2011; Alam and Rashid, 2012). Studies in this field report a positive association between attitudes toward electric cars and different adoption indicators (Moons and De Pelsmacker, 2012; Nayum and Klöckner, 2014; Barbarossa et al., 2015; Degirmenci and Breitner, 2017).

While numerous studies suggest a strong association between attitudes and behavior in the environmental domain, other authors highlight the poor predictability of behavior from attitudes; this inconsistency is usually referred to as the attitude-behavior gap (Gifford and Sussman, 2012). A possible explanation of this discrepancy lies in the choice of the methods of collecting behavioral data. The most common method in social research is self-reported behavior, through questionnaires and other measures that frequently do not reflect the actual adoption of a behavior and are more subject to a social desirability bias (Gifford and Sussman, 2012). This aspect suggests the plausibility of moderating factors intervening in the relation between attitudes and behaviors in the energy domain such as the actual vs. self-report measurement method.

### Intentions

Behavioral intention is commonly assumed to be an immediate antecedent of behavior (Ajzen, 1991), although that does not mean that intentions always predict behaviors (e.g., Sheeran, 2002; Webb and Sheeran, 2006; Frederiks et al., 2015). Intention serves as a presupposition of favorable energy-saving choices and encompasses the likelihood of a specific course of action, such as for example purchasing a particular energy-efficient product or adopting specific energy-saving solutions as a result of environmental needs.

Energy-related intentions were in fact seen to have a moderate positive association with energy efficiency behaviors (e.g., Zierler et al., 2017). Afroz et al. (2015a) found a link between intention and behavior in the purchase of environmentally friendly vehicles. A moderate, although indirect, effect of behavioral intention was found also on purchase decisions in relation to LED technology adoption, in a study by Khorasanizadeh et al. (2016). Thus, it is worth to include intentions in our meta-analysis as a factor to be estimated as a potentially relevant predictor of energy-related choices.

## Values

The role of human values in pro-environmental behaviors has been often deemed as fundamental. Some values can hinder pro-environmental actions, other values can encourage the adoption of more sustainable ones (Steg and De Groot, 2012). A widely cited model in the literature, such as the value-belief-norm theory (see Stern et al., 1999) emphasizes the indirect association between values and decisions about the environment. Many studies showed associations between biospheric value orientations and specific energy related behaviors such as, for example, residential energy usage (Schultz, 2000; Abrahamse and Steg, 2009, 2011). Thus, in our meta-analysis, it is worth considering the link between biospheric values and energy-saving behavior.

Other studies also showed that altruistic or self-transcendent values (as opposed to self-enhancement ones) are linked to pro-environmental attitudes and behaviors (Nordlund and Garvill, 2002; Schultz et al., 2005; Collins et al., 2007). In particular, the study by Schultz et al. (2005) was conducted across six different countries, involving around 720 participants, and showed that self-transcendent values are positively related to environmental concern, while self-enhancement values are negatively related to general concern, consistently across different cultures.

In sum, values have been commonly related to human behavior in the energy domain. However, as in the case of attitudes and knowledge, a “value-action gap” should also be taken into account (e.g., Huddart-Kennedy et al., 2009). Daily life presents many situations where people endorsing values promoting the mitigation of negative consequences of environmental problems (e.g., global warming, climate change) and the adoption of energy-saving solutions or “low carbon” technologies (such as renewable energy sources) fail to translate these values, beliefs and attitudes into practical actions in their daily life choices. It is therefore important to systematically assess the strength of the relation between value endorsements and energy-related behavior.

## Awareness

For the purposes of this paper, under the label “awareness” we group together aspects that have been linked to individuals’ energy choices, such as knowledge of environmental facts, awareness of the consequences of one’s own behavior, or beliefs about climate change or global warming. Although people’s direct knowledge about environmental issues is usually limited, it has been argued that “high level of awareness enables individuals to make conscious choices for acting in an environmentally friendly way” (e.g., Partanen-Hertell et al., 1999, p. 9). Environmental awareness has also been defined in terms of environmental knowledge and/or recognition of environmental problems (Grob, 1995). In our meta-analysis, we refer to those environmental problems that derive from the effects of global climate change and to public’s awareness of adverse consequences of environmental problems. The awareness of consequences (or increasing knowledge) is also an important factor identified in widely-studied models of pro-environmental action, such as the Value-Belief-Norm theory (Stern et al., 1999) or Norm Activation Model (Schwartz, 1977). Indeed, previous

studies documented an increase in the public awareness of adverse consequences of climate change (e.g., Ockwell et al., 2009; Steg, 2008). Although it has been suggested that “while awareness about the issue is now very high, climate change continues to be a low priority issue for most people” (Whitmarsh, 2011, p. 691), it is arguable that being aware of climate change facts or global warming trends can impact individual energy-related decisions. A 2009 survey of the UK Department for Environment, Food and Rural Affairs found for example that the majority of respondents claimed that they were trying to cut down on the use of gas and electricity at home in response to the threats of climate change (see Thornton, 2009). Indeed, awareness of consequences has been shown to increase the intention to adopt an electric vehicle (Bockarjova and Steg, 2014), or to curtail energy consumption (van der Werff and Steg, 2015). Likewise, people with higher awareness of consequences have been identified as more likely to adopt an electric car (Nayum et al., 2016). In their meta-analysis, Bamberg and Möser (2007) suggest, however, that awareness is an important but indirect determinant of pro-environmental behavioral intentions: this seems to be somehow corroborated by recent contradictory and partly surprising findings (e.g., Whitmarsh et al., 2020).

## Emotions

Emotions have a crucial role in motivating human behavior (Damasio, 1994; LeDoux, 2012; Levine and Leven, 2014), including pro-environmental and energy-related behaviors (Hine et al., 2007; Carrus et al., 2008; Ferguson and Branscombe, 2010; Onwezen et al., 2013; Rees et al., 2015).

For example, anticipated emotions can be a direct cause of human behavior: an individual’s ability to appraise a future emotional state enables to elaborate and to assess the value of the potential outcomes of one’s own behavior (e.g., Panno et al., 2015). In fact, it has been shown that people’s negative emotions (e.g., anger, frustration, sadness) about engaging in pro-environmental behavior (for example in the area of transport modes choice or waste recycling) reduced their desire to engage in these pro environmental behaviors (Carrus et al., 2008), while positive emotions regarding cycling (e.g., feeling happy and satisfied) increases the desire to choose cycling as transportation mode (Passafaro et al., 2014).

An association between emotions and behavior in the environmental domain was also highlighted for two specific types of discrete emotions: feelings of guilt and pride (e.g., Kaiser, 2006; Elgaaid, 2012). A positive effect of a guilt induction (compared with no emotional induction) emerged in a study on support for climate change policy (Lu and Schuldt, 2015). In an experimental study, Schneider et al. (2017) examined the causal effects of pride vs. guilt on pro-environmental decision making and behavioral intentions, inducing these anticipated emotions just prior to asking participants to make a series of environmental decisions. Results showed that stimulating people to anticipate feelings of pride for positive future pro-environmental actions seems to have a more significant effect compared to prompting feelings of guilt for inactions. Understanding the role of

emotions in everyday life energy choices has therefore the potential to help in defining strategies and designing behavioral interventions to promote the sustainable energy transition. However, the study of emotions as antecedents of energy-related behavior received so far a relatively limited attention in the environmental psychological literature. Thus, in this paper, we considered emotions (either anticipated emotions or other types of emotional states) as a relevant predictor of energy-saving.

## METHOD

### Eligibility Criteria

For the research methodology in this study, we used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) provided by Moher et al. (2009).

The goal of our literature search was to identify published empirical studies that examined the links between attitudes, intentions, values, awareness and emotions (X) and people's observed and actual behaviors in the energy domain (Y). Thus, in the meta-analysis we included papers that reported firsthand data about the relationship between X and Y. Technically speaking, we conducted five separate meta-analyses between variable pairs. We completed the literature search on June 20th, 2017. Various criteria were applied to select eligible data for inclusion in the analysis. Specifically, studies were included in the meta-analysis if: (1) they were published in a peer-reviewed journal in the last 10 years; (2) they were published in English; (3) the dependent variable was an energy-saving behavior (actual or self-reported) or an energy-saving behavioral intention; (4) among the independent variables there was at least one of the following measures: attitudes, pro-environmental values, awareness, emotions, intentions (intentions were considered as predictors only for studies where the criterion variable was behavior); (5) in case of studies using an experimental design, the studies were included only if the experimental design had a control group; (6) in the case of papers where bivariate correlations between the respective dependent and independent variables and the sample size were not reported, we contacted authors to obtain the data via email; in case of no response after two email reminders, the correlations were estimated starting from other data available in the paper, whenever possible (e.g., regression coefficients). When a direct coefficient-based estimation was not possible, the paper was not included in the analysis.

In addition to excluding studies that did not meet the inclusion criteria cited above, we also excluded those studies that, rather than on energy use and consumption, were focused more on ideological, political or social stances that individuals, groups and communities might have in regard to energy-related issues; in this category, there are for example many studies that investigate people's reactions to nuclear energy policies, or people's aesthetic judgements or attitudes toward wind turbines, power lines, and so forth: these kind of studies were not included in our meta-analysis. Finally, qualitative studies that did not

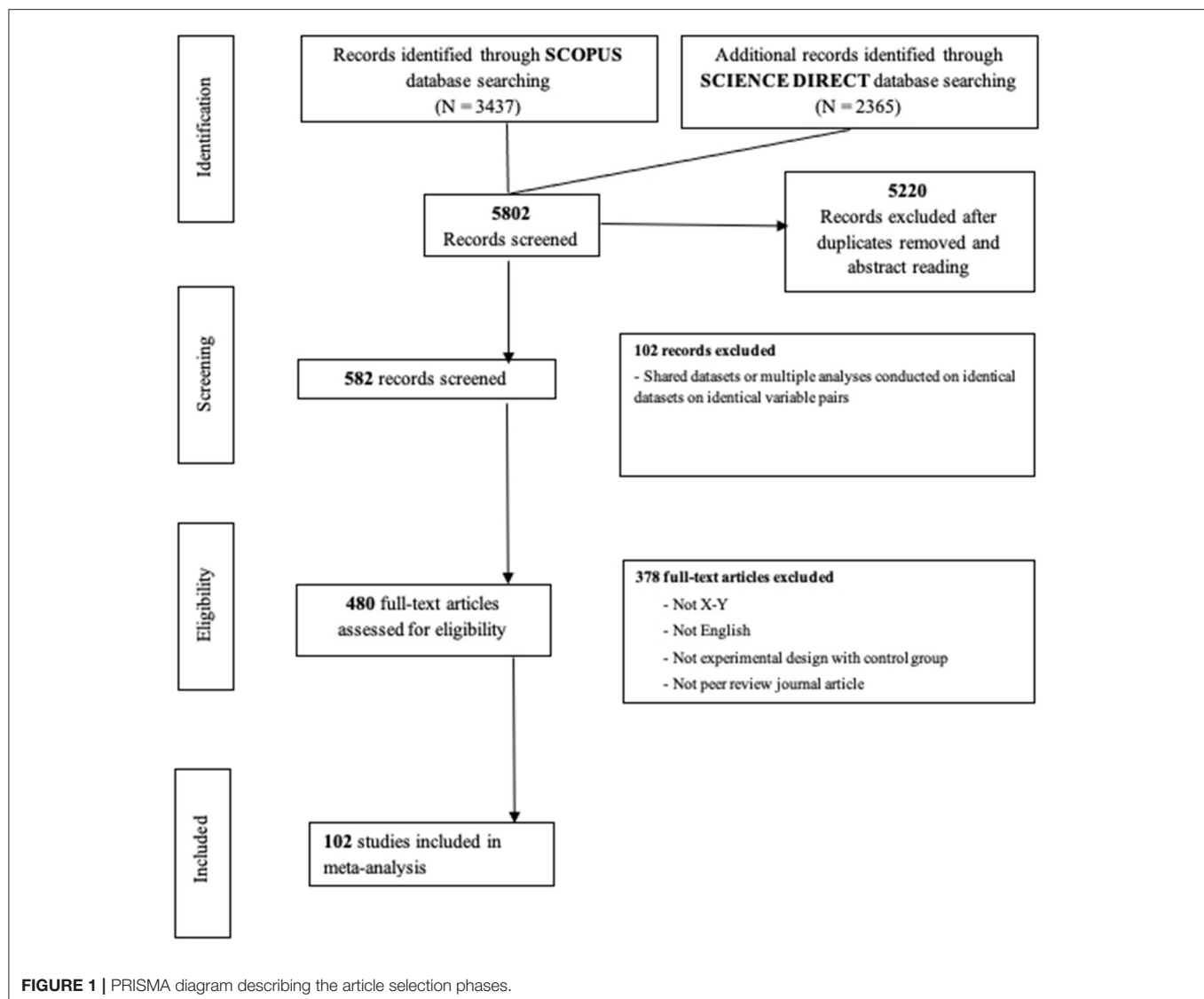
provide sufficient statistical data to allow the calculation of an effect size were not included.

### Search Strategies and Study Selection

We conducted the literature search considering a time frame of 10 years (2007–2017). The main strategy consisted of searching two major electronic databases of scientific literature (ScienceDirect and Scopus) using the following search terms:

“(attitude and energ\*) or (attitude and electric\*) or (emotion\* and energ\*) or (emotion\* and electric\*) or (guilt and energ\*) or (guilt and electric\*) or (pride and energ\*) or (pride and electric\*) or (anger and energ\*) or (anger and electric\*) or (“belief\* in climate change” and energ\*) or (“belief\* in climate change” and electric\*) or (“belief\* in global climate change” and energ\*) or (“belief\* in global climate change” and electric\*) or (“belief\* in global warming” and energ\*) or (“belief\* in global warming” and electric\*) or (“belief\* of climate change” and energ\*) or (“belief\* of climate change” and electric\*) or (“belief\* of global climate change” and energ\*) or (“belief\* of global climate change” and electric\*) or (“belief\* of global warming” and energ\*) or (“belief\* of global warming” and electric\*) or (“belief\* about climate change” and energ\*) or (“belief\* about climate change” and electric\*) or (“belief\* about global climate change” and energ\*) or (“belief\* about global climate change” and electric\*) or (“belief\* about global warming” and energ\*) or (“belief\* about global warming” and electric\*) or (“climate change risk perception” and energ\*) or (“climate change risk perception” and electric\*) or (“perception\* of climate change” and energ\*) or (“perception\* of climate change” and electric\*) or (“climate change perception” and energ\*) or (“climate change perception” and electric\*) or (“knowledge in climate change” and energ\*) or (“knowledge in climate change” and electric\*) or (“knowledge in global climate change” and energ\*) or (“knowledge in global climate change” and electric\*) or (“knowledge in global warming” and energ\*) or (“knowledge in global warming” and electric\*) or (“knowledge about climate change” and energ\*) or (“knowledge about climate change” and electric\*) or (“knowledge about global climate change” and energ\*) or (“knowledge about global climate change” and electric\*) or (“knowledge about global warming” and energ\*) or (“knowledge about global warming” and electric\*) or (awareness and energ\*) or (awareness and electric\*) or (intention\* and energ\*) or (intention\* and electric\*) or (“environment\* value” and energ\*) or (“environment\* value” and electric\*) or (“value system” and energ\*) or (“value system” and electric\*).”

Furthermore, we hand-searched in the references of the selected journal articles further relevant studies that were not initially found through the database search and that were conducted on this topic. As a consequence of these bibliographic searches, we initially found 5,802 articles. This number includes duplicate hits (e.g., when the same paper was located in both databases). After removing the duplicates, we examined the abstracts of potentially relevant papers to determine whether they met our inclusion criteria. A total of 582 papers remained to be inspected. Based on this set, we eliminated entries that were inconsistent with our eligibility criteria and papers that shared the same dataset of a study already selected for the meta-analysis, such as multiple analyses conducted with an identical dataset on an



identical variable pair ( $K = 480$ ). Finally, we contacted authors for additional data in the case of papers that did not include the necessary information to compute the effect sizes. A final set of 102 research articles was included in the current meta-analysis after the application of all the exclusion decisions. The PRISMA diagram in **Figure 1** describes how articles were selected and filtered through different phases of the search process, including reasons for excluding articles during the in-depth review stage.

## Coding

From each study, we extracted data regarding: (a) sample size; (b) mean age in the sample; (c) gender (coded as the percentage of women in the sample); (d) type of sample: 1 = student sample, 2 = non-student sample, 3 = representative sample. In addition to this, other more specific coding procedures were applied. With regard to the dependent variable (i.e., intentions, self-reported or actual behavior) we often found articles reporting two or more of these measures. Our strategy was to choose

as dependent variable the more “objective” measure included in a given study. For example, if a study included measures of all these three different outcomes (intentions, self-reported behavior, actual behavior), to calculate the effect size we used the actual behavior measure. If we found two of these three outcomes (e.g., intentions and self-reported behavior), we used the self-reported behavior outcome. If the primary study reported both self-reported and actual behavior, we used the actual behavior. In other words, the more “objective” outcome available in each study was been selected for the meta-analysis. Such a strategy allowed us to reduce the number of studies reporting multiple non-independent effect sizes that could affect the final estimates in the current meta-analysis.

## Sensitivity Analysis

Because in some cases the data for the calculation of effect sizes were derived from multivariate analyses (multiple regressions, path models, SEM, etc.), the effect sizes based on  $r$  values may



**TABLE 1 |** Summary of ES of the association between attitudes and energy saving behaviors (or intentions).

References	Statistics for each study			
	Sample size	Correlation	95% LLCI	95% ULCI
Afroz et al. (2015a) (ESPR Journal)	350	0.20	0.10	0.30
Aini et al. (2013)	201	0.14	0.00	0.27
Al-Amin et al. (2016)	300	0.30	0.19	0.40
Barbarossa et al. (2015)	611	0.67	0.62	0.71
Barbarossa et al. (2015)	600	0.77	0.74	0.80
Barbarossa et al. (2015)	794	0.73	0.70	0.76
Carmi et al. (2015)	1,160	0.26	0.21	0.31
Claudy et al. (2013)	254	0.34	0.23	0.44
Craig and Allen (2014)	2,058	0.78	0.77	0.80
Degimenci and Breitner (2017)	167	0.33	0.19	0.46
Dixon et al. (2015)	2,919	0.14	0.10	0.17
Engelken et al. (2016)	109	0.74	0.64	0.81
Fornara et al. (2016)	432	0.31	0.22	0.39
Gaspar and Antunes (2011)	1,303	0.19	0.13	0.24
Halder et al. (2016)	402	0.64	0.58	0.70
Halder et al. (2016)	130	0.55	0.42	0.66
Han et al. (2017)	607	0.77	0.74	0.80
Hansla et al. (2008)	855	0.42	0.36	0.47
Hatzl et al. (2014)	58	0.21	−0.05	0.44
Hertel and Menrad (2016)	104	0.51	0.35	0.64
Kim et al. (2014)	1,647	0.61	0.58	0.64
Klößner et al. (2013)	1,787	0.22	0.17	0.26
Korcaj et al. (2015)	200	0.40	0.28	0.51
Lin and Syrgabayeva (2016)	305	0.32	0.22	0.42
Litvine and Wüstenhagen (2011)	170	0.26	0.11	0.40
Mohamed et al. (2016)	3,505	0.72	0.71	0.74
Moons and De Pelsmacker (2012)	1,199	0.56	0.52	0.60
Murtagh et al. (2013)	83	0.46	0.27	0.61
Nayum and Klößner (2014)	1,517	0.18	0.13	0.23
Nguyen et al. (2016)	682	0.29	0.22	0.36
Park and Ohm (2014)	1,429	0.50	0.46	0.54
Pettifor et al. (2015)	295	0.11	0.00	0.23
Prete et al. (2017)	128	0.58	0.45	0.68
Rai and Beck (2017)	522	0.38	0.30	0.45
Scott et al. (2014)	279	0.87	0.84	0.90
Shi et al. (2017)	580	0.70	0.66	0.74
Wittenberg and Matthies (2016)	213	0.48	0.37	0.58
Wolske et al. (2017)	904	0.44	0.39	0.49
Yang et al. (2016)	526	0.30	0.22	0.37
Yun and Lee (2015)	753	0.77	0.73	0.79
Zierler et al. (2017)	628	0.15	0.07	0.22

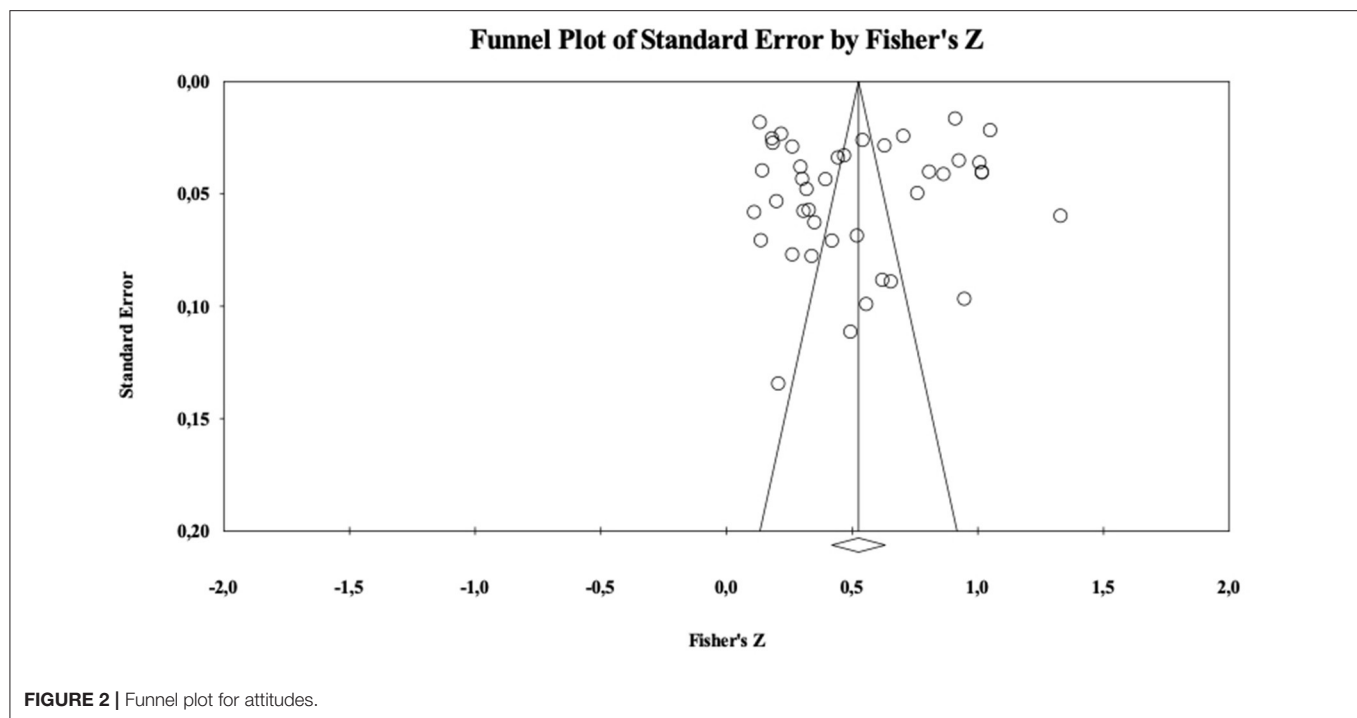
A 95% CI that does not include zero provides evidence of a significant effect.

be –over- or underestimated. Therefore, we explored, through a sensitivity analysis, if the effect size estimates vary as a function of effect sizes that are zero-order (i.e., derived from univariate analyses) or derived from partial coefficients (see the Statistical tests section for more details). A sensitivity analysis has also

been carried out to highlight any eventual difference between studies reporting and not-reporting multiple non-independent effect sizes (see the Results section for more details). Finally, a sensitivity analysis has been carried out to investigate potential differences between studies that use a general measure of awareness of consequences and studies that focus on more specific awareness measures, such as beliefs in climate change (see the Results section for more details).

## Statistical Tests

We used the  $r$  correlation coefficient as the effect size metric for the current meta-analysis. For studies that only reported  $\beta$  coefficients we had applied Peterson and Brown (2005) formula:  $r = \beta + 0.05 \lambda$  (where  $\lambda = 1$  for non-negative  $\beta$ s, and  $\lambda = 0$  for negative  $\beta$ s) in imputing the corresponding  $r$  coefficients. We also computed  $r$  values for studies that did not conduct correlational analyses via sample sizes along with  $t$ -values,  $\chi^2$  values,  $p$ -values, and standardized mean differences (i.e., Cohen's  $d$ ). In addition, we reverse-scored several measurements to assure that each positive effect size computed would represent a direct positive association between the various predictors (attitude, intentions, values, awareness, and emotions) and energy-saving behavior (ESB). We adopted a random-effects model to calculate the aggregated effect size of each predictor on ESB. Because our sample contained studies conducted with noticeably different features, we did not use a fixed-effect model. In fact, the latter model assumes that all the studies included are functionally identical and share a single canonical effect size (Hedges and Vevea, 1998; Borenstein et al., 2010). In addition to relaxing this assumption, the random-effects model allows for more unconditional inferences (i.e., a generalizable conclusion to situations beyond the sampled studies) of the results (Field, 2001). Even though it was not very frequent, sometimes we found studies reporting non-independent effect sizes (e.g., multiple measures of the same variable). In these cases, we computed effect sizes using Cooper's (1998) Shifting-Unit-of-Analysis method for studies that report multiple, non-independent effect sizes. As such, we referred to the study as the unit of analysis meaning that each study included would contribute only to one summary effect size to the main analysis (see Cooper, 1998; see also the sensitivity analysis paragraph for more details about this point). We display the 95% confidence intervals alongside indices of heterogeneity assessment like  $I^2$ , i.e., the cross-studies "inconsistency index" (Higgins and Thompson, 2002; Higgins et al., 2003), Cochran  $Q$ , and tau-squared (the "study-to-study variances"; Borenstein et al., 2009). We also addressed publication bias by examining the funnel plots, where all effect sizes are plotted against the standard error. To check for a potential publication bias, we visually inspected the symmetry of the funnel plots. We also examined the classical Rosenthal's (1979) fail-safe  $N$ . We applied the mixed-effects model in the categorical univariate moderator analyses and the meta-regression analyses for the continuous moderators. All analyses in the current meta-analysis were conducted using the Comprehensive Meta-Analysis (CMA) software, Version 3.0 (Borenstein et al., 2009, 2014).



**TABLE 2 |** Summary of ES of the association between intentions to adopt energy saving solutions and energy saving behavior.

References	Statistics for each study			
	Sample size	Correlation	95% LLCI	95% ULCI
Afroz et al. (2015a) (ESPR Journal)	350	0.32	0.22	0.41
Ajzen et al. (2011)	79	0.62	0.46	0.74
Akman and Mishra (2015)	157	0.25	0.10	0.39
Al-Amin et al. (2016)	300	0.28	0.17	0.38
Azar and Al Ansari (2017)	227	0.56	0.46	0.64
Carmi et al. (2015)	1,160	0.18	0.12	0.24
Dixon et al. (2015)	2,919	0.24	0.21	0.27
Gerpott and Paukert (2013)	453	0.23	0.14	0.32
Hatzl et al. (2014)	58	0.31	0.05	0.52
Khorasanizadeh et al. (2016)	221	0.44	0.33	0.54
Klöckner et al. (2013)	1,787	0.33	0.28	0.37
Murtagh et al. (2013)	83	0.15	-0.07	0.35
Nayum and Klöckner (2014)	1,517	0.34	0.30	0.39
Rai and Beck (2017)	522	0.11	0.02	0.19
Webb et al. (2013)	200	0.25	0.12	0.38
Zierler et al. (2017)	628	0.27	0.19	0.34

A 95% CI that does not include zero provides evidence of a significant effect.

## RESULTS

### Sensitivity Analysis

Results of the sensitivity analysis did not show differences among the sub-groups of effect size estimates derived from univariate

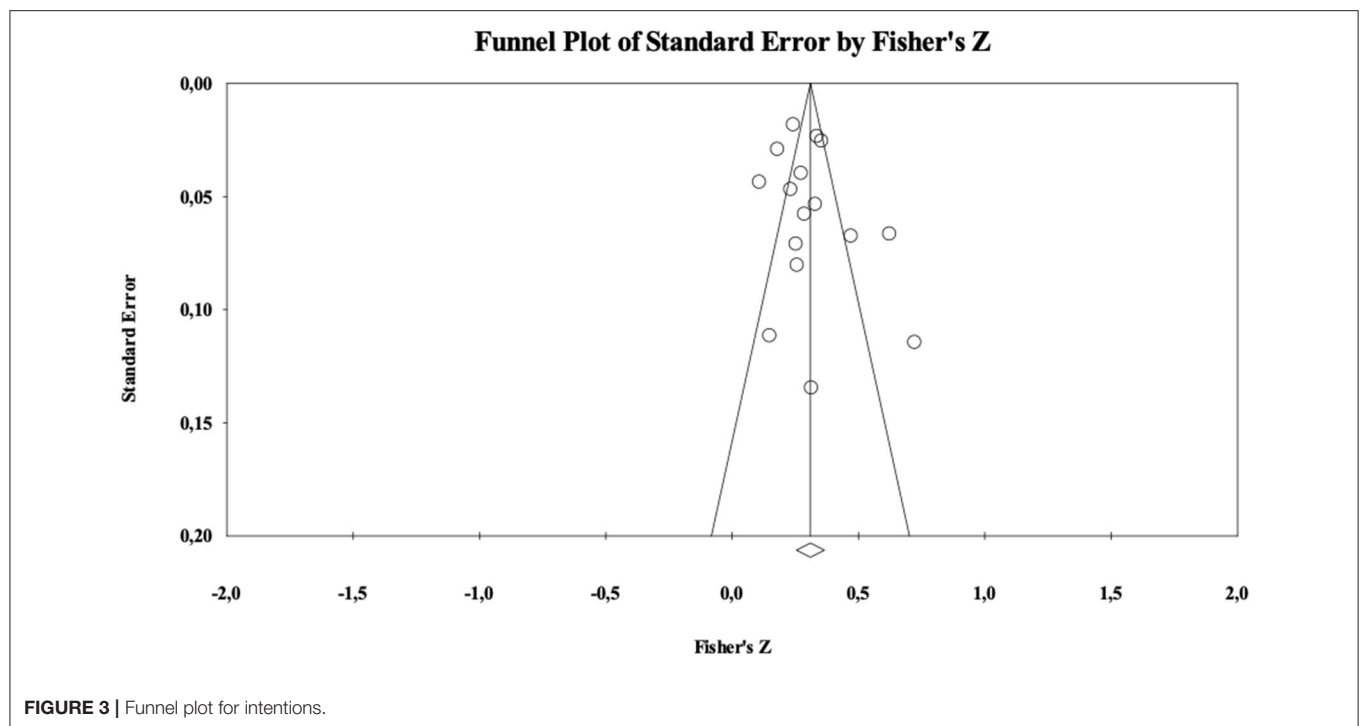
analyses (i.e., zero-order) vs. from multivariate analyses (i.e., partial coefficients), across each predictor (all  $ps = ns$ ). Likewise, the sensitivity analysis did not show differences among the sub-groups of studies reporting vs. not-reporting multiple non-independent effect sizes, across each predictor (all  $ps = ns$ ). Finally, results of the sensitivity analysis concerning differences between studies employing measures of general or specific measures of awareness are reported in the next sections (i.e., *Awareness* section). In the following sections, we describe the results on the estimation of average effect size of predictor-criterion relations, publication bias, and relevant moderators.

### Attitudes: Overall and Publication Bias Results

The estimated effect sizes of the association between attitudes and energy-saving behaviors (or intentions) are displayed in **Table 1**.

The analysis revealed a moderate/large positive association between attitude and ESB:  $r = 0.482$ ; 95% CI (confidence interval) lower limit (LLCI)/upper limit (ULCI) = 0.396/0.559;  $p < 0.001$ . We observed a non-negligible level of variation in the distribution of effect sizes (Tau = 0.343, Tau-squared = 0.117). This might be explained by the considerable extent of heterogeneity [i.e.,  $I^2 = 98.84$ ;  $Q(40) = 3458.58$ ,  $p = 0.0001$ ] inherent among the sampled studies.

To address the extent of publication bias we first examined the classical Rosenthal's (1979) fail-safe N. This index estimates how many unpublished studies with a null effect size would be necessary to turn a significant population effect size estimate into a non-significant one based on the Stouffer Z-test. Rosenthal (1979) recommended the fail-safe N to be smaller than a 5K+10 benchmark. In our meta-analysis, for the relationship



**TABLE 3 |** Summary of ES of the association between values and energy saving behaviors (or intentions).

References	Statistics for each study			
	Sample size	Correlation	95% LLCI	95% LCI
Barbarossa et al. (2017)	2,005	0.36	0.32	0.40
Fornara et al. (2016)	432	0.06	−0.03	0.15
Girod et al. (2017)	1,101	0.37	0.32	0.42
Hatzl et al. (2014)	56	0.22	−0.04	0.46
Murtagh et al. (2013)	83	0.14	−0.08	0.35
Nayum et al. (2016)	1,508	0.27	0.23	0.32
Yang et al. (2016)	526	0.33	0.25	0.40

A 95% CI that does not include zero provides evidence of a significant effect.

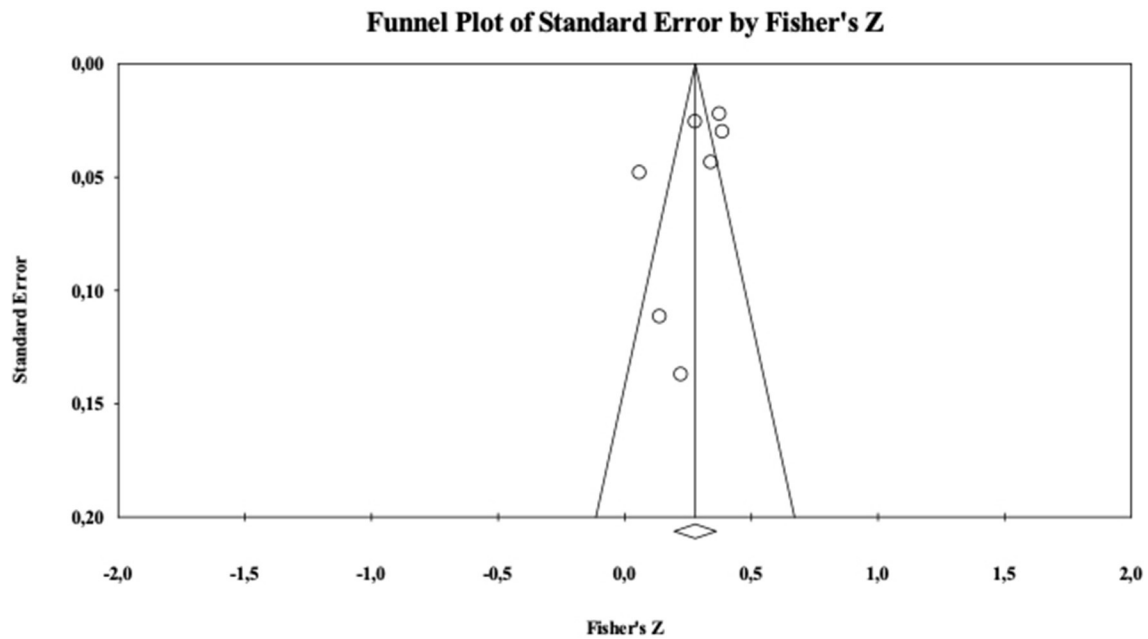
between attitudes and ESB, the critical value  $5K+10$  was 215. The analyses showed a  $Nfs = 75,246$ . Moreover, we inspected the so-called “funnel plot,” that is a graphical technique in which the standard error of each study’s effect size is plotted against the standardized effect size itself. Lack of publication bias is suggested by a symmetrical cloud of studies centered around the population effect size, with increasing variability at increasing levels of standard error. This is because there should be about as many studies providing non-significant results as those providing significant ones at each specific level of standard error, whereas studies with smaller standard errors should also be closer to the population effect size. As shown in the **Figure 2**, the funnel plot has a rather symmetrical shape. In sum, both these

indicators suggest that the present analysis is not contaminated by publication bias.

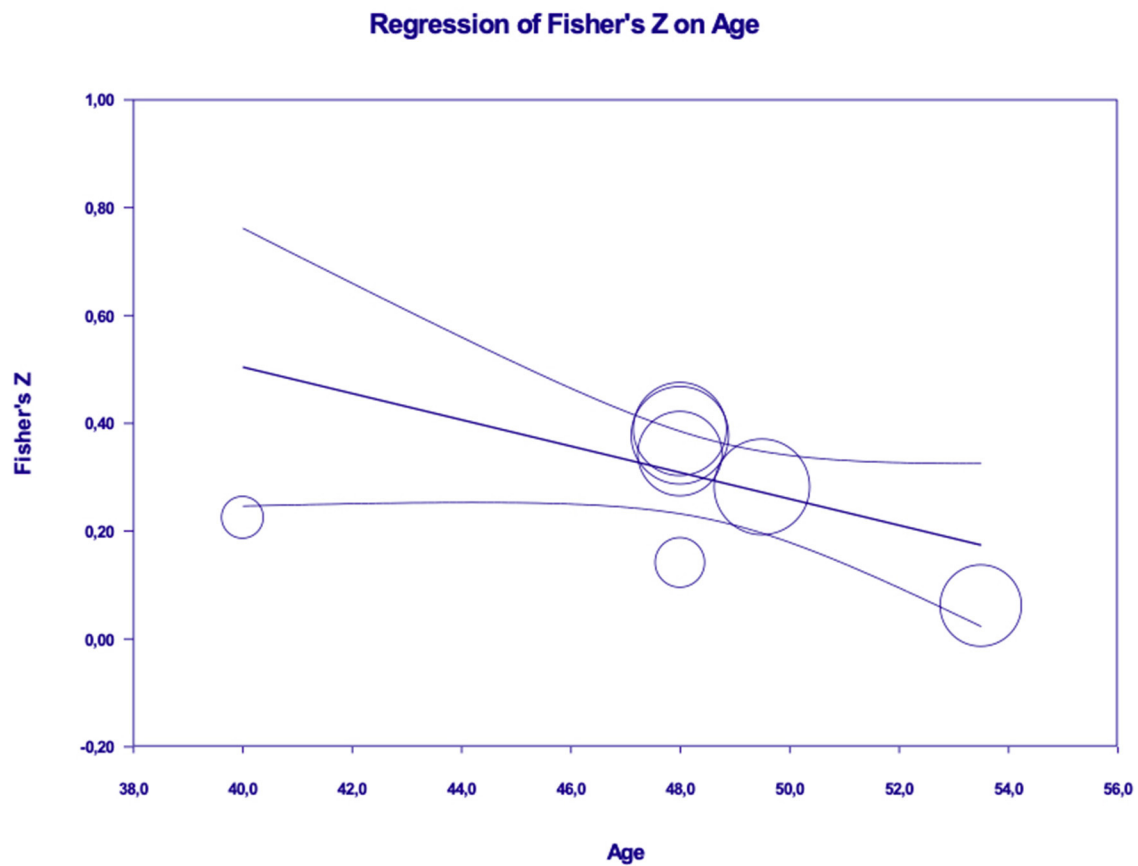
## Attitudes: Moderation Effects

For all the predictors, we used the percentage of women in the sample as a continuous variable to be included in a meta-regression model that aims to estimate the potential moderating effect of gender on the relationship between the independent variable and ESB. In the case of attitudes, results show no significant moderating effect of gender ( $\beta = 0.001$ ,  $p = ns$ ). A similar meta-regression model was conducted considering participants’ age as moderator in the relationship between ecological attitude and ESB. Results show no significant moderating effect of age on the relationship between ecological attitude and ESB ( $\beta = 0.001$ ,  $p = ns$ ). Concerning the different types of sample (i.e., students vs. non-students vs. representative sample; see the previous section), results did not show a significant moderating role of this factor,  $Q(1) = 0.014$ ,  $p = ns$ .

Interestingly, results showed a significant moderating role of the type of dependent variable considered in the study. Associations with attitudes were significant for studies that considered intentions ( $r = 0.565$ , LLCI/ULCI =  $0.475/0.643$ ) and self-reported behavior as outcomes ( $r = 0.312$ , LLCI/ULCI =  $0.147/0.460$ ). On the contrary, the association with attitudes was not significant in the case of studies that considered actual behavior as outcome ( $r = 0.338$ , LLCI/ULCI =  $-0.099/0.666$ ),  $Q(2) = 9.03$ ,  $p < 0.01$ . Moreover, results showed that the effect size of the association between attitudes and intention ( $r = 0.565$ , LLCI/ULCI =  $0.475/0.643$ ) is significantly larger than the effect size of the association between attitudes and self-reported



**FIGURE 4 |** Funnel plot for values.



**FIGURE 5 |** Moderation effect of age in the relation between values and energy saving behaviors (or intentions).



behavior ( $r = 0.312$ , LLCI/ULCI = 0.147/0.460),  $Q(1) = 8.40$ ,  $p < 0.01$ .

## Intentions: Overall and Publication Bias Results

To assess the strength of the association between intentions to adopt energy-saving solutions and energy-saving behaviors, we considered in the current meta-analysis only those studies that measured actual or self-reported ESBs as outcomes. The estimated effect sizes are displayed in **Table 2**.

The analysis revealed a moderate positive association between intention and ESB:  $r = 0.300$ ; 95% CI LLCI/ULCI = 0.249/0.350;  $p < 0.0001$ . We observed a non-negligible level of variation in the distribution of effect sizes (Tau = 0.096, Tau-squared = 0.009). This might be explained by the moderate/large extent of heterogeneity [i.e.,  $I^2 = 84.65$ ;  $Q(15) = 97.76$ ,  $p = 0.0001$ ] among the sampled studies.

The critical value  $5K+10$  of Nfs was 90. The analyses showed a Nfs = 2,925. As showed in **Figure 3**, the funnel plot is rather symmetrical. In sum, both these indicators suggest that the present analysis is not contaminated by publication bias.

## Intentions: Moderation Effects

Results showed no significant moderating effects of gender ( $\beta = 0.001$ ,  $p = ns$ ) and age ( $\beta = -0.003$ ,  $p = ns$ ) on the relationship between intentions and ESB. A significant moderating effect of sample type emerged (students vs. non-students):  $Q(1) = 4.55$ ,  $p < 0.01$ . Although associations were significant for both student ( $r = 0.421$ , LLCI/ULCI = 0.300/0.529) and non-student samples ( $r = 0.274$ , LLCI/ULCI = 0.214/0.333), the effect size was significantly larger in the former case. Regarding the type of dependent variable (actual vs. self-reported behavior), no significant moderation effects were shown [ $Q(1) = 0.61$ ,  $p = ns$ ].

## Values: Overall and Publication Bias Results

The estimated effect sizes of the association between values and energy saving behaviors (or intentions) are displayed in **Table 3**.

The analysis revealed a small/moderate positive association between pro-environmental values and ESB:  $r = 0.271$ ; 95% CI LLCI/ULCI = 0.193/0.346;  $p < 0.0001$ . We observed a non-negligible level of variation in the distribution of effect sizes (Tau = 0.097, Tau-squared = 0.009). This might be explained by the moderate/large extent of heterogeneity [i.e.,  $I^2 = 86.93$ ;  $Q(6) = 45.93$ ,  $p = 0.0001$ ] emerging among the sampled studies.

The critical value  $5K+10$  of Nfs was 45. Analyses showed a Nfs = 715. As showed in **Figure 4** the funnel plot was rather symmetrical. In sum, both these indicators suggest that the present analysis is not contaminated by publication bias.

## Values: Moderation Effects

Results revealed a significant moderation effect of age ( $\beta = -0.02$ ,  $p < 0.05$ ;  $R^2$  analog = 0.59), with the effect approaching to zero as participants' age increases (See **Figure 5**). No significant moderation effects emerged for gender ( $\beta = -0.002$ ,  $p = ns$ ), type of the sample [ $Q(1) = 1.25$ ,  $p = ns$ ] and type of dependent variable [ $Q(2) = 0.79$ ,  $p = ns$ ].

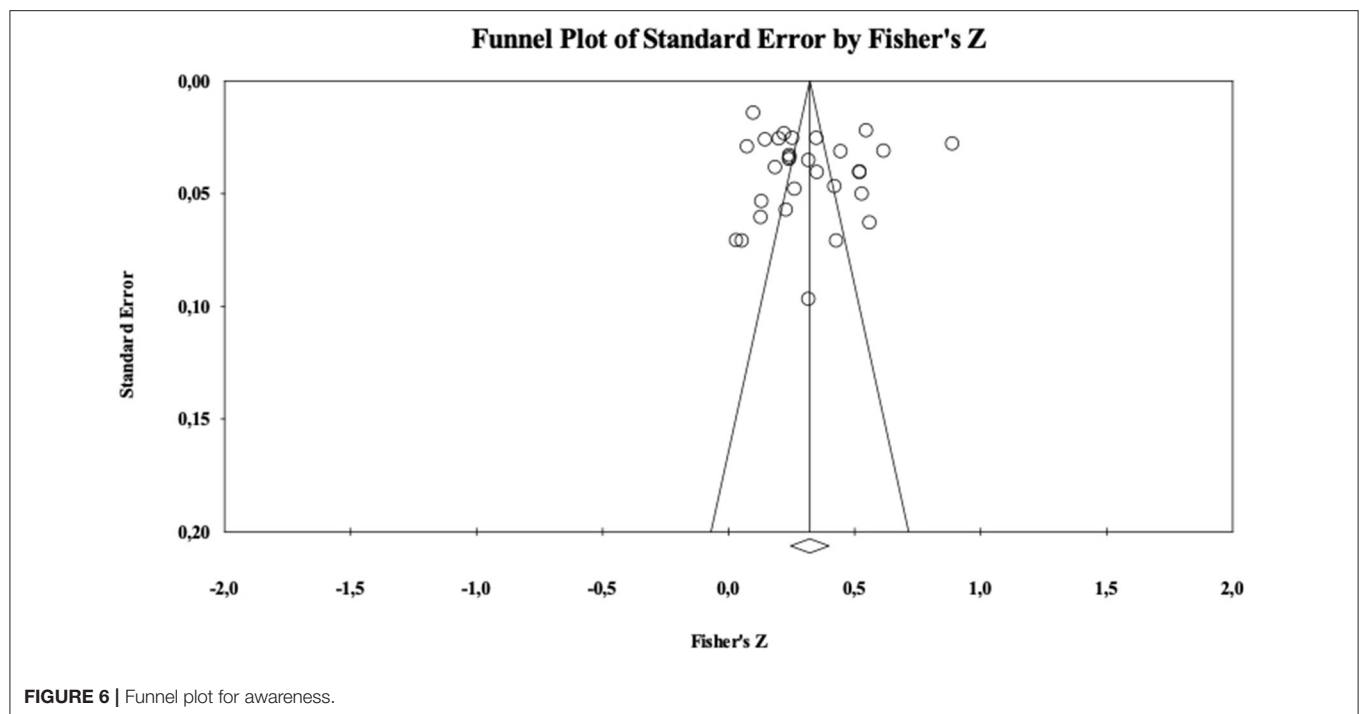
**TABLE 4 |** Summary of ES of the association between awareness of consequences/beliefs in climate change and energy saving behaviors (or intentions).

References	Statistics for each study			
	Sample size	Correlation	95% LLCI	95% ULCI
Afroz et al. (2015b) (Eurasia Journal)	200	0.06	-0.08	0.19
Alam et al. (2014)	200	0.41	0.28	0.52
Barbarossa et al. (2015)	611	0.48	0.42	0.54
Barbarossa et al. (2015)	600	0.48	0.42	0.54
Barbarossa et al. (2015)	794	0.31	0.25	0.37
Barbarossa et al. (2017)	2,005	0.50	0.47	0.53
Bichard and Kazmierczak (2012)	671	0.19	0.11	0.26
Engelken et al. (2016)	109	0.31	0.13	0.47
Fornara et al. (2016)	432	0.26	0.17	0.34
Gerpott and Paukert (2013)	453	0.40	0.32	0.47
Hansla et al. (2008)	855	0.24	0.17	0.30
He and Zhan (2017)	396	0.49	0.41	0.56
Hobman and Frederiks (2014)	1,154	0.08	0.02	0.13
Karytsas and Theodoropoulou (2014)	201	0.03	-0.11	0.17
Klößner et al. (2013)	1,787	0.22	0.18	0.26
Lillemo (2014)	1,004	0.42	0.37	0.47
Lin and Syrgabayeva (2016)	305	0.23	0.12	0.33
Menon and Mahanty (2016)	1,017	0.55	0.51	0.59
Nakada et al. (2016)	4,750	0.10	0.07	0.13
Nayum and Klößner (2014)	1,517	0.25	0.20	0.30
Sapci and Considine (2014)	602	0.34	0.27	0.41
Spence et al. (2010)	1,491	0.20	0.15	0.25
Tsagarakis et al. (2011)	1,440	0.15	0.10	0.20
Vaccaro and Echeverri (2010)	1,257	0.71	0.68	0.74
Wang et al. (2011)	816	0.24	0.17	0.30
Wang et al. (2017)	253	0.51	0.41	0.60
Wolske et al. (2017)	904	0.24	0.18	0.30
Li et al. (2013)	1,516	0.34	0.29	0.38
Zhang X. et al. (2013)	349	0.13	0.03	0.23
Zhang Y. et al. (2013)	273	0.13	0.01	0.24

A 95% CI that does not include zero provides evidence of a significant effect.

## Awareness: Sensitivity Analysis

As stated before, under the label "Awareness," we included both studies that dealt with the more general concept of "awareness of consequences of one's own behavior" and studies that dealt with the more specific dimension of "beliefs in climate change." Therefore, prior to the main effects and moderation tests, we performed a sensitivity analysis to explore whether the effect size in the index of association that was derived from a measure of awareness of consequences ( $r = 0.333$ , LLCI/ULCI = 0.255/0.407) is different from the effect size derived from a measure of beliefs in climate change ( $r = 0.223$ , LLCI/ULCI = 0.057/0.378). While both effects were significant, they were not significantly different from each other,  $Q(1) = 1.512$ ,  $p = 0.219$ . Thus, we can conclude that the overall effect size of the



relationship between this predictor and ESB is not affected from specific measurement features used to assess either awareness of consequences or beliefs in climate change.

## Awareness: Overall and Publication Bias Results

The estimated effect sizes of the association between awareness of consequences/beliefs in climate change and energy saving behaviors (or intentions) are displayed in **Table 4**.

Results revealed a moderate positive association between awareness and ESB:  $r = 0.311$ ; 95% CI LLCI/ULCI = 0.241/0.379;  $p < 0.001$ . We observed a non-negligible level of variation in the distribution of effect sizes (Tau = 0.209, Tau-squared = 0.044). This might be explained by the considerable extent of heterogeneity [i.e.,  $I^2 = 97.51$ ;  $Q(29) = 1168.14$ ,  $p = 0.0001$ ] across the sampled studies.

The critical values  $5K+10$  of Nfs was 160. Analyses showed such a Nfs = 8,803. As showed in the **Figure 6**, the funnel plot reveals a rather symmetrical distribution. In sum, both these indicators suggest that the present analysis is not likely to be contaminated by publication bias.

## Awareness: Moderation Effects

Results revealed no significant moderating effects in the relation between awareness and ESB for gender ( $\beta = -0.001$ ,  $p = \text{ns}$ ), age ( $\beta = 0.001$ ,  $p = \text{ns}$ ), sample typology [ $Q(1) = 0.70$ ,  $p = \text{ns}$ ] and type of dependent variable [ $Q(2) = 0.08$ ,  $p = \text{ns}$ ].

**TABLE 5 |** Summary of ES of the association between emotions and energy saving behaviors (or intentions).

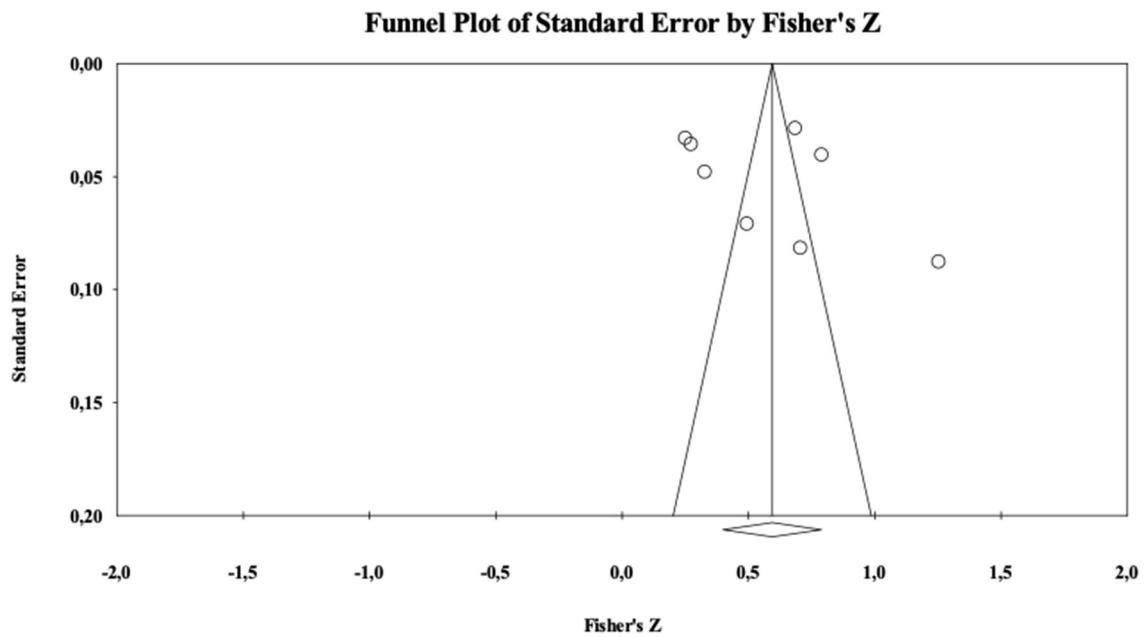
References	Statistics for each study			
	Sample size	Correlation	95% LLCI	95% ULCI
Fornara et al. (2016)	432	0.32	0.23	0.40
Han et al. (2017)	607	0.66	0.61	0.70
Moons and De Pelsmacker (2012)	1,199	0.60	0.56	0.63
Taufik et al. (2016)	152	0.61	0.50	0.70
Taufik et al. (2016)	132	0.85	0.79	0.89
Wang and Wu (2016)	775	0.27	0.20	0.33
Webb et al. (2013)	200	0.46	0.34	0.56
Wolske et al. (2017)	904	0.25	0.19	0.31

A 95% CI that does not include zero provides evidence of a significant effect.

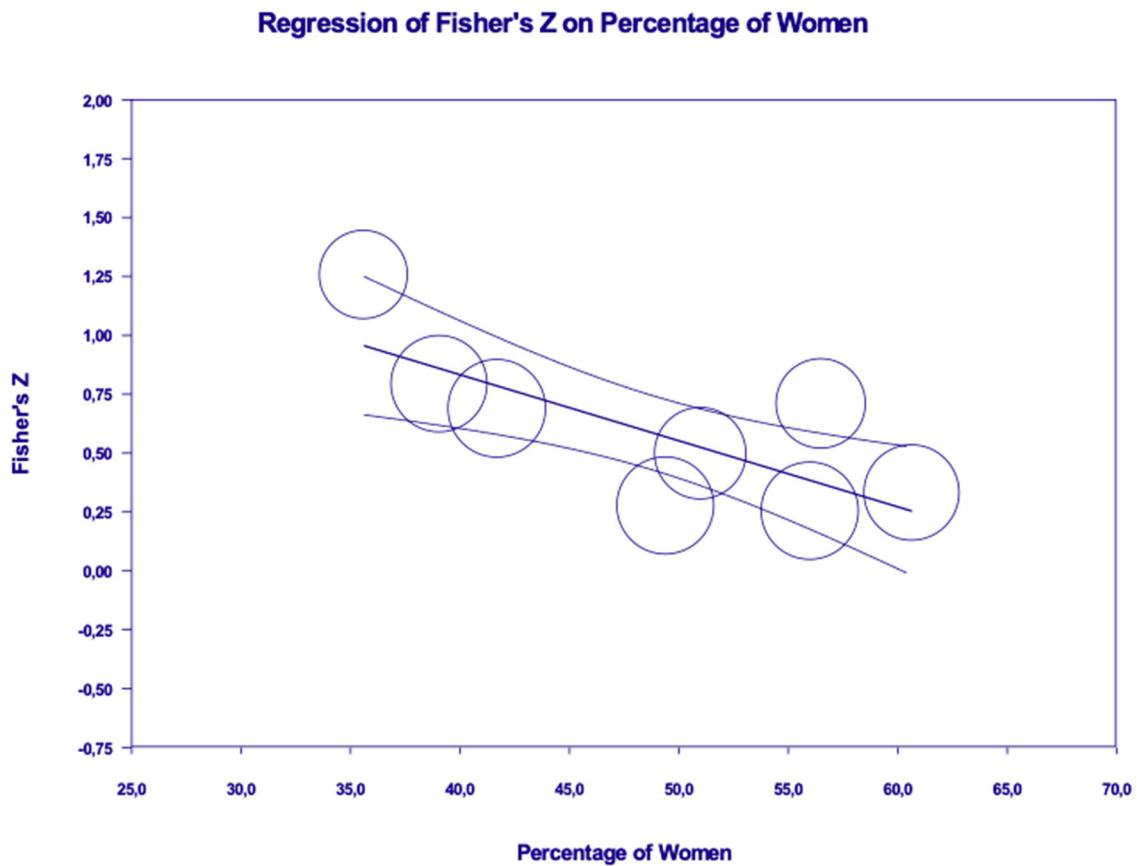
## Emotions: Overall and Publication Bias Results

The estimated effect sizes of the association between emotions and energy saving behaviors (or intentions) are displayed in **Table 5**.

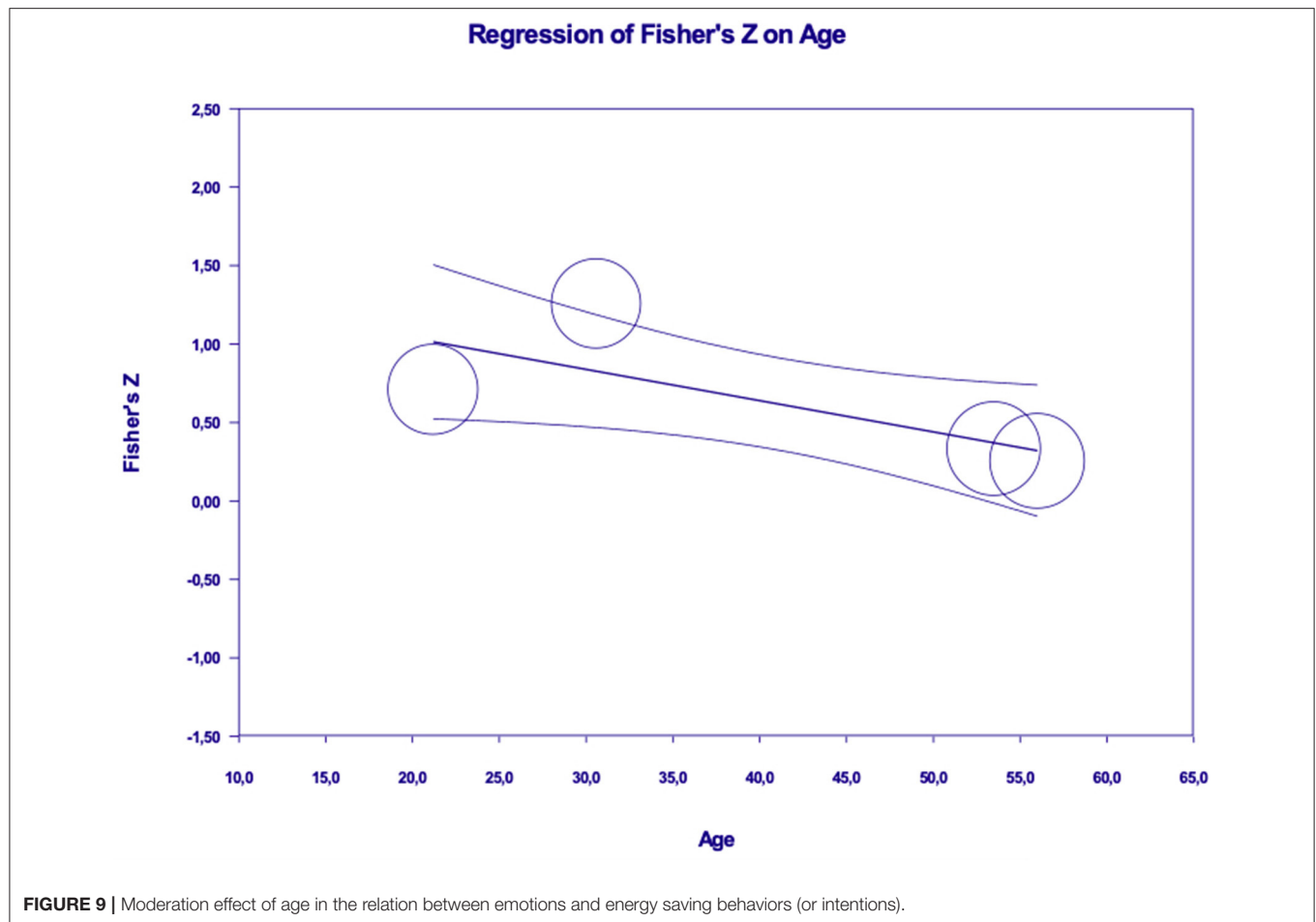
As the number of studies on single discrete emotions (e.g., pride, guilt, or anger) was rather limited, in our meta-analysis we pooled all these emotions together as potential predictors of ESB. This was possible because, independently from the emotional valence, each study included here considered these emotions as drivers of ESB. Results revealed a large positive association between emotions (e.g., guilt, pride, etc.) and ESB,  $r = 0.533$ , 95% CI LLCI/ULCI = 0.379/0.658,  $p = 0.0001$ . We observed a



**FIGURE 7 |** Funnel plot for emotions.



**FIGURE 8 |** Moderation effect of gender in the relation between emotions and energy saving behaviors (or intentions).



non-negligible level of variation in the distribution of effect sizes ( $\text{Tau} = 0.276$ ,  $\text{Tau-squared} = 0.076$ ). This might be explained by the considerable extent of heterogeneity [i.e.,  $I^2 = 97.49$ ;  $Q(7) = 279.62$ ,  $p < 0.0001$ ] inherent among the sampled studies.

The critical values  $5K+10$  of Nfs was 50. Analyses showed a Nfs = 2,357. As showed in **Figure 7**, the funnel plot was rather symmetrical. In sum, both these indicators suggest that the present analysis is not contaminated by publication bias.

### Emotions: Moderation Effects

Results revealed a significant moderation effect, in the relation between emotions and ESB, for gender ( $\beta = -0.03$ ,  $p < 0.001$ ;  $R^2$  analog = 0.60) and age ( $\beta = -0.02$ ,  $p < 0.05$ ;  $R^2$  analog = 0.59), with the effects approaching to zero as the percentage of women and participants' age increase (see **Figures 8, 9**). Results did not show a significant moderation effect for sample type [ $Q(1) = 0.176$ ,  $p = \text{ns}$ ] and type of dependent variable [ $Q(1) = 0.124$ ,  $p = \text{ns}$ ].

## DISCUSSION, CONCLUSIONS, AND PRACTICAL IMPLICATIONS

Taken together, results indicate that the five classes of psychological factors considered in this meta-analysis are

positive and significant predictors of energy saving behaviors (and intentions).

We show a large association of energy saving behaviors with positive and negative emotions (such as guilt, anger or pride); a positive moderate/large association of energy saving behaviors with pro-environmental attitudes; a positive moderate association of energy saving behaviors with awareness of consequences/beliefs in climate change; a positive moderate association of energy saving behaviors with intentions to adopt energy saving solutions; a positive small/moderate association of energy saving behaviors with pro-environmental values. Thus, while all the potential determinants included in our study might be important to explain energy saving behaviors, some predictors, like emotions, show more explanatory power than others, like values or beliefs. It is difficult to explain these differences, without a direct empirical comparison of the mechanisms involved in such relations. On a speculative level, one might argue that pro-environmental beliefs or biospheric values are widely shared in contemporary society, at a global level (particularly among respondents that usually participate in psychological studies); thus, it might be hard to explain differences in human actions on that basis. Also, attitude-behavior or value-behavior gaps are not novel in social psychological or sociological research. Conversely, affective states or emotions associated to a particular



course of action in the energy domain (or in the environmental domain in general), might be more directly associated to real-life choices, especially when individuals are asked to change habitual or routinary patterns of behaviors (see also Carrus et al., 2020).

Our moderation analyses also uncovered some interesting results. Participants' age emerged as a relevant moderator in the associations of pro-environmental values and emotions with energy saving behaviors (or intentions) suggesting that the role of these variables is weaker among older people.

In the case of emotions, gender also emerged as a significant moderator, suggesting that associations between emotions (such as guilt or pride) and energy-related behaviors are weaker among women, compared to men.

Both the tests of the direct effect sizes and the moderation analyses might have interesting practical implications. In particular, regarding the moderation effects of age in the case of values and emotions, our results suggest that these variables could represent key target factors for intervention strategies addressed to younger generations. Likewise, the moderation effect of gender in the association between energy saving behavior and emotions, suggest how these might be a specific factor to be addressed in practical interventions or persuasion campaigns designed purposively to influence energy choices among men, rather than women. Once again, it is not easy to provide a clearcut explanation for these moderation effects, particularly in the case of gender differences: certainly, understanding age and gender differences in the determinants of energy-related choices is an interesting issue for future investigation.

Moderation effects by the typology of the sample recruited (e.g., student vs. non-student) and type of outcome measure (actual vs. self-reported behavior vs. behavioral intentions) are also interesting to discuss. Moderation effects by sample type showed larger effect sizes in student samples compared to non-student samples. Moderation effects by the type of outcome measure (actual vs. self-reported behavior vs. behavioral intentions) when assessing the attitude-behavior links suggest that attitudes are a significant predictor of both intentions and (to a lesser extent) of self-reported behavior. Conversely, our analysis suggests that attitudes might not be a good predictor of actual energy use (e.g., actual electricity consumption measured in kWh).

These kind of moderation effects suggest the existence of both conceptual and methodological issues in current social psychological research on energy saving behaviors (and in general). While it is out of the scope of this paper to discuss the reliability of self-reports in psychological investigation, or the fundamental aspects of the intention-behavior links, it is certainly possible to take these results as an interesting input for the debate on the ecological validity of psychological studies in general, and as a contribution to the necessity to embrace a deeper and more open self-reflexive stance on the quality of research practices in environmental, social and cognitive psychology.

Some limitations of the present study must also be acknowledged: for example, our meta-analytical tests of the effect sizes for values and emotions are based on a relatively limited number of studies. This suggest that these factors could have been under-investigated, at least in the temporal range that we

considered here, and in published studies: it might be the case that considering more recent studies and/or including "gray" literature in future meta-analysis could complement the present findings. This fact seems quite surprising in the case of values (a wide investigated variable in environmental psychological research), but less so in the case of emotions, which, on the contrary, have been rather neglected by people-environment studies in the past (e.g., Damasio, 1994; Carrus et al., 2008). This aspect suggests the need for more environmental psychological research on emotions and energy use, especially because emotions emerged from our meta-analysis as the factor having the largest effect size in relation to energy saving. Emotions are an essential motivational driver of human behavior and should thus be considered as a relevant tool to leverage people's transition to more sustainable energy-related decisions.

Another limitation is represented by our choice of the specific predictors to be included in the meta-analysis. Our choice was based on a previous exploration of the literature on energy choices and pro-environmental behaviors, as well as on widely known models of human deliberate action in the environmental domain (e.g., the Theory of Planned Behavior or the Value-Belief-Norm theory). However, other important variables could have been included in our analysis, such as for example personality traits, motives, skills, risk perception, or perception of costs and benefits: future meta-analysis or systematic reviews are thus needed to assess also the role of these factors in energy-related decisions.

In sum, we can conclude that, taken together results of the meta-analyses presented in this paper could have relevant applied implications for both academics and policy makers, as they can provide relevant insights to improve future studies on the psychological determinants of energy saving behaviors, and provide guidelines to tailor specific policies, intervention programs and public campaigns for changing human energy-related behaviors and promoting a sustainable energy transition.

## DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: MA data available on request to the corresponding author. Requests to access these datasets should be directed to [giuseppe.carrus@uniroma3.it](mailto:giuseppe.carrus@uniroma3.it).

## AUTHOR CONTRIBUTIONS

GC supervised the conception of the meta-analysis, conduction of the study, and contributed to the writing and revision of the manuscript. LT contributed to the data acquisition, coding, writing, and revision of the manuscript. AP performed the statistical tests and contributed to the conception of the meta-analysis, conduction of the study, writing, and revision of the manuscript. PC, IF, CK, SM, TM, and SV contributed to the writing and revision of the manuscript. All authors contributed to the article and approved the submitted version.

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# The Significance of Enabling Human Consideration in Policymaking: How to Get the E-Ferry That You Want

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There is broad agreement in literature and policy that the transport sector needs to maximise electric mobility, in order to lower both energy consumption and greenhouse gas emissions. This ongoing transformation continues to require a high degree of technological innovation. Consequently, policymakers are striving to reward innovation in procurement tender contracts, in order to achieve sustainable innovation. At the same time, such contracts are often designed with a principle of technology neutrality in mind, to prevent any distortion of the market logic. This article suggests that it is misguided to try to perfect the logic of the tender system and that articulating contract that rewards innovation is no guarantee of a sustainable solution. Rather than being *technological*, the problem should be seen as *moral*: the mounting environmental challenge. Policymakers thus have clear ideas about the action needed based on what they, through moral conviction, consider to be appropriate action. This case study—conducted as a part of the EU H2020-funded ECHOES Project under Work Package 6—on the electrification of the Flakk–Røyrvik ferry connexion reveals how policymakers were able to achieve the intended results: in this case, an e-ferry rather than a biodiesel ferry, in spite of, rather than because of, the tender system logic. They achieved this by involving stakeholders in the process with a continuous and uninterrupted dialogue. The project stakeholders were able to intervene in the tender system logic in favour of human considerations. We argue that this project was a success because human judgement, not system logic, was the driving force. By extension, we argue that systems will only allow policymakers to pursue moral issues to the degree that they allow human intervention.

**Keywords: e-ferry, technology neutrality, policymaking, electric mobility, transportation, sustainability, innovation, climate change**

## INTRODUCTION

In order to reach global decarbonisation objectives, it is important to include ferries and high-speed shuttles in the electric mobility revolution. Norway is recognised as a leader in this revolution, both with regard to electric cars and in the maritime sector. The charging of ferries, however, requires technical and infrastructural innovations. The battery packages are massive, and both the state-of-art smart energy technologies and charging infrastructure are involved in facilitating their charging. Flakk–Røyrvik is considered to be one

of the most difficult ferry connexions to electrify in Norway because of its weather and water conditions, as well as its intensive schedule.<sup>1</sup> The decision-making process behind the electrification of this connexion is therefore of particular interest.

This article describes and discusses the successful implementation of electric ferries at Flakk–Rørvik,<sup>2</sup> a 7.4-km ferry connexion. It is the seventh most trafficked ferry lane in Norway, located just outside Trondheim, connecting the city and mainland to Fosen at the other side of Trondheimsfjorden. This fjord has strong currents and temperatures at times reaching below minus 20°C. The new ferries need to be able to cope with these strong currents and potentially very cold temperatures. Because of this, these ferries require unusually high energy consumption compared with most others operating in Norway. The ferry lane was previously serviced by three liquefied natural gas (LNG) ferries managed by the ferry operator Fjord1 on a contract from 1 January 2011 to 31 December 2018.<sup>3</sup>

Fosen Namsos Sjø<sup>4</sup> won the tender and began operating in early 2019, their contract lasting until December 2028. A shipyard on the Norwegian west coast delivered two hybrid ferries, both with a battery system of 2.2 MWh battery packs provided by Siemens.<sup>5</sup> The charging infrastructure transfers energy equivalent to the capacity of one large Tesla per minute to the ferry batteries. This volume is a first-of-its-kind and requires intermediary dock-side battery banks. Both ferries are 103 m long, with a capacity of 399 passengers, 130 light-duty vehicles, and 10 trailers. They depart at 30-min intervals, and the journey lasts about 25 min. The inter-departure docking time is estimated at 6 min, allowing 5 min of efficient charging. Although the ferries are expected to be mainly powered by electricity, a hybrid solution was chosen due to the short docking time, strict schedule and challenging weather conditions. The ferries are commissioned to run on electricity at least 40% of the time, while the rest on certified biodiesel, and the operational rate is 43%. As a backup, a third reserve ferry is available, powered entirely by biodiesel. The operation is expected to be optimised during its first year by increasing the average electrical operating time.

Plans for a new tender for Flakk–Rørvik were initiated in 2015. The county<sup>6</sup> authority was in charge of the process,

with assistance from the Norwegian Innovative Procurement Programme. Together, they arranged dialogue meetings with interested parties, such as vendors and suppliers. The county owns the tender and opted for a contract tender that included eligibility requirements. Specifically, in order to be considered, proposals must adhere to strict emission limits. This eligibility requirement criterion enabled the county and AtB,<sup>7</sup> their company responsible for the administration of transportation, to produce a standard price/quality tender, weighted at 70% price/30% quality, and without environmental requirements or specific technological demands.

One important result of the dialogue meetings was the understanding that a high degree of electrification of the ferry connexion is practically possible. Electrification is a central policy strategy in Norway, and the county could apply for funding from the state-owned support agency Enova toward the costs of establishing the electric infrastructure necessary for the dock-side charging. This enabled the county to guarantee the charging infrastructure for any proposals relying on electrification.

This article presents a real case of ferry electrification and explores the enabling process. E-ferries represent a great opportunity for potential economic savings and environmental conservation when compared with traditional diesel, diesel-electric and, to a lesser extent, LNG-powered ferries. In order to unleash this potential, however, policymakers need to find ways of facilitating the selection for e-ferries, as opposed to, e.g., biodiesel ferries; i.e., they seek strategies to *achieve the results they intend*. Here, they had to operate within the confines (and opportunities) of the tender system. In order to achieve their goal, it was imperative that stakeholders were involved through frequent dialogue, which increased the level of human judgement that was permitted and enabled them to influence the procurement process. The tender system logic itself does not inherently ensure sustainability, but rather encourages an emphasis on technological innovation, which may not necessarily result in greater sustainability when compared with technologically conservative solutions. Sustainability is thus a factor of *human interest*, not *systemic rule-following*, and this (or indeed, any) human interest is best expressed through clear personal communication, rather than attempting to mediate it through a system, although the reliance on systems is indeed unavoidable in policymaking. However, we argue that rather than attempting to encode policymaker intentions in these systems, policymakers should ensure that the systems are sufficiently open to permit interventions of human consideration.

## MATERIALS AND METHODS

The research reported in this study was undertaken as a part of ECHOES' Work Package 6, coordinated by Mehmet Efe Biresselioglu, and Work Package 3, coordinated by Jens Olgard Dalseth Røyrvik—both are the authors of this study. This reported research also contributed to D6.3 and D3.1 of the ECHOES (2017, 2019) Project, in which Mehmet Efe

<sup>1</sup>About the connection weather and currents: NRK Website "Her er fjordens svar på tesla." Available online at: <https://www.nrk.no/trondelag/bygger-hypermoderne-ferjeleier-for-landets-kraftigste-elferjer-1.13884818> (accessed April 2, 2021).

<sup>2</sup>Formal and technical aspects about this ferry connection can be read on the basis for competition for operating the connection: AtB Website Basis for Competition (2019). Available online at: [www.mercell.com%2Fm%2Ffile%2FGetFile.ashx](http://www.mercell.com%2Fm%2Ffile%2FGetFile.ashx) (accessed April 2, 2021).

<sup>3</sup>About the new ferries: <https://www.tu.no/artikler/kleven-bygger-hybrid-ferger/364498>.

<sup>4</sup>About the company: Fosen Namsos Website "About us." Available online at: <http://www.fosennamsos.no/om-oss/category163.html> (accessed April 2, 2021).

<sup>5</sup>The technical details (only in Norwegian) can be downloaded: Fosen Namsos Website «Munken er Her». Available online at: <http://www.fosennamsos.no/aktuelt/mf-munken-har-ankommet-norge-article9720-892.html> (accessed April 2, 2021).

<sup>6</sup>The county about the ferry connection: Trøndelag Fylke Website "Ferjelading." Available online at: <https://www.trondelagfylke.no/nyhetsarkiv/forst-i-verden-med-hoyspent-ferjelading/> (accessed April 2, 2021).

<sup>7</sup>"AtB" is the legal name of the company; it is an expression meaning "getting from A to B."

Biresselioglu was also the lead author. Both authors, together with Muhittin Hakan Demir and Simen Rostad Sæther, contributed to these deliverables. More specifically, three authors of this article, namely Simen Rostad Sæther, Mehmet Efe Biresselioglu and Muhittin Hakan Demir, are also the writers of the “E-Ferries (Norway)” case study in D6.3 (ECHOES, 2019).

## Case Methodology

This article relies on an in-depth case study—a common method used in social science for the comprehensive examination of sustainable energy transition issues (e.g., Tiberio et al., 2020), chosen for its appropriateness in understanding the intentions, dependencies, and reflections, of the developments in this particular project. The development of a case description and case themes was supported by gathering and analysing in-depth and detailed data derived from interviews, documents and news media (Creswell, 2013). This way, results from case studies can be verifiable and representative (Geering, 2004).

The main source of data in this case study was semi-structured in-depth interviews with the stakeholders, presented in section Main Stakeholders, aimed to explore their perceptions and reflections. This method allowed us to uncover the process that led to this authentic case of electrification, and to explore the decision-makers’ intentions and lessons learned.

The aim of this study was to understand the methods that enable policymakers to favour e-ferries over conventional alternatives. Representatives were given a central position when determining the sample. The choice of a qualitative method, and our selection of interviews, allowed us to enter into a dialogue with the key actors in the case, and thus enabled discussion of the intentions of those involved, and how they themselves assess their success and the strategies involved in achieving these results. Judgemental sampling was used, taking into account issues such as feasibility, time, and budget sensitivity. This involved selecting participants based on a specific criterion, i.e., direct involvement in the decision-making process, whether as top-level executive or mid-level manager. We, therefore, conducted semi-structured in-depth interviews with the County Project Manager, the Senior Adviser in State Support Agency and the Project Manager in the Innovative Procurement Programme.

The interviews followed a protocol design based on the literature review (ECHOES, 2017) and the existing policies analysis, which in turn followed the protocol below in line with the D6.3 of the ECHOES Project (ECHOES, 2019):

- (a) The actual case to be described
- (b) The existing alternatives to be analysed
- (c) The approach used for the roadmap and solutions
- (d) The different phases of implementation
- (e) The results of the implementation
- (f) The results from impact and diffusion
- (g) Suggestions and recommendations.

Requirements for ethical and confidentiality from GDPR and the Norwegian legislation, including anonymity, were strictly complied with. All interviewees were provided with project information before signing a consent form. We conducted the interviews in Norwegian (the native language of the interviewees), and then anonymised transcripts

were translated into English. The interviews lasted 60–90 min. They were all recorded, transcribed and coded in NVivo.

We produced a two-page debrief report after each interview, focussing on the emerging themes, the most central points, observations and reflections. These reports, transcriptions and translations were delivered to the wider project group. The debriefs were central for effectively implementing triangulation by analysing the interviews in the light of other data sources, such as policy documents and media texts from this case, and comparing the data with other data and initiatives. Triangulation methods ensured the robustness of our analysis.

## Background and Literature Review

The transport sector, one of the main consumers of fossil fuel, produces a substantial share of the EU’s total greenhouse gas (GHG) emissions; it is one of the largest emission sectors, and it is the only sector that continues to *increase* its GHG emissions (EEA, 2016; Taefi et al., 2016). This sector is thus having an increasingly detrimental impact on the environment and climate change, as well as increasing its own dependence on fossil fuels (EEA, 2016).

In the EU H2020-funded ECHOES Project, we conducted a literature review focussed in large part on consumer behaviour and e-mobility, discussed at either the micro-, meso- or macro-level (ECHOES, 2017). Particularly relevant are findings at macroeconomic level, i.e., formal social units, which are themselves divided, for research purposes, into three levels: (1) formal social units that function as political decision-makers and/or energy suppliers; (2) collective decision-making units that are more formally structured, and which have relatively lower information and power symmetries; and (3) individual consumers.

The shift toward electric mobility seems to establish new market opportunities for those able to modernise infrastructure, digitalise technology and embrace innovation. As a consequence of changes in the manufacturing industry, service, and energy companies may also benefit from electrification, as these sectors will experience increased activity. In sum, innovation and development of new environmentally focussed technology in these sectors are predicted to create new employment opportunities (e.g., Haddadian et al., 2015; European Commission, 2016), which may be different from traditional ones (Røyrvik et al., 2015). Thus, electric mobility is the main focus of discussions concerning sustainable and energy-efficient means of transportation (Peters et al., 2011; Faria et al., 2014).

Our case study concerns the public transportation system, specifically e-ferries. An extended targeted literature search revealed a small number of relevant results,<sup>8</sup> which largely agreed on the potential for electrification of waterborne transport, a sector with high amounts of energy consumption and carbon emissions. Of the very few case studies, none was as detailed as

<sup>8</sup>Web of Science only yields four hits on “e-ferry.” There were vastly more hits on broader search topics. This includes 330 hits on “ferry” and “environment,” 153 hits on “ferry” and “policy,” 871 on “public transport” and “electric,” and 90 on “e-mobility” and “transport.”



the current case. This lack of actual cases must be seen as a barrier to further adoption, as case studies confer significant leverage over policymakers.

The European Commission considers public transport a strategy for lowering emissions (European Commission, 2016), and therefore part of the solution to the European emissions problem, a position with which the IPCC agrees (Sims et al., 2014). In order to address the problem with emissions in the public transport sector, the goal set by the European Commission is emission-free urban passenger transportation by 2050 (i.e., no more conventionally fuelled cars in cities) and emission-free freight transportation in urban areas by 2030. Andong and Sajor (2017) conducted a case study on the Metro Manila, showing that urban sprawl and the associated workplace–home distancing in developing countries lead to greater public transportation use and consequently more emissions. They point out several interacting factors leading to increased carbon emissions from the transport sector. One of these factors is the low fuel efficiency of public transport. However, even with better fuel efficiency, emissions will inevitably rise with growing passenger volume.

Gagatsi et al. (2016) show that shipping, though technically fuel-efficient, is a major energy consumer and a significant source of carbon emissions due to the enormous volumes involved. Despite the relatively small number of ships compared with road vehicles, the energy consumption and carbon emissions of shipping are in fact not far behind those of road transport. Gagatsi et al. further show that maritime shipping represents 11% of the global transportation sector's petroleum use and highlights how this enormous volume is growing so fast that maritime carbon emissions are expected to surpass those of all land-based sources by 2030. If this is to be avoided, serious action is required.

Several of these arguments are repeated by Christodoulou and Cullinane (2020), calling attention to the potential for achieving large reductions of emissions through a combination of measures and policies, and stressing that no single measure achieves meaningful change on its own. The same problems form the basis of a case study of ferry lanes in Croatia by Ančić et al. (2020), who conclude that there is great potential for lowering these emissions.

Attitudes toward electric vehicles (EVs) are proven to have a significant impact on adoption rates, a topic that is integrated into the existing literature on collective decision-making units (e.g., Kaplan et al., 2016; Matthews et al., 2017; Biresselioglu et al., 2018a). Attitudes are found to be one of the key indicators, particularly vital to the decision-making process, and are considerably affected by technical aspects, among additional layers of factors and variables (Quak et al., 2016; Biresselioglu et al., 2018b; Usmani and Rösler, 2015).

Charging infrastructure, considered to be of great importance for the adoption of EVs, is already one of the most investigated aspects in this field of research (e.g., Barlag, 2015; Laurischkat et al., 2016). Existing studies from similar contexts have focussed on the same topic (e.g., Caramizaru and Barlag, 2015; Laurischkat et al., 2016), underlining the strong need for knowledge about charging infrastructure as well as charging solutions. Thus, insufficient charging infrastructure is considered to be a core barrier (e.g., Barlag, 2015; Caramizaru and Barlag, 2015).

The characteristics of EV-usage represent vital information for decision-making (e.g., Norland and Ishaque, 2006; Ambrosino et al., 2015). Among the characteristics that affect the apparent potential to switch to EVs are vehicle use and tour patterns (Klaunenberg et al., 2016).

There remain a number of operational challenges, for instance, grid issues for large fleets and limited availability of EVs. These represent important barriers (Quak et al., 2016). Companies working to transform their fleet to battery-driven EVs are similarly facing highly demanding major change processes (Laurischkat et al., 2016).

Among other significant factors needing to be considered, of course, are economic factors. Some, such as low fuel costs or efficiency of operation, are motivators, or push factors (Quak et al., 2016). On the other hand, other factors are barriers: high procurement costs of EVs; uncertainty about oil prices; energy prices; and the issue of limited, unreliable, and costly after-sales support (Laurischkat et al., 2016; Shao et al., 2016).

The role of operational and economic factors is magnified by issues pertaining to trust, in addition to the quality of, and accessibility to, information and knowledge (Quak et al., 2016; Biresselioglu et al., 2020). One final type, not to be underestimated, is environmental factors, such as environmental performance and vehicle noise level. For some segments, these factors may emerge as central to the decision-making process (Quak et al., 2016).

## Policy Analysis

We have established that the transport sector is a significant source of CO<sub>2</sub> emissions in the EU, and an area highly prioritised in the idea of a coming transition to a low-carbon/low-emission society. In the Strategic Energy Technology (SET) plan (European Commission, 2014), decarbonisation in the transport sector from fossil-fuelled to electric mobility has evolved into a highly prioritised research and innovation area. Electric mobility comprises a large and diverse domain of expertise: from plug-in battery electric cars and plug-in hybrid electric vehicles, to electric bicycles and motorbikes, electric busses and transporters, and electric aviation and ferries. This diversity is so far not recognised in most current policy documents, which focus on electric or hybrid passenger cars.

Various aspects of the electrification of the transport process are prioritised in a number of EU-level initiatives, such as the European Economic Recovery Plan (European Commission, 2008) and the Green Car Initiative (European Commission, 2012). According to the European Commission, in policies supporting the transition to battery-powered vehicles, the overall solutions revolve around technological optimisation and market development.

One future obstacle or challenge of the transition will be establishing and maintaining a sufficient charging infrastructure and plug-in solutions, and another is the need for improving battery reliability and durability. Among other numerous additional related topics that require attention are supercapacitors, reducing battery weight and volume, safety, and cost reduction (European Commission, 2021).

With the H2020-funded E-Ferry Project (E-ferry, 2015), the EU funded €15M of the €21.3M total cost. This project created an e-ferry connexion between Ærø and mainland Denmark. The e-ferry operating cost is estimated at between 24 and 36% lower than that of a diesel or diesel-electric ferry. Additionally, e-ferry battery technology costs are decreasing, and the availability of charging systems and grid infrastructure is inevitably increasing, pointing to even greater future savings. The e-ferry resulted in significantly reduced pollution compared with a diesel or diesel-electric ferry. Finally, the project reports high passenger satisfaction and thus produces social as well as financial and environmental benefits.

## CASE STUDY

The Flakk–Rørvik e-ferry is a case of policymakers successfully achieving their intended results, i.e., the implementation of new technology and environmental policy, within the confines of the tender system. The main data for this case study are the interviews with stakeholders described above, namely the County Project Manager, the Senior Adviser of the State Support Agency and the Project Manager in the Innovative Procurement Programme.

On 5 February 2016, AtB registered the ferry contract tender in the Doffin system, the formal Norwegian Database for all public procurement. In April of the same year, the first tender conference was arranged, and the deadline for proposals was 25 April 2016. The assessment process took place during weeks 17–23 of 2016, and the contract was awarded at the end of this period. After a 3-week period for appeals, the contract was finally signed on week 26, 2016.

## Stakeholders

This case study shows the realisation of the e-ferry Project, in which stakeholders successfully reached the desired solution, despite a system that only takes into account specifications, rather than the concrete wants of stakeholders. See **Figure 1** for an actual image of the e-ferry discussed in the case. The success was due to the ability of stakeholders to mediate these wants. It furthermore shows how this success depended on the stakeholders' different abilities to promote their interests through dialogue with each other. **Figure 2** shows a map of stakeholders for the Flakk–Rørvik Project derived from the interviews.

### Main Stakeholders

**Trøndelag County**, the home of the Flakk–Rørvik ferry connexion, is a key stakeholder in this case and employs the two project managers. In Norway, ferry operations connected to county roads are managed by the counties, while those connected to national roads are managed by the Norwegian Public Roads Administration. In our case, the county owns all resources, including the road-dock infrastructure, the publicly announced operations tender, and 100% of the stocks in AtB, the transport company that manages Trøndelag's public transport. The county and AtB furthermore hire consultant firms, such as DNV GL, to perform the complex calculations necessary for

meeting the energy consumption and grid capacity requirements for new ferries. The project's level of novelty demands a high level of management and coordination of the solutions and actors, leading to the unusual situation of both project managers being involved from the office and in the field.

**The administrative company, AtB**, is responsible for managing the public transport service through planning, purchasing and marketing. Their operations include running the county buses (including school buses), trams and boats (including ferries), among others. AtB is registered as a limited company, entirely owned by Trøndelag county (AtB Website, 2018).

**The ferry operator, Fosen Namsos Sjø AS**, won the public tender for operating the Flakk–Rørvik ferry route with their two newly acquired hybrid ferries from 1 January 2019, with a backup ferry running on biodiesel. The hybrid ferries were purchased from a local shipping company, *Myklebust Verft*, built in one of their shipyards in Western Norway. Myklebust Verft received financial support from the NO<sub>x</sub> fund, a funding scheme for the private sector, administered and financed by the sector itself. Norway has for some time been investigating the possibility of establishing a similarly structured fund aimed at CO<sub>2</sub> emissions. The ferry operator purchased the required electricity from a local provider. The project managers stated that this electricity was cheaper than the biodiesel required for the generators, providing a strong incentive to maximise the rate of electrification.

**Enova SF** is owned by the Norwegian Ministry of Climate and Environment and is the Norwegian government's main tool for providing economic incentives for reducing GHG emissions and supporting the development of more efficient energy technologies, as well as for ensuring the reliability of the energy supply.

The county is eligible for Enova funding toward the dock-side infrastructure costs. There are, however, several criteria for Enova funding, with regard to eligibility, the extent of funding and the potential to innovate or achieve otherwise unattainable results (Enova Website, 2018).

**The National Programme for Supplier Development**, often referred to as “the Innovation Procurement Programme,” was set up to accelerate the rate of innovation and development of new solutions through strategic public procurement and, at the same time, contribute to opening up new markets for these innovations (Innovative Procurement Programme Website, 2018). The programme is a collaboration between important public and private sector entities, aiming to harness their unique strengths, networks and goals.

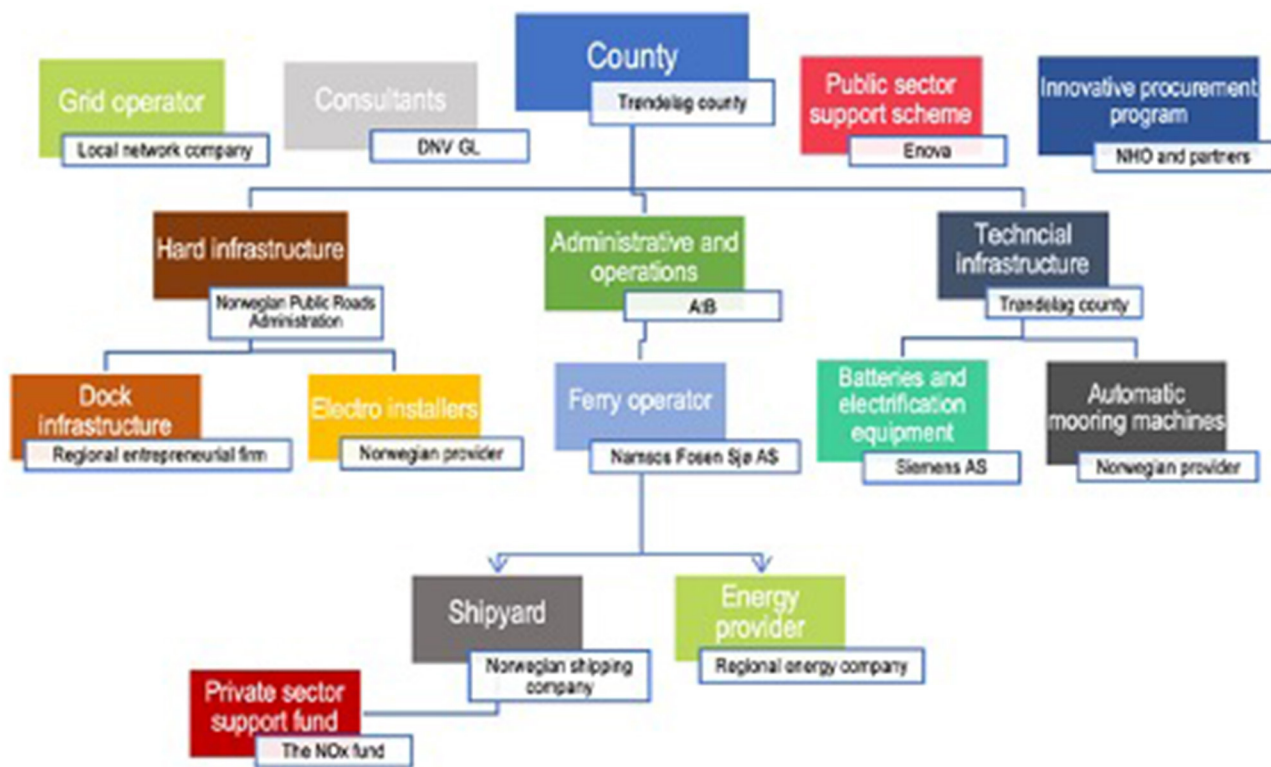
**The Agency for Public Management and eGovernment (Difi)** is involved in the field specifically to support the development of tools and guidance on public procurement, particularly with regard to innovative public procurement.

**The Norwegian Association of Local and Regional Authorities (KS)** links projects to local and regional authorities in order to stimulate actors toward innovation in public procurements.

**The Confederation of Norwegian Enterprise (NHO)** links projects to actors in the private sector. NHO host the Programme



**FIGURE 1** | E-ferry. Image: Fosen Namsos Sjø.



**FIGURE 2** | Stakeholder map. Visual representation of the relevant stakeholders in the Flakk-Rørvik project.

Secretariat, giving direct access to relevant suppliers from specific sectors.

**Innovation Norway** (IN) is the Norwegian Government's tool for enabling innovation and development of enterprise and industry. They support companies

in developing their competitive advantage and enhancing innovation.

**The Research Council of Norway** (FR) is the government authorities' chief advisory body concerning research policy issues. They annually distribute



approximately nine billion NOK for short-term research and innovation activities.

In this case, the programme was initiated in advance, thereby connecting and engaging actors and facilitating their dialogue with Trøndelag county and AtB in the early stages of the procurement process.

### Other Stakeholders

Several other business actors and stakeholders are present on the hard dock-side infrastructure. Management was outsourced to the Norwegian Public Roads Administration, who was tasked with handling tenders and contracts with subcontractors for the dock-side infrastructure and electro-installers. The contract to build and upgrade the dock-side infrastructure was awarded to a regional entrepreneurial firm.

The county managed the technical infrastructure itself. Tenders were announced for the dock-side land-battery system and the automatic mooring machines. The only option for providing sufficient charging for the docked ferries was to supply high-voltage power from a land-based battery buffer. Siemens supplied the battery system to the ferry operator.

### Planning and Development: Interests and Technology Neutrality

Procurement processes are designed to hedge against competition-distorting factors through various strategies, e.g., a principle of technology neutrality—viz. tenders cannot openly favour more-or-less-specific technologies over other technologies that are equally effective. At the same time, it is obvious that policymakers favour certain alternatives over others both in terms of technologies and in broader terms concerning solutions. This may be because certain solutions are understood as inherently superior or as instruments—i.e., accepted as a way of achieving a goal. An e-ferry is a clear case of the latter, being perceived as an instrument toward a goal of great moral import: the environmental and climate goals of society.

The Flakk–Rørvik ferry lane is in a county with its own unique approach to how transport is organised. Some counties use technology-specific orders in their tenders—i.e., “only electric need apply”—while others try to maintain a principle of technology neutrality. The process in this case, however, was described neither as top-down nor as bottom-up, but as having dynamics resembling a wave.

“It was by no means an order that we received, certainly not in this county. It will vary a lot from county to county. You don’t have to go further than to our closest county, where it was much more of an order. So there the county politicians went like, we are going to have electric ferries, so fix it, that sort of thing. [...] Here it has been more from the transport department and the county administrative director to the politicians and down again, so it’s been more like waves. [...] It has been a lot of sparring, much back and forth between different actors. So there is nothing clearly defined, neither top-down nor bottom-up that I can see at least. And it has not come from the ferry crew either if you take it all the way there.”

### Interview Norway, County Project Manager

The manager argued that the reason for this dynamic was due to the overarching goals of the project:

“It has nothing to do with transport directly, it was about greenhouse gas emissions and stuff like that that really led to this. It never stood anywhere that we should have electrical ferries.”

### Interview Norway, County Project Manager

When asked to expand on this, the project manager focussed on the tender’s eligibility requirements and pointed out that the biodiesel option would have been selected had it turned out to be the cheaper solution:

“One should strive to be as technology neutral as possible in the tenders for the ferries. So, if, let’s say it, and then we would have been disappointed for sure, but if the ferry offer with biodiesel was the cheapest, it would have won. Because in order to be eligible you had to fulfil the requirements right, but it wasn’t the cheapest, so...!”

### Interview Norway, County Project Manager

In Norway, it is now mandatory to include low-emission technologies in all new ferry tenders, although this ruling includes no provision for funding. To alleviate this situation, the state-owned support agency, Enova, was made responsible for providing additional funding for such projects. The promise of funding was designed to have a triggering effect, and Enova is furthermore responsible for providing expertise in mapping project needs and feasibility—in collaboration with other consultants involved. The senior advisor at Enova explained that there are many factors to consider in conducting a successful tender.

Enova is therefore generally a central part of the tender process, having developed extensive in-house capability based on their experience of following and facilitating a number of tenders. After the preliminary reviews and calculations, the county applies for funding from Enova in cases in which the project’s innovation potential is the key factor. If granted, up to 40% of the infrastructure costs are funded by Enova, with the justification that:

“Our goal is, on the overarching level, we’re heading for a low-emission society, and then we have to change the market in order for us to get there. Thus, we have market transformation goals as guidelines for our work throughout the organisation, and for maritime transport, this is zero emissions, competitive zero emission vessels.”

### Interview Norway, Senior Adviser in State Support Agency

Enova is regulated so as to prevent the distortion of competition, but they are permitted to support a project that would be otherwise unfeasible, and continue support until the project is independently profitable. The senior advisor explained that their goal is to ensure that the supported projects are competitive and to support technologies that are considered financially sustainable, i.e., projects they predict will eventually be



profitable. In this regard, another rationale was also considered important in their evaluation:

“When we started out, our rationale was to support these projects because we wanted to build the entire value chain of battery technology. We have great potential to do this in Norway. The value added from the fact that the entire value chain is located here is huge. [...] Here we really have the opportunity to create jobs and create added value and technology development in Norway. And when we control the whole value chain, it's also easier to create market change. [...] When we support ferry connexions, it's not only in order to have as many electrified ferry connexions as possible but so that we can eventually include the entire maritime sector.”

#### **Interview Norway, Senior Adviser in State Support Agency**

Another central actor, the national programme for supplier development, was also an early collaborator on the Flakk–Rørvik Project. The project manager stated an interest in ensuring and facilitating a professional process for public procurement. The role of this programme is to be located between public and private/business actors, ensuring mutually innovative solutions and beneficial partnerships.

The supply chain for ferries in Norway is relatively small. The number of actors is manageable for the involved parties, underlined by both the project manager of the national programme and the senior advisor from Enova. Furthermore, they both drew attention to the specific, and special, ways that these actors try to maintain a balance of cooperation and competition:

“Very manageable [number of actors]. And the industry [actors] know each other very well. And they often have open communication lines among themselves. There is, of course, a little competition, I mean they compete, but at the same time, they cooperate a lot. They are very open about that, especially on the development side, I think.”

#### **Interview Norway, Project Manager in the Innovative Procurement Programme**

“What is special about Norway is that we have clusters working together, essentially cooperating when they can and competing when they have to. There's something Norwegian about this... And many have stressed that this success could not have happened in any other place than Norway, because they simply don't have that [business] culture.”

#### **Interview Norway, Senior Adviser in State Support Agency**

At a very early stage in the process, the county, together with the Innovative Procurement Programme, invited the stakeholders to dialogue meetings. Respondents were unanimous that this step was considered pivotal for the success of the project. The county project manager elaborated:

“The county conducted [the market dialogue] through dialogue conferences and one-to-one meetings, and that is a very open process that is two parts, where we go out and present openly what we are searching for, and we also let the market actors into closed

cubes where they can speak. So in those, we will not take any reference or notes, so there they are at liberty to speak, and what comes out there is between those who are there. So then, we go out of there and make an assessment based on the information we have gathered there. So we get a lot of different actors' perspectives and get a lot of input.”

#### **Interview Norway, County Project Manager**

The project manager of the Innovative Procurement Programme underlines the importance of careful considerations at this stage of the project. There are a number of challenging decisions, and different options ought to be examined, thereby highlighting the need for, and relevance of, a programme focussed on process knowledge. The programme's manager also mentions the importance of frequent dialogue, in ensuring a dynamic and flexible process:

“We often assist in writing a so-called dialogue-note that we are working out when we invite actors to dialogue. Once we have come this far then, we may have to work a lot with the need. Then we provide input on how they can do it, how can they explore the need, how can they clarify the need, etc. Then there is the dialogue, yes. So, there we have the dialogue-note, we can help you prepare and either write a little on it or provide feedback on it, as well as to create a good program for a dialogue conference and subsequent dialogue, so how can we facilitate that in a good way. And here there are many ways to choose from. One can have the providers come in very early, also perhaps in the need phase sometimes, in order to get the common understanding of the need. Or they can be drawn into the dialogue phase. Also, we are a discussion partner along the way in the dialogue phases. Perhaps especially important after they have gone through the dialogue phase when they are sitting there with a lot of info and impressions and are thinking; Wow! What do we do next? So, we talk with them then and after that, we can talk about, for instance, what can be done in the new contracts? [...] So, there are a lot of questions here.”

#### **Interview Norway, Project Manager in the Innovative Procurement Programme**

The county manager simply states that in a development phase, inevitable hindrances and difficulties will need to be overcome. He further explains that even small and seemingly insignificant infrastructural obstructions may have complex consequences:

“So, well, you have, all these simple hurdles with the infrastructure to be able to dock these ferries, then you have to supply power. You actually have to sign a supplier that is willing to deliver whatever equipment you need and manage it, and you need some development in the market. And you need acceptance on all levels. Then you need a ship-owner that is willing to deliver an electrical ferry. You then need to get an operator or administrative company that is willing to bet on it, for their tender. You need politicians who are willing to approve, and you need support schemes that can help you fund it by allocating some money for it. So, there are plenty of things that are not straight forward, for sure.”

### Interview Norway, County Project Manager

The data analysis from the project interviews identified three main success criteria: one was the early market dialogue described previously; another, the county council's very ambitious climate goal—halving GHG emissions by 2020—in a context where transport accounts for close to 85% of emissions. This caused the county managers to focus intensely on each segment. The final success criterion identified for the Flakk-Rørвик Project was the tender's incorporation of a climate bonus arrangement.

As a path to success, Enova's senior advisor highlighted the impact of active dialogue between the county council and the city's technology actors, combined with the ability to act on this dialogue. The rationale for the climate bonus model was clarified by the county project manager:

"We had that absolute requirement and the fact that we decided that we should not have any environmental criteria in the tender, because that is our assessment, and well yes it becomes problematic. Because you see that when you set that absolute requirement that is an eligibility requirement to enter the tender, and you make that, you have no incentive to go further, right. So, we added that climate bonus there as a carrot instead of a stick."

### Interview Norway, County Project Manager

The county manager does not suggest this bonus arrangement as being intended as a formal challenge to the bidders. Rather, they explain and underline the spontaneity of the decision, as a spur-of-the-moment idea. Both ship owners and operators responded positively, and the arrangement was therefore immediately added to the contract. According to the manager, this also had a positive outcome for the ship owners, whose costs would be lowered by switching to electricity. They would get extra compensation, in effect, be paid extra to save money. However, compared to the NOK 30 million saving with the NOK 2 billion contract, as the manager points out, the sum is relatively modest (€1 ≈ kr10.5 at the time of writing).

The tender's climate bonus arrangement was specifically hailed by the project manager of the Innovative Procurement Programme as a very significant innovation. The flexibility of the contract allowed for continuous improvements, including upgraded batteries and optimising the rate of electric operation:

"What was special about this particular procurement, is that in the contract it says that during the contract period the supplier-vendor can make sure to include ferries that emit less and less continually. So, it's not a static solution that they've gone for. So, they managed to create a contract that allows them to include continual technological development with respect to emissions. And that was a great innovation really in this context."

### Interview Norway, Project Manager in the Innovative Procurement Programme

They also underlined the need for flexibility to succeed throughout the whole system.

"The support instruments are a bottleneck now. Because we don't really have tools suitable for innovation processes. We have

instruments that are suitable for technology development, but not innovation. This becomes clearer and clearer for me, every day. The Research Council is not suitable for innovation. It is suitable for research! [...] Research is desperately important, but we are not done with innovation at that stage [...] There have to be flexible means that need to be available when we (the innovator) need them. So we cannot have an application that you apply for funds, so you have to spend a lot of resources on, and it takes a year before you get it. Then it's too late. When the air goes out of the balloon, it's gone."

### Interview Norway, Project Manager in the Innovative Procurement Programme

We have so far established that in the planning and development phase, the procurement process was designed to promote the idea of technological neutrality, intended to counteract the distortion of competition through rival stakeholder interests. However, quite apart from the technical aspects, the e-ferry might also be regarded as an instrument for a moral end: in this case, an end that the county was able to achieve by out-manoeuvring a supposedly neutral and objective tender system logic. The empirical evidence suggests that this was made possible through a process involving dialogue, cooperation and an overall notion of the project's significance. This achievement was only possible because the system was open and flexible, and permitted human interventions and considerations to overturn the system logic.

## Implementation and impact

The actors involved conclude that the e-ferry emerged as the winner because of the dialogue and collaboration that characterised the process. Additionally, the stakeholders feel a sense of pride and ownership, precisely because the technology is perceived not as neutral, but rather as the most appropriate solution. The success of the implementation was founded upon the moral conviction that this project is *the morally acceptable thing to do*.

There were also obstacles in the implementation phase, and the most serious of these was the dock-side infrastructure. The charging system was still incomplete when the two ferries started operating in January 2019 and was eventually finished in mid-June, which means that the ferries relied on diesel alone for the first 6 months. Nevertheless, AtB's guarantee that 43% energy consumption should be electric<sup>9</sup> still applied across the whole period of the contract.

Interestingly, the project manager focused on the informal aspects as key to the success of the process, firstly on their feelings of being involved:

"Actually, what goes on is ownership and pride. We see that now, that is it incredibly important. You notice it when someone who doesn't quite have the ownership and then gets a little... And if someone has ownership, then it will be good. So you want to create a showcase window (for your solution, product). All the actors that are part of this ferry project get that showcase window. So they can point to that and say, we or I made that part or system

<sup>9</sup><https://www.atb.no/ferje/>, visited 2020-11-24.

right there. So now, you have many that are very proud of what the work execution they have done here and contributed to. So that is really important.”

#### **Interview Norway, County Project Manager**

Furthermore, it seems that the group shared a common goal, crucial for the direction of the process:

“It is all about making sure you have a common goal to succeed, so the actors are united in saying that we will solve things that come up. Moreover, that we manage to distinguish what is contractual and legal and problematic from what is possible to solve here and now, so you just do it, note it, and sort it out afterward. [...]”

#### **Interview Norway, County Project Manager**

He further points out that the biggest challenges the project faced were related to difficulties with communication:

“I guess one of the biggest challenges for the project has been that sometimes someone is waiting on someone else that needs to do something, but not telling us that they are waiting.”

#### **Interview Norway, County Project Manager**

The main parts of the case study were conducted during the latter part of 2018 before the project was implemented in January 2019; therefore, it was difficult to assess the success of the project. The county and the ferry operations considered that at least a year should pass before firm conclusions could be drawn. In this context, it is nevertheless the case that the decision to choose e-ferries in itself can be considered a success, and according to the project manager, it was already clear in 2018 that the project was a success in terms of the communication of ambitious climate and environmental objectives by actors. This attitude was evident not only among the managers but also among employees in the various organisations. This gave decision-makers hopes for similar ambitions extending across the whole transport sector, as well as other routes and ferry operators. Some of these transport sectors—such as speedboats—have other, and sometimes more challenging technical and organisational issues, and it is, therefore, crucial to have ambitious targets to aim for.

The most obvious of the impacts of the project was on ferry connexions in the areas in and around Trøndelag, summed up in the argument: “if we were able to achieve this very ambitious project, electrification of the other ferry connexions should be relatively simple.” By taking on the most challenging connexion first, the county effectively initiated a solution to the problem of electrifying ferries. Siemens decided to locate their new state-of-the-art battery factory in Trondheim in no small part due to their involvement with the electrification equipment and battery systems for the Flakk–Rørvik connexion.

“When that first county contract was signed, I think a lot of heads turned and asked, if they dared to sign such an agreement, they wonder if they could achieve it too. Moreover, it is clear that this ferry lane is really demanding, so if we succeed here, we will succeed on all our other ferry lanes in the county. [...] There are a lot of ripple effects, the new battery factory that is established in

Trondheim, it has our ferry lane as a showcase window, if you are going to buy an electrical ferry with Siemens technology, you will be invited to come and see it here. So, there are a lot of those types of things that many are not aware of.”

#### **Interview Norway, County Project Manager**

The project manager of the Innovative Procurement Programme observed several ripple effects and in-house experiences. This project is highlighted as an example, which shows the potential of well-thought-out projects in achieving challenging goals. The senior advisor in the state-owned support scheme agency related that the biggest in-house ripple effect was a change of orientation from simply measuring energy consumption reduction in absolute numbers to a complete change in market conditions.

On a final note, the success of this case has undoubtedly inspired some of the more recent developments in Norwegian ferry connexions. The Norwegian Public Roads Administration awarded a developmental contract for the first hydrogen-electric ferry to the ferry operator Nordled (the operator of MF Ampere, the world's first fully electric ferry), on the Hjelmeland–Nesvik–Skiptavik connexion in Rogaland county, in south-western Norway. From 2021, the ferry is expected to use equal amounts of energy from hydrogen and from batteries charged from the dock. Additionally, the government has decreed (Regjeringen, 2020) that one of the longest Norwegian ferry connexions, Bodø–Moskenes, must employ hydrogen ferries from 2024.

The implementation appears as having favourable outcomes both for the Flakk–Rørvik ferry lane itself and for the general situation regarding ferries. In this case, the stakeholders were thereby proven right in their conviction. The solution must be seen as the most appropriate option precisely because it was founded on human judgement.

## **DISCUSSION AND CONCLUDING REMARKS**

### **Technology Neutrality and Innovation: for Better and Worse**

The tender system and economic discourse in Norway tend to favour technology neutrality, and this was a specific requirement in Trøndelag County. This causes a dilemma, in that while it may help move the focus from technology to sustainability, it may also make it more difficult to achieve set goals. We saw that interviewees worried that the tender logic, if unguided and uninfluenced, might have favoured a diesel ferry. Fortunately, in this case, the intended goals were realised, but this was in spite of rather than because of the system logic.

The system emphasises the importance of innovation in proposed solutions. This too produces a dilemma, in that innovation is good only if it allows goals to be achieved. If the system blindly rewards innovation, it risks promoting unsustainable solutions on account of their innovative capabilities. Innovation is not synonymous with sustainability, and treating it so can be dangerously misleading in cases of such paramount importance to the sustainability of human life.

We saw that Enova rewards innovation, which they emphasise as intrinsically beneficial; however, equally, we saw innovation criteria supporting policymakers' aims, i.e., tenders requiring low-emission solutions.

To ensure that policymakers succeed, flexibility is important, and complaints throughout the project typically revolved around the perceived lack of flexibility in the process. The interviewees stressed the importance of pride and ownership, reflecting people's need to feel involved in the project. These issues are interconnected and culminate in the desire to exercise human considerations in projects of great societal importance. This ability to exercise judgement is, in turn, necessary in order to curb the role of technology neutrality and innovation, allowing the balance to be tipped in favour of policymakers.

## A Case of Success

An overwhelming number of studies demonstrate that investment in the construction of e-ferries rather than conventional diesel ferries will result in massive reductions in energy consumption and GHG emissions from the maritime transport sector. Said reductions will be of an exceptionally important magnitude if Norwegian national policy were to favour e-ferries, opening the door for potential worldwide replication. At the same time, it is clear that greater further efforts are needed to ensure the continued electrification of the maritime transport sector. This article shows some of the important aspects concerning (a) stakeholders that inevitably take part in this process, (b) the procurement principles at play and (c) the actual implementation of such a project.

On 26 November, The Norwegian Broadcasting Corporation (Norsk rikskringkasting AS) reported<sup>10</sup> that the Norwegian government has announced that, from 2023, all new ferry tenders will require low- or zero-emission ferries. Erna Solberg, the Norwegian prime minister, highlighted the reduction of Norwegian emissions as the primary motivation for this new demand, and also allocated an undisclosed amount of public funding to this end.

## A Case for Human Judgement and Flexibility

This case study is primarily a study of the success of policymakers achieving the results they intended. This success was, however, not guaranteed or safeguarded by the system logic. It is imperative that the success of the case is neither considered as a success of the system with which the project participants had to contend, nor considered as an argument in favour of technology neutrality or innovation as intrinsically valuable in and of themselves. By gaining an insight from decision-makers and public officials, we are able to understand their intentions and the perceived effects that e-ferries might have beyond this one specific case. The case can also serve as an inspiration for policymakers and decision-makers in general, and also other sectors facing the challenge of sustainable transition.

While it may superficially seem that the technology and policymaking work together in tandem toward intended results, in reality, it is more complex. Technology works to maximise technological progress and innovation, and policymaking seeks to leverage this by rewarding innovative technologies, e.g., the "climate bonus" reference in the case, or how Enova rewards innovative technologies that help society transition to low-emission solutions. *Prima facie*, it appears that technologies use policymaking to advance technology and that policymakers use technology to advance policymaking—and to some extent, this is indeed true. What lies at the core of the desire for an e-ferry on the Flakk–Rørvik line cannot, however, be explained as merely technological; it is a *moral* point: we need to transition to a low-emission society in order to allow the planet, including, of course, its people, to survive and flourish. This moral point must then be *techno-logically* mediated through the tender system. The result is the amoral specification for a technological solution. The policymakers, however, aim not at a technological solution, but a moral solution. In the policymakers' intentions, the e-ferry as technology is an arbitrary element in the moral problem of humans attuning themselves sustainably to their environment. However, in the technological system, this relationship is inverted, so that the moral problem becomes the arbitrary element, and the technology becomes primary. We contend here that policymakers regard e-ferries as the means to an end, i.e., environmentally orientated travel, whereas, from a technological point of view, the environment itself becomes the means of triggering financial rewards through mechanisms such as innovation funding and climate bonuses.

Policymakers should be *informed*, not *formed* by science. Science can never legitimise moral decisions, but it may inform and thereby assist us. Correspondingly, scientists should not have their activity shaped by policymakers. The legitimisation of political strategy cannot be the scientists' creed. It is, hopefully, not controversial to assert that science should not be subordinated by immoral objectives; a society's moral convictions always precede both science and policymaking. The role of policymakers here is to reflect the morals of the society. Since, in the case in point here, much is at stake, regarding present-day environmental challenges, it is important that policymakers are as well informed as possible, which is the role of science today. In order for this to be successful, the importance of dialogue cannot be overstated, as is reflected by the case study interviewees. Dialogue is, as Feyerabend (1987) argues, essential to science in a free society.

In the end, human interests can only be articulated and preserved by exercising the human quality of judgement that stems from the—human—capacity for care. Disembodied machines and systems operate by following rules expressed in the propositional knowledge they receive as input, but while a well-designed system will indeed identify the correct solution to a well-formed problem, its greatest weakness from a human point of view is that the system simply has no investment in the outcome. Thus, such systems are in constant need of human intervention if they are to provide the desired outcomes. To preserve human interests, systems must have

<sup>10</sup><https://www.nrk.no/norge/stiller-krav-om-lav--eller-nullutslippsferger-innen-2023-1.15261914>.



the flexibility to allow for intervention, thereby maximising human considerations. To do this is to facilitate dialogue, which requires ensuring that all parties are fully involved. This relationship is reciprocal; this system flexibility is necessary to ensure the capacity for dialogue and, conversely, dialogue, to ensure judgement.

## DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: <https://www.echoes-project.eu>.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by it has undergone the Ethics Committee of the H2020 project ECHOES, and the Norwegian committee NSD. The patients/participants provided their written informed consent to participate in this study.

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The research reported in this study was undertaken as a part of ECHOES' Work Package 6, coordinated by MB and Work Package 3 coordinated by JR, both are the authors of this study. This reported research also contributed to D6.3 and D3.1 of the ECHOES (2017, 2019) project in which MB was the lead author as well. Both authors together with MD and SS contributed to these deliverables. More specifically, three authors of this article, namely, SS, MB, and MD are also the writers of the E-Ferries (Norway) case study in D6.3 (ECHOES, 2019).

## AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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**Conflict of Interest:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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# Disease Avoidance Model Explains the Acceptance of Cohabitation With Bats During the COVID-19 Pandemic

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Bats and humans have a close relationship based on cohabitation, with bats taking roost in buildings. It has been suggested that bats function as a reservoir of the SARS-CoV-2 virus that causes the COVID-19 disease in humans. A misconception that bats can spread SARS-CoV-2 to humans may have increased negative emotions toward bats and reduced individuals' acceptance of cohabitation with bats during the COVID-19 pandemic. By applying the disease avoidance model, we tested whether knowledge about bats would be associated with reduced negative emotions toward bats, which in turn would be associated with increased acceptance of cohabitation with bats. Moreover, we tested whether previous experiences of bats, perceived COVID-19 risk, age, gender and level of education would be associated with negative emotions and acceptance of bats. A quantitative survey ( $N = 577$ ) collected during the COVID-19 pandemic in Finland was analyzed with multiple linear regression. The results supported the disease avoidance model. Negative emotions toward bats reduced the acceptance of cohabitation with bats. However, knowledge about bats was associated with increased acceptance of bats both directly, as well as indirectly, *via* reduced negative emotions. Moreover, perceived COVID-19 risk was associated with increased negative emotions toward bats, and reduced acceptance of bats. Females were more likely than other respondents to report negative emotions, and reduced acceptance of cohabitation with bats. Prior experience of bats was associated with increased acceptance of bats as neighbors. These findings suggest that COVID-19 pandemic may threaten the existence of bats if no action is taken. The findings highlight the importance of correcting misunderstandings about non-human species as transmitters of diseases to humans.

**Keywords:** bats, disease avoidance, COVID-19, cohabitation, conservation, mediation, knowledge, negative emotions

## INTRODUCTION

Bats and humans have had a lengthy coexistence that dates back to the time when hominids began to regularly use caves (Usinger, 1966; Rossina, 2006). This is exemplified by the fact that bats and humans share their respective lineages of *Cimex lectularius*, the bed bug, which colonized humans in the shared living quarters (Roth et al., 2019). The close relationship between bats and humans,

based on cohabitation, has carried to this day, with bats taking roost in buildings (Marnell and Presetnik, 2010). At northerly latitudes, bats depend on the shelter and warmth of buildings during pregnancy and lactation (Humphrey, 1975). Bats also benefit humans as they provide a wide range of valuable ecosystem services, such as pollination (Howell and Roth, 1981) and pest control (Boyles et al., 2011; Kemp et al., 2019; Weier et al., 2019). Just lately, it has been estimated that bats save vineyards with up to 7% of their production through pest suppression (Rodríguez-San Pedro et al., 2020). However, despite their usefulness for humans, bats have suffered from fear, hostility as well as cultural prejudice throughout history (Kingston, 2015). Even though attitudes toward historically stigmatized species have improved in modern times (George et al., 2016), bats are a species group still heavily associated with fear and phobias (Knight, 2008).

Bats are also associated with potentially zoonotic pathogens, including bacteria (Veikkolainen et al., 2014; Hokynar et al., 2016; Lilley et al., 2017) and viruses (Li et al., 2005; Jakava-Viljanen et al., 2010; Drexler et al., 2012). The current COVID-19 pandemic has now led to an even stronger association between bats and zoonotic pathogens than before the pandemic (Cerri et al., 2020; WHO, 2020), contributing to a more widespread view on bat persecution (MacFarlane and Rocha, 2020; Sasse and Gramza, 2020). During the COVID-19 pandemic, bats have been wrongly implied as the natural reservoir for the SARS-CoV-2 virus, which causes the disease in humans (Zhang et al., 2020). Although bats provide important ecosystem services, the media in general is inclined to portray a negative image of bats; most often as reservoirs of deadly viruses (López-Baucells et al., 2018). This could be partly due to misinformation related to COVID-19 that people read and share especially on social media platforms (Pennycook et al., 2020).

The prevailing COVID-19 pandemic may affect willingness of humans to accept non-human species in their immediate environment, which may be particularly pronounced for those species with some link to the SARS-CoV-2 virus. Especially during the early stage of the pandemic, rumors circulated about the connection between COVID-19 and wildlife, however, there is still uncertainty as to which species the virus originally transferred to humans from (Neupane, 2020). The framing of the message on the origin of the SARS-CoV-2 virus can have a significant influence on the opinions of people (Bolsen and Palm, 2020; MacFarlane and Rocha, 2020), and thus affect the extent to which people are willing to coexist with bats. A great deal of ambiguities and even misinformation are related to the COVID-19 outbreak (MacFarlane and Rocha, 2020; Bolsen and Palm, 2020), which can foster false beliefs of the role of bats in the disease outbreak. At least among humans, cues of disease may lead to discrimination of other human beings, including even those who do not increase the risk of disease to others (Park et al., 2003). Similarly, for bats, this could mean discriminating against them on the basis of false beliefs, which could lead to an increase in reluctance to co-exist with them. Because attitudes toward bats and perception of threats to bats are the most important factors supporting management (Fagan et al., 2018), the recent worldwide events have the potential to initiate

devastating impacts on bat conservation. Therefore, there is a direct need to gain a deeper understanding on how the COVID-19 pandemic has affected attitudes toward bats.

The disease avoidance model helps to explain the process of avoidance of potential or real threat. The model is based on the assumption that humans have evolved a tendency to avoid potential threat of diseases, and this is one of the reasons for the avoidance of certain animals from which humans could contract a contagious disease (i.e., associated risk of contamination) (Prokop and Fančovičová, 2013; Hunt et al., 2017). Disease avoidance is associated with the emotions of fear and disgust toward disease- or threat-related animals (Oaten et al., 2009; Prokop and Fančovičová, 2013). These negative emotions have an adaptive function, their evolutionary role is to protect the organism from contact with contaminants and prevent the acquisition of disease (Matchett and Davey, 1991), as well as to avoid diseases (Curtis et al., 2011). People can also differ in terms of their sensitivity to have such negative emotions, and that can affect their mental health, as well as their behavior in a positive or negative direction. For example, higher disgust sensitivity could lead to high health anxiety and further, to hypochondriasis as its extreme case (Fan and Olatunji, 2013). However, disgust sensitivity could also motivate and maintain health-safety behavior (e.g., washing hands) (Fan and Olatunji, 2013). In addition to this, for contagious diseases such as Ebola and Zika, disgust sensitivity has been found to be the main driving force behind public attitudes toward these diseases and avoiding regions where the disease is present (Kam, 2019).

The omitted disease cues (either accurate or inaccurate) can lead to stigmatization and the activation of the disease avoidance system, manifested by physical and social avoidance (Oaten et al., 2011). The influencing factors of disease avoidance are the knowledge and beliefs that are related to the possible threat of disease. Ethnic outgroups or foreigners are often blamed for outbreaks of epidemic diseases, which can trigger neglect toward these groups in the human society (e.g., Faulkner et al., 2004). However, similar processes can also be directed at animals. For example, a belief in myths together with a poor knowledge of bats has been found to be related to negative attitudes toward bats and avoidance of them among both children and adults (Prokop and Tunnicliffe, 2008; Prokop et al., 2009; Musila et al., 2018). In the case of the COVID-19 disease, it is yet unclear how the (false) beliefs on the role of bats in the disease outbreak affect acceptance of cohabitation with bats. As we already know that negative verbal information can increase fear of animals (Kingston, 2015), news coverage related to zoonoses can further skew people's attitudes toward bats (Schneeberger and Voigt, 2015).

People's perceptions of bats may also differ by gender. For example, Musila et al. (2018) found that women had more negative attitudes toward bats and they also believed more in myths about bats than men. Similar gender differences have been observed also in other studies for animals associated with fear or disgust: attitudes of females have been more negative than those of males (Davey et al., 1998; Bjerke and Østdahl, 2004). Higher age, instead, has had both a positive (Musila et al., 2018) and a negative association (Bjerke and Østdahl, 2004) with attitudes toward bats. Higher level of education has been found to be



associated with more positive attitudes toward bats (Bjerke and Østdahl, 2004; Musila et al., 2018).

Another factor that may contribute to avoiding the potential threat of disease is concern related to the disease itself. With regards to COVID-19, Shook et al. (2020) found that concern toward this disease was related to behavior that sought to prevent the onset of the disease among the United States citizens. They also found that disgust toward pathogens was related to a greater concern about the COVID-19 disease. However, sometimes concern toward the disease can also lead to irrational behavior, for instance, due to prejudices. Park et al. (2003) found that people who are more concerned about a disease may avoid contacts with disabled people, although these situations are not associated with the risk of contracting a disease. Bearing this in mind, concern toward the COVID-19 disease could influence reluctance to accept bats in the immediate environment.

The aim of this study was to explore whether the COVID-19 pandemic has affected individuals' acceptance of cohabitation with bats. Disease avoidance model suggests that explicit knowledge, beliefs and myths that associate neutral object with disease contamination make the neutral object appear disgusting (Oaten et al., 2009, 2011; Prokop et al., 2009). As a consequence, people want to avoid that object in order to avoid contamination. Therefore, disease avoidance model suggests that the association between knowledge and object is strongly mediated by negative emotions related to disease avoidance such as disgust, fear, and perceived anxiety (e.g., Matchett and Davey, 1991; Curtis et al., 2011; Davey, 2011; Prokop and Fančovičová, 2013).

In this study we tested three hypotheses related to the disease avoidance. More specifically, we wanted to test the hypothesis that negative emotions toward bats would be associated with reduced acceptance of cohabitation with bats (Hypothesis 1). In addition, we wanted to test the hypothesis that knowledge about bats would be associated with increased acceptance of cohabitation with bats directly, as well as indirectly, *via* reduced negative emotions toward bats (Hypothesis 2). In other words, this hypothesis suggests that negative emotions related to disease avoidance would mediate the association between knowledge about bats, and acceptance of cohabitation with bats. Moreover, we wanted to test the hypothesis that increased concern about the COVID-19 risk in Finland would increase negative emotions and reduce acceptance of bats as neighbors (Hypothesis 3).

## MATERIALS AND METHODS

### Survey Design and Participants

We conducted an online survey in Finland during May-June 2020. The survey was administered in Finnish and it included several questions related to opinions and knowledge of bats and COVID-19, as well as questions on respondents' socio-demographic background. We used relevant sections of that broader survey in this study. The link to the survey was distributed in social media through institutional (University of Helsinki, BatLab Finland, Helsus, Luomus), Natural Resources Institute Finland (Luke) and personal Facebook and Twitter

accounts. However, to include individuals explicitly with more experiences with bats in our sample set, a direct survey link was also sent to the participants of an ongoing citizen science (CS) "Papanapankki" project on bats. The CS project involved people who had a bat colony in either the building they live in, a building on their premises, or at their summer cottage. The CS-participants collected bat fecal pellets for researchers to determine the distribution and changes in diet composition in latitudinal and temporal gradients of different bat species. Altogether, we received 577 responses to our survey. The majority of the respondents were female (68.8%), their mean age was 45 years (SD = 14.47, range 20-91), they were highly educated and most of them lived in a city (see **Table 1**). Roughly one-tenth of them were participants of the CS project. In addition, more than half of the respondents (56.5%) reported to have bats in their immediate environments either in the attic of their home, courtyard building or summer cottage (**Table 1**).

## Measures

### Acceptance of Cohabitation With Bats

We asked whether the respondents would accept cohabitation with bats by asking them to choose the option that corresponded to their opinion about the following statements using a 7-point Likert scale ranging from 1 = completely disagree to 7 = completely agree: I do not mind if bats use (a) my residential

**TABLE 1 |** Sociodemographic background of the respondents ( $n = 577$ ) and prior experiences with bats.

Variable		%	<i>n</i>
Gender <sup>a</sup>	Female	68.8	397
	Male	25.1	145
	Gender unknown	6.1	35
Residential area type	City	61.4	353
	Suburb	18.4	106
	Countryside	20.2	116
	Missing	0.003	2
CS-project participant	Yes	11.9	69
Level of education	Comprehensive school	1.7	10
	1-3-y. vocational degree	9.9	57
	Upper secondary school degree	10.2	59
	An engineering-, business and administration or nursing degree	5.7	33
	Polytechnic degree	14.4	83
	Lower academic degree	12.3	71
	Master's degree or specialist medical doctor degree	32.8	189
	Licentiate or Ph.D. degree	11.1	64
	I do not want to say/missing	1.9	11
Bats occur in the immediate environment <sup>b</sup>	Yes	56.5	326

<sup>a</sup>Variable gender had four categories (female, male, other and prefer not to say). The category "Gender unknown" includes the last two categories and missing values.

<sup>b</sup>Whether bats are present at least in one of the following places in the vicinity of the respondent: in the attic of the home, in the courtyard building or in the summer cottage. This variable reflects previous experiences with bats.

building as a day roost, (b) my courtyard building as a day roost, and (c) my summer cottage as a day roost. If the respondents did not have the above-mentioned premises, we asked them to imagine they would and respond on that basis. The mean score of the three items was used (*Cronbach alpha* = 0.91).

### Knowledge of Bats

We measured knowledge of bats using seven statements that were either true or false [e.g., Humans can get rabies from a bat bite (true)]. Respondents expressed their responses using a 5-point Likert scale. We reverse coded three items so that larger value indicated better knowledge and then calculated the mean of the items. According to Stadler et al. (2021), knowledge is formed by aspects that are not necessarily associated with each other, and therefore the Cronbach alpha should not be used for assessing how well a certain scale can measure respondents' knowledge on a specific domain. Therefore, Cronbach alpha was not applicable for this scale. The mean variable was used in the regression analysis.

### Negative Emotions Toward Bats

We asked the respondents to indicate their emotions of disgust, fear and anxiety toward bats at the moment using a 7-point Likert scale ranging from 1 = not at all to 7 = extremely. We calculated a mean variable from these three items for analysis (*Cronbach alpha* = 0.83).

### Perceived Risk of COVID-19

We asked the respondents to express their concern about the COVID-19 situation using three questions: concern about the COVID-19 situation in Finland, the perceived risk to themselves and for people close to them. We used a 7-point Likert scale ranging from 1 = not concerned at all to 7 = extremely concerned. We calculated a mean variable from these three items (*Cronbach alpha* = 0.78).

### Prior Experiences of Bats

We asked our respondents whether there are bats in their immediate vicinity in the following buildings: attic of the home, courtyard building, or their summer cottage. From these, we formed a new dichotomous variable ("prior experiences with bats") based on the respondents' "yes" answers (1 = there are bats in at least one of these buildings, 0 = bats are not present in any of these, *Cronbach alpha* = 0.90).

### Sociodemographic Variables

We asked the respondent's age, gender and level of education. From these, we formed a dichotomous variable "gender female" (1 = yes, 0 = no) and highly educated (1 = yes, 0 = no). We used age as a continuous variable in the regression analyses.

Descriptive statistics of the main variables are shown in **Table 2**. Acceptance of cohabitation with bats correlated negatively with negative emotions and perceived risk of COVID-19 as well as with age and gender (being female). There was a positive correlation between acceptance of bats, knowledge and previous experiences with bats. Furthermore, negative emotions correlated positively with perceived risk of COVID-19 and education as well as negatively with knowledge.

## Data Analysis

The mediation model was tested with multiple linear regression using the PROCESS v3.3 package (Hayes, 2018) and the IBM SPSS Statistics version 25.0. Knowledge was used as an explanatory variable and the acceptance of cohabitation with bats was used as the dependent variable. Negative emotions were used as a mediator variable. In addition, prior experiences of bats, perceived COVID-19 risk, age, gender and the level of education were used as covariates in the model. Indirect association between knowledge of bats and acceptance of cohabitation with bats was estimated using the 95% confidence intervals and 5,000 bootstrap samples.

## RESULTS

The mediation model included two linear regressions (Agler and De Boeck, 2017; Hayes, 2018). They together explained about 49% of the variation in the responses, which can be considered good (**Table 3**). According to the results, negative emotions were associated with reduced acceptance of cohabitation with bats, as expected (Hypothesis 1).

Knowledge about bats was directly associated with increased acceptance of cohabitation with bats. In addition, bootstrapped 95% confidence interval for the indirect association between knowledge and acceptance of bats was statistically significant ( $B = 0.69$ ,  $S.E. = 0.13$ ,  $LL = 46$ ,  $UL = 0.96$ ). Therefore, the association between knowledge and acceptance of cohabitation with bats was partially mediated by negative emotions, as expected (Hypothesis 2). In addition, increased perceived COVID-19 risk was associated with increased negative emotions toward bats, and reduced acceptance of cohabitation with bats as neighbors, as expected (Hypothesis 3).

In addition, females and those with an academic degree were more likely to report negative emotions toward bats than other respondents (**Table 3**). Older respondents and females were less likely to accept cohabitation with bats than other respondents.

## DISCUSSION

The results suggest that negative emotions of disgust, fear, and anxiety toward bats reduced acceptance of cohabitation with bats. However, knowledge of bats was associated with increased acceptance of cohabitation with bats both directly, as well as indirectly, *via* reduced negative emotions toward bats. Moreover, increased perceived COVID-19 risk was associated with negative emotions toward bats. These results bear resemblance to the Prokop et al. (2009) study, in which a belief in myths about bats was associated with avoidance of bats. In addition, our results support the proposition of Shook et al. (2020) that increased concern of COVID-19 may lead to increased pathogen disgust sensitivity. Therefore, our study supports the disease avoidance model indicating that negative emotions related to disease avoidance such as disgust, fear and anxiety are essential emotions that mediate the association between the perceived threat object and avoidance

**TABLE 2 |** Means, standard deviations and correlations (Spearman rho).

	<i>M</i>	<i>SD</i>	<i>Age</i>	<i>Gender (female)</i>	<i>Level of educ. (acad.)</i>	<i>Knowledge of bats</i>	<i>Negative emotions</i>	<i>Experiences of bats</i>	<i>Perceiv. COVID-19 risk</i>	<i>Acceptance of cohab. bats</i>
Age	45.01	14.47	1.00	−0.01	−0.06	0.10*	−0.04	0.17***	0.25***	−0.10*
Gender (female)	—	—	−0.01	1.00	0.03	0.06	0.05	0.04	0.03	−0.15***
Level of educ. (acad.)	—	—	−0.06	0.03	1.00	0.11**	0.11*	0.00	−0.01	−0.05
Knowledge of bats	4.03	0.46	0.10*	0.06	0.11**	1.00	−0.28***	0.06	0.09*	0.24***
Negative emotions	1.85	1.30	−0.04	0.05	0.11*	−0.28***	1.00	0.01	0.11**	−0.48***
Experiences of bats	—	—	0.17***	0.04	0.00	0.06	0.01	1.00	0.05	0.08*
Perceiv. COVID-19 risk	4.13	1.32	0.25***	0.03	−0.01	0.09*	0.11**	0.05	1.00	−0.09*
Acceptance of cohab. bats	5.44	1.87	−0.10*	−0.15***	−0.05	0.24***	−0.48***	0.08*	−0.09*	1.00

\* $p < 0.05$ , \*\* $p < 0.01$ , and \*\*\* $p < 0.001$ .

behavior. However, no longitudinal data is yet available on the COVID-19 situation to test the causal directions between risk perception, knowledge, negative emotions and acceptance/avoidance.

It is clear that we should not underestimate the emotions that are evoked by false beliefs and myths (e.g., Onyishi et al., 2021). Emotional dispositions toward wildlife can be innate, conditioned, or consciously learned (Jakobs and Vaske, 2019). Some animals, such as spiders or snakes, evoke more innate emotional responses, explained by evolutionary threat reaction. For example, the predisposition to develop fear toward spiders and snakes is found even with 6-months-old infants by studying their pupillary reactions compared to other animals and natural objects (Hoehl et al., 2017). Such innate emotional reactions are difficult to change, especially by just giving cognitive information. However, communication to change learned beliefs is possible (Jakobs and Vaske, 2019), yet difficult if these beliefs and myths

are loaded by conflicting or misleading information and shared by many people (Castillo-Huitrón et al., 2020).

In this day and age, information travels rapidly through various social media channels, which also applies to information on COVID-19. People may not, however, be critical enough of the material shared on social media and therefore they may continue to endorse and share false beliefs related to the ongoing pandemic (Pennycook et al., 2020). These misconceptions and false beliefs, in turn, can affect attitudes toward species associated with spreading the disease and be detrimental to their conservation. From the disease avoidance perspective, it has been suggested that the association between the disgust elicitor, negative emotions such as disgust and avoidance behavior is rather automatic (Oaten et al., 2009). Therefore, interventions aiming at reducing “false alarms” may be more successful if they focus on correcting false beliefs instead of reducing negative emotions related to disease avoidance. However, correcting false beliefs may be challenging because people tend to selectively pay attention to information that confirms their prior beliefs and behaviors (Vainio, 2019). Therefore, our results further underline the importance of explicitly correcting these false beliefs on the role of species in the pandemic. For example, even in scientific literature on virology, bats have often been wrongly portrayed as the cause of diseases that threaten humans (López-Baucells et al., 2018), which may further negatively impact their status even among the scientific community. Therefore, instead, the role of bats as providers of ecosystem services (e.g., their benefits to humanity) should be emphasized. So far, this emphasis has been seriously lacking in scientific debate, especially in the field of virological research (López-Baucells et al., 2018).

We also found that females, more likely than other respondents, reported negative emotions (fear, disgust and anxiety) toward bats and less acceptance of cohabitation with bats. Our results mirror findings on gender differences from previous literature, in which females have shown more negative attitudes toward bats (Prokop et al., 2009; Musila et al., 2018), as well as other species associated with fears (Røskoft et al., 2003; Prokop and Fančovičová, 2010). The same phenomenon was also observed in disgust-relevant animals in a cross-cultural study: females expressed more fear toward disgust-relevant species than males, reflecting the greater disgust sensitivity in females (Davey et al., 1998).

**TABLE 3 |** Results of the mediation model: unstandardized regression coefficients (*B*) and standard errors (*SE*).

	<b>Model 1</b>		<b>Model 2</b>	
	<b>Negative emotions toward bats</b>		<b>Acceptance of cohabitation with bats</b>	
	<i>B</i>	<i>SE</i>	<i>B</i>	<i>SE</i>
Intercept	4.57***	0.60	5.81***	0.83
Negative emotions toward bats			−0.73***	0.07
Knowledge about bats	−0.96***	0.14	0.46*	0.20
Perceived COVID-19 risk	0.14**	0.04	−0.02	0.06
Experiences of bats	0.03	0.11	0.45**	0.14
Age	0.00	0.00	−0.02**	0.01
Gender (female)	0.26*	0.11	−0.47**	0.14
Level of education (academic degree)	0.28*	0.12	0.02	0.12
<i>R</i> <sup>2</sup>	0.14***		0.35***	

\* $p < 0.05$ , \*\* $p < 0.01$ , and \*\*\* $p < 0.001$ .

Higher age was associated with lower acceptance of cohabitation with bats in our study. In accordance, younger people showed greater tolerance for snakes in Greece compared to older people (Liordos et al., 2018). When studying human preferences for a variety of species, Bjerke and Østdahl (2004) also found that age was negatively associated with preferences for bats, corresponding to the decreased willingness to cohabit with bats observed in our study. However, higher age has also been observed to have a positive association with attitudes toward bats (Musila et al., 2018). Because of these inconclusive results it is evident that more studies are needed to clarify the role of age.

It is good to bear in mind that negative views on bats have neither been universal nor always prevailed in the human history. For example, in the Asia-Pacific region, bats have been associated with good luck (Rocha et al., 2021) and for the most part attitudes toward bats have been positive in that area (Low et al., 2021). However, global pandemics can exacerbate human attitudes toward bats. For instance, a study in China showed that the COVID-19 outbreak had changed people's attitudes toward bats to a more negative direction, mainly due to misconception on the relationship between bats and COVID-19. Even the specially organized bat conservation lecture failed to correct the misconception that bats transmit SARS-CoV-2 to humans directly. The authors suggested that this was due to the frequent inaccurate media coverage, general cultural bias, but also the way virologists talk about the associations between bats and diseases (Lu et al., 2021).

Global pandemics and the linking of diseases to bats can also increase support for bat culling. In many parts of the world, bats have been persecuted as a consequence of their role as the probable origin of SARS-CoV-2. For instance, there were multiple reports of bats evicted from houses after the beginning of the pandemic in China, some of which led to direct deaths of bats (Zhao, 2020). Some countries, such as Indonesia, adopted bat culling as a strategy to combat COVID-19 (CMS, 2020; Tsang, 2020). With science linking bats to COVID-19, the public and policy managers may have directly or indirectly related bats to COVID-19, which has led to the repelling and culling of bats. However, these misunderstandings may drive new threats to bats (MacFarlane and Rocha, 2020; Zhao, 2020). For now, there is no evidence that culling bats is an effective measure to control bat-borne diseases (Hallam and McCracken, 2011; Streicker et al., 2012), and furthermore, culling may in fact increase the spread of bat-borne viruses and risk to humans (Plowright et al., 2008; Amman et al., 2014; Plowright et al., 2015; Olival, 2016).

Traditionally, bats have been regarded as an object of respect in Nordic countries (Eklöf and Rydell, 2021). For example, in a review of old literature in Sweden and the Swedish-speaking parts of Finland, Eklöf and Rydell (2021) found no support for bats being considered dangerous or pathogenic among Nordic people in the past. Indeed, the general attitude toward bats in Finland, where our study was conducted may be very different to that in countries where cullings have taken place today. Historically, bats were considered powerful creatures in Nordic countries. They were well known and highly respected in terms of amulets of good luck and ingredients of magical charms (Eklöf and Rydell, 2021). A bat colony in a house was, in fact, believed to protect the

inhabitants from any illnesses in Finland (Wessman, 1952). These ancient beliefs may still be reflected in the results of our study. The Christian church introduced bats as evil creatures in the middle ages, but old beliefs were not discarded, and pagan beliefs and Christianity flourished side by side (Eklöf and Rydell, 2021). The behavior and nocturnal activity of bats was associated with some dark activities, but never in the Nordic history were they considered to carry any illnesses or diseases (Eklöf and Rydell, 2021). Besides this, bats and their roosts are strictly protected by law in Finland, which would ultimately prevent any culling practices from taking place.

## Limitations of This Study

The analysis was based on a convenience sample conducted through the Internet and so the results cannot be generalized to the whole population. The link to the survey was distributed in social media both through authors' institutions as well as personal accounts, and therefore it is possible that respondents are more interested in nature compared to the general population. In addition, a part of the participants was recruited from the bat related CS project. In general, the participants were rather amiable toward bats, as the estimated negative emotions toward them were rather low. Furthermore, the knowledge of bats was relatively good among the respondents and there were clearly more people in our sample who accepted bats as their neighbors compared to the ones who did not. However, the purpose of the study was not to obtain a representative view of the distribution of knowledge of bats, negative emotions and acceptance of bats in Finland, but to test the associations between these constructs. The mediation model explained the total variance in the data well, and the Cronbach alphas were good ( $>0.70$ ) for all mean variables. Moreover, our study was based on the analysis of cross-sectional data, and therefore, the directionality of the associations between knowledge, negative emotions, acceptance of cohabitation with bats and perceived risk of COVID-19 cannot be tested. Thus, additional studies with longitudinal datasets are needed to explore the causal directions between these variables.

However, for novel diseases such as COVID-19, information on their possible impact on attitudes toward species, such as bats, is still limited, and therefore our study provides a new insight on this topical issue. Furthermore, our study provides novel information on the perceptions of adults about bats since previous research on attitudes toward bats has often been conducted from the perspective of children or university students (e.g., Knight, 2008; Prokop and Tunnicliffe, 2008; Prokop et al., 2009; Borgi and Cirulli, 2015).

## Final Consideration

In our view, our study increases the understanding of the willingness of people to cohabit with wildlife in the COVID-19 -landscape present in 2020, at least from the viewpoint of those individuals who followed social media channels and answered our questionnaire. This information is important for the conservation of wildlife, as conservation measures need support from humans, and pandemics such as COVID-19, can affect whether people accept wildlife in their immediate



environment. Social media channels are also important in this regard—the information that spreads rapidly through them can affect people's opinions, whether it is real information or based on misunderstandings. Because of the increasing encroachment of natural habitats, the coexistence of humans and wildlife is being put under more and more pressure.

In particular, the protection of species that live in close vicinity with humans requires coordinated cooperation between stakeholders to put bat-related health risks into context and to provide society with understanding of the importance of our coexistence with wildlife and the environment in general (Rocha et al., 2020). Awareness could be promoted through integrating nature-city-interactions, to assist in understanding the human-animal-environment nexus from a “shared risk” perspective (Vanhove et al., 2020). This kind of integrative approaches, that jointly consider the health of humans, animals and the environment have been adopted by approaches such as One Health, EcoHealth, and Planetary Health.

Public awareness and understanding are a necessity to provide effective conservation measures to ensure the viability of biodiversity and the important ecosystem services (Rocha et al., 2020). Often knowledge alone is not enough to enhance positive attitudes, but changes are more associated with increasing knowledge through a subjective experience. If the public is unwilling to cohabitate with some species due to false beliefs (e.g., a belief that bats are reservoirs of diseases such as COVID-19), these experiences are not sufficient. As an example, CS combines research, education and civic participation, and can be a useful link in this regard. By participating in citizen science projects, people gain environmental knowledge and science interpretation skills, but also facilitate the collection of large datasets that are out of the reach of researchers alone (e.g., Krasny and Bonney, 2005; Jordan et al., 2011). This win-win concept has the potential for large-scale societal changes in attitudes and enhancing criticism toward the media in public. Therefore, stakeholders should better acknowledge and utilize this method in future endeavors to steer the relationship between humans, wildlife and the surrounding environment in a more positive direction.

## DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the survey was conducted in Finnish, and the data of this

project will be stored in the Finnish Social Science Data archive in 10 years after this project has been ended under the project: Naapuruussuhteen rakentaminen lepakoihin kansalaistieteen voimin (English, Building a neighborly relationship with bats through citizen science). Requests to access the datasets should be directed to <https://www.fsd.tuni.fi/en>.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

PL, AO, AV, and TL contributed to conceptualization and funding acquisition. PL, AO, and AV contributed to investigation. AV analyzed the data. AO supervised the project. All authors contributed to methodology and writing the original draft.

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# Study of Effective Corridor Design to Improve Wayfinding in Underground Malls

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In retail space, wayfinding difficulties can cause problems, such as loss of time, stress, or discomfort, negatively affecting the shopping experience of consumers and even their patronage intentions. Although studies have reported that space configuration may facilitate navigation, there has been a lack of detailed discussion, particularly in underground malls, where people often encounter wayfinding issues. In this study, a series of exit-finding tasks in virtual malls were simulated to determine if it was practical to encourage turn taking by changing the corridor width, length, height, or angle. The results showed that people have a right-turn preference during exit finding. Moreover, exit-finders mostly prefer taking the upward pathway via stairs followed by corridors with broader widths or curved corners, exhibiting visible and similar navigation effects. Shorter corridors have a visible but relatively small affinity. This study provides some empirical evidence of how the corridor configuration influences the turn taking of people and provides a theoretical reference for adding a guiding function to the spatial arrangement in underground malls.

**Keywords:** wayfinding, turn taking, built environment, virtual reality, virtual environments

## INTRODUCTION

Traffic congestion and ground space limitations highlight the need for more urban underground spaces (Broere, 2016; Lee et al., 2017). In some densely populated cities, underground malls (also known as underground streets) have started hosting daily commuting and amusements because they provide pleasant thermal comfort, convenient traffic, and low-cost rent (Zhou and Zhao, 2016). On the other hand, in windowless spaces (including underground malls or buildings with closed doors and sealed windows), the absence of an external view may cause some occupants to experience claustrophobic symptoms, such as feeling trapped and uneasy, losing a sense of control over their environment, or cardinal directions (Ringstad, 1994; Lee et al., 2017), which may lead to wayfinding difficulties (Yokoi et al., 2015).

Retailers in malls, or otherwise trying to improve wayfinding, face an interesting dilemma. The retailers want customers to stay longer in the mall to encourage impulse purchases, but exit-finding difficulties negatively influence the shopping experience of the customers and even degrade the reputation of the store (Dogu and Erkip, 2000). Through signage or decoration methods, such as adding words, signs, and lighting to the environment (cf., Hidayetoglu et al., 2012; Vilar et al., 2014), wayfinding issues can be addressed effectively. Nevertheless, they cannot be eradicated because these methods are only considered supporting features. They cannot compensate for an adverse spatial design, such as limited space size, form, or layout (Raubal and Egenhofer, 1998;



Buchner et al., 2009; Marquardt, 2011). Moreover, these methods barely address the core issues of wayfinding management in malls, such as providing practical information while not burdening the architectural space (Dogu and Erkip, 2000).

Environmental psychological studies have revealed the navigational function of spatial information (Arthur and Passini, 2002), as they suggest that well-designed spaces provide efficient cues inherent to the environment, which can guide people subconsciously while guaranteeing a smooth experience of wayfinding (cf., Raubal and Egenhofer, 1998; Apelt et al., 2007). These investigations have been followed by some studies conducted in terms of image choices, such as floor plans and virtual environment (VE) screenshots or photographs (Buchner et al., 2009; Frankenstein et al., 2010; Wiener et al., 2012), to explore the preference of the pathfinders of different spatial configuration attributes during an emergency (Veeraswamy et al., 2011; Vilar et al., 2013) or in a maze (Buchner et al., 2009; Frankenstein et al., 2010; Veeraswamy et al., 2011; Wiener et al., 2012; Hsieh et al., 2018; Süzer and Olguntürk, 2018). These studies are good reference points for improving indoor wayfinding through architectural methods. On the other hand, the results of wayfinding in an emergency or maze may not apply to everyday wayfinding issues in underground malls. This is because people may feel completely different in underground environments than in aboveground or outdoors (Ringstad, 1994; Lee et al., 2017). Moreover, human strategies in everyday wayfinding are believed to be different from emergency escape (Symonds et al., 2017). In particular, during emergencies, such as power outages or fires, pathfinders tend to rely more on human information (e.g., following crowds) and environmental (e.g., emergency signs, lights, and maps) than spatial information (including space size, form, and layout; Golledge, 1999; Arthur and Passini, 2002; Symonds et al., 2017). In leisure wayfinding, however, a spatial strategy is considered the preferred strategy rather than a signage strategy, social strategy, or others (Arthur and Passini, 2002; Symonds et al., 2017).

This study examined whether it was practical to encourage turn taking by changing the corridor width, length, height, or angle using virtual roaming technology to simulate specific turns when walking through the corridors. Four spatial configuration attributes (width, length, height, and angle) were extracted from a literature review and combined into pairs to obtain 11 different T-type intersections. Subsequently, the 3D Studio Max (3Dmax) and Unreal Engine 4 (UE4) were used to produce virtual malls that included all the intersections, followed by a simulated series of exit-finding tasks of 124 college students. Finally, the route choice of the participants and their time spent in the decision area were combined to measure the wayfinding performance during turn taking.

## WAYFINDING ACCESS-RELATED STUDIES

Unlike navigation, wayfinding is a daily life process that may be as simple as moving from room to room or as complicated as escaping from a building (Raubal and Egenhofer, 1998;

Dogu and Erkip, 2000). Clear designs of wayfinding are intuitive and nonverbal and help users access various spaces within a building, thereby reducing stress and increasing efficiency (Apelt et al., 2007). This section presents a systematic review of indoor wayfinding design studies and divides wayfinding access into three dimensions: signage, decoration, and spatial configuration.

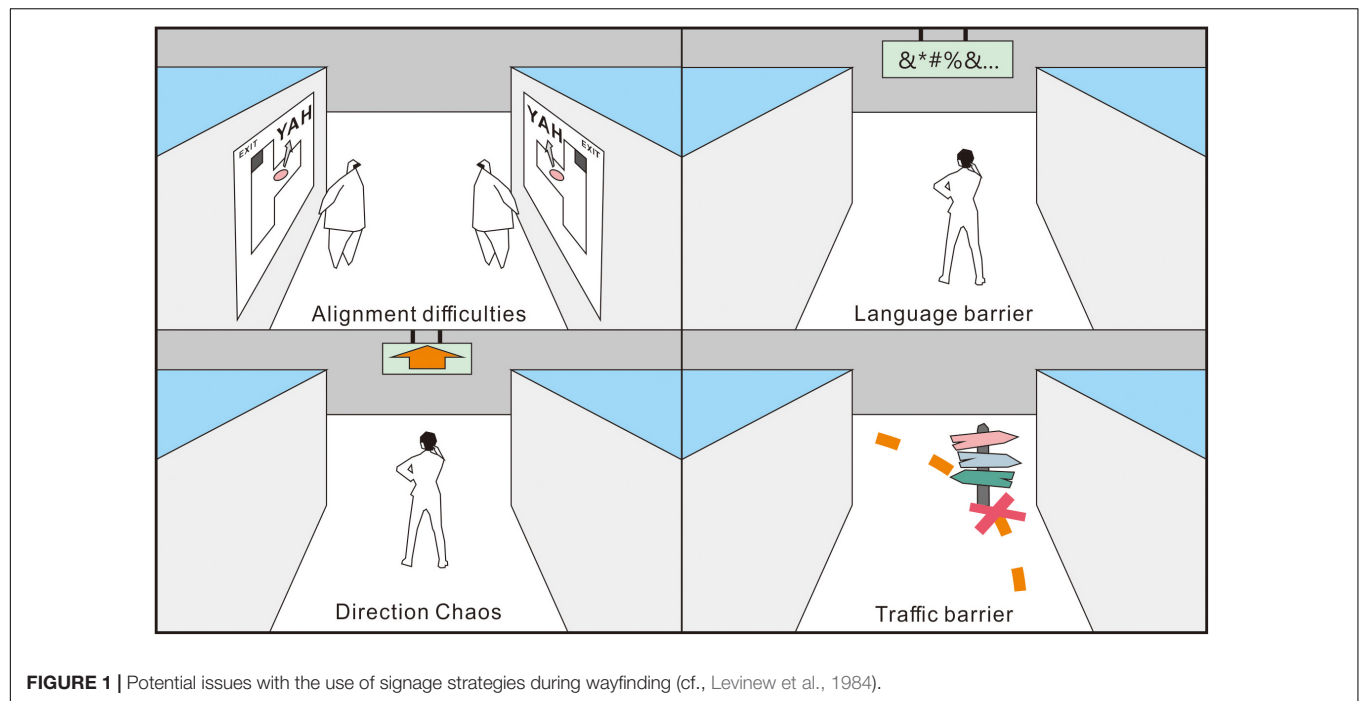
## Signage and Decoration Methods

The addition of signs, including the posted maps, is considered an effective method to resolve wayfinding problems in existing environments. Designers are keen to post arrows, swords, pictograms, and even maps on ceilings or walls at various decision points.

Balancing signage simplicity and regularity is considered problematic (cf., Levinew et al., 1984; Calori and Vanden-Eynden, 2015; Marquez et al., 2017). Calori and Vanden-Eynden (2015) suggested that effective signage must be legible from a distance, clear, and straightforward in design, have sufficient but not too much information, and be placed precisely where the travelers need information (e.g., at decision points). An obvious sign may also be confusing when placed in an arena of other signs competing for visual attention. Moreover, the challenge of designing comprehensible and iconic symbols for signs is particularly significant (**Figure 1**). For example, does an arrow pointing straight up mean “go forward” or “go up one floor?” Most nonprofessionals find it difficult to relate a 2D map (e.g., the “you are here” map) to directions in real 3D space (Levinew et al., 1984).

Focusing on these limitations in signage strategy, designers have attempted other ways to assist in wayfinding. Arthur and Passini (2002) reported that wayfinding does not need to be sign-upon-sign-upon-sign; they suggested that designers “use light and color before words, and then use words.” The differences between spaces are enhanced by adjusting the color or lighting (cf., Süzer and Olguntürk, 2018) or adding greenery (Tifferet and Vilnai-Yavetz, 2017), which in turn improves the understanding and memory of the people of their position. In other words, they pay more attention to the weighting of different nonspatial cues designed to provide wayfinding information.

For example, researchers conducting a study on hotel corridor design found that most participants selected directions with better lighting when lost because of their need for security (Vilar et al., 2013). Tifferet and Vilnai-Yavetz (2017) reported that the presence of greenery enhances the approach behavior of people. Lee et al. (2017) stated that it appears natural for people to logically link greenery to outdoor spaces, followed by some designers who used artificial plants as a landmark to guide people to the exits (**Supplementary Figure 1**). Although signage and decoration methods have alleviated wayfinding problems in underground environments, even the best-designed or best-placed signs and decorations cannot entirely compensate for the poor characteristics of architectural space. This is because the spatial configuration attributes (i.e., corridor width, length, height, and angle) have a relatively permanent nature—once space is built, they would hardly change in the short term (Buchner et al., 2009; Marquardt, 2011).



**FIGURE 1** | Potential issues with the use of signage strategies during wayfinding (cf., Levinew et al., 1984).

## Spatial Configuration and Wayfinding

Environmental psychology-related studies have suggested that that thoughts and feelings of people are shaped by the spaces they inhabit (Hall, 1966; Gehl, 2011; An et al., 2019). In an indoor environment (**Supplementary Table 1**), a corridor space comprises a ceiling, a floor, and two sidewalls that contribute the following four spatial attributes, namely: width, length, height, and angle. Among them, the adjustment of the corner curvature of the wall and the addition of steps to the floor are the most economical and effective means of changing the corner curvature and height, respectively. The four spatial configuration attributes of a corridor concern the human need for safety, privacy, public order, curiosity, and even authority, facilitating behavioral adjustments (Golledge, 1999; Barker, 2019) and have potential navigational functions.

### Corridor Width

The corridor width is associated with privacy because it restricts the social distance among occupants. Hall (1966) found that the shortest distance a person can tolerate between their acquaintances is 4 ft (~1.2 m). Once a stranger enters the area, an occupant may feel nervous and stressed and may even want to escape (**Figures 2, 3**). In an emergency escape (Sun and de Vries, 2013; Vilar et al., 2013), the width of the corridor influences the perceptions of safety, and broader corridors are considered safer. Vilar et al. (2013) examined the route choices of 30 students using five photographs of a computer-generated hotel (each photo simultaneously displayed two corridors with different widths). Before the experiment, the researcher stated, “The hotel is on fire now. You need to leave here as soon as possible.” The participants were then asked to choose one of the static images by pressing a left or right button.

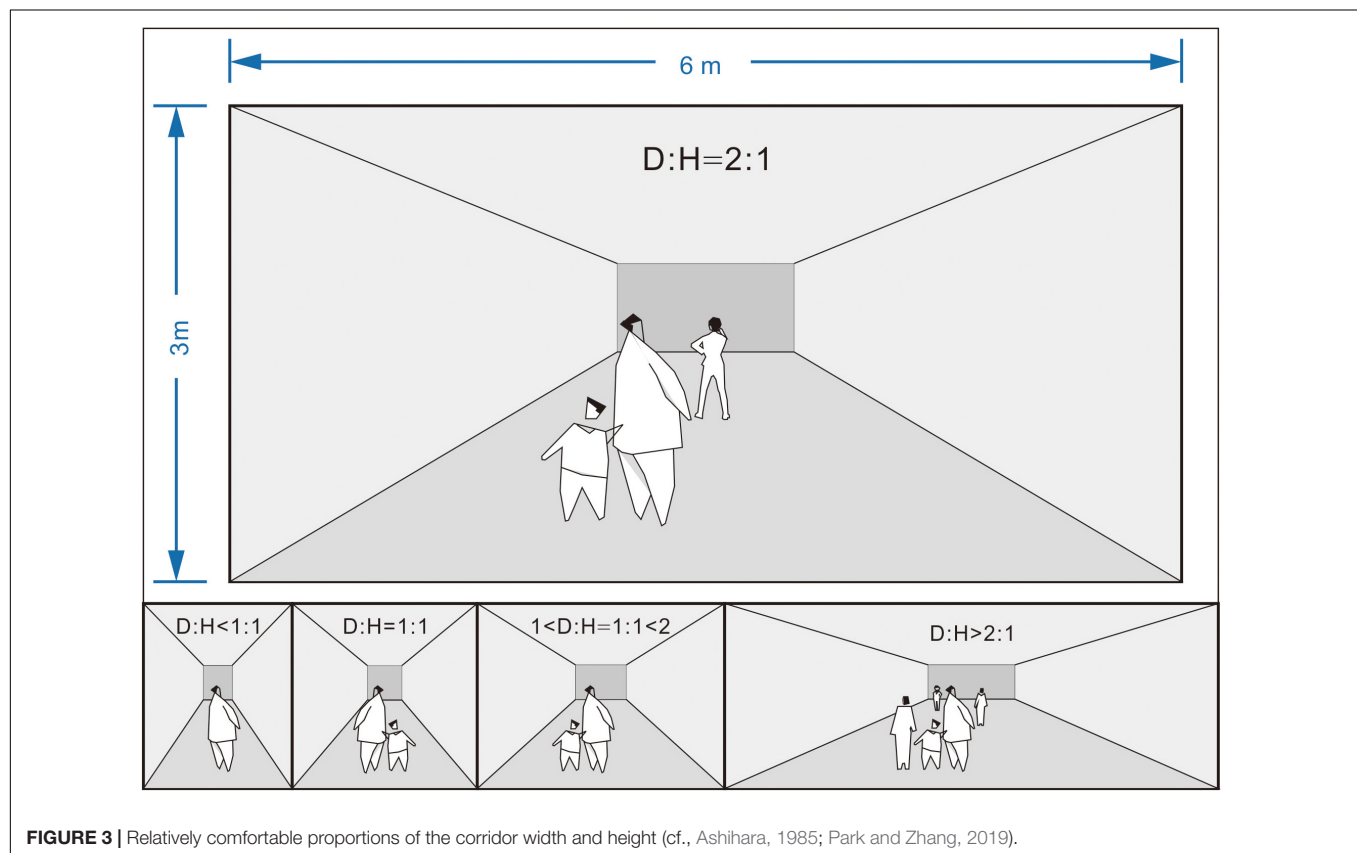
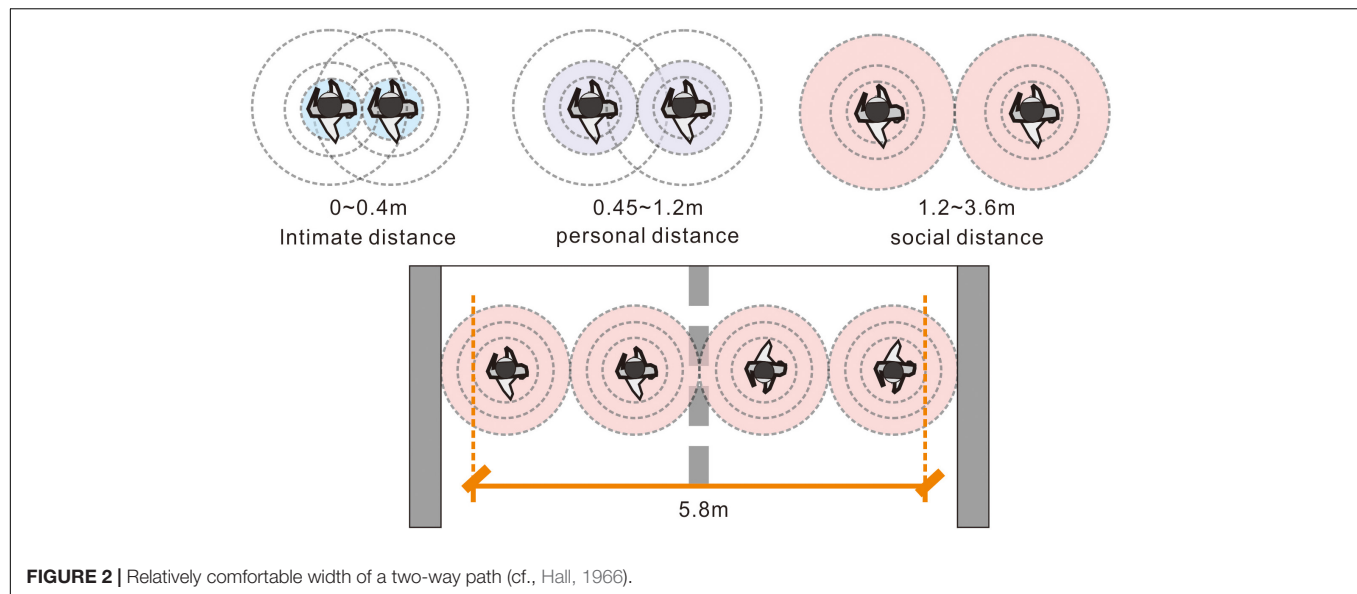
Approximately 70% of the participants chose the picture with the most expansive pathway.

### Corridor Length

The corridor length influences the curiosity and desire of the pathfinders to explore, with longer corridors promising more information gain than alternative ones (Buchner et al., 2009; Frankenstein et al., 2010; Wiener et al., 2012). In a treasure-hunting simulation using a maze (Wiener et al., 2012), 20 adults searched for a gold bar among 30 screenshots that displayed a virtual space with different depths of view. As the participants performed the task, eye-tracking equipment recorded their sight focus. The results suggested that viewers stared more frequently at relatively longer paths. In another simulation to find the center and exit of a maze (Frankenstein et al., 2010), 21 adults engaged in a forced-choice task between two snapshots of a virtual maze (with each picture showing corridors with different lengths). Most participants preferred the longer path when the difference in length between two paths exceeded 10 m.

### Corridor Height

A higher spatial position usually indicates safer conditions or higher social status, the same way that a podium functions in a classroom or a lecture hall (Gehl, 2011). In an outdoor environment, pedestrians and vehicles can be divided effectively by sunken squares or roadside platforms as pedestrians will consciously walk in higher places (Shaofei and Zhongwei, 2016). Niu (2009) reported that stair settings influence the route choice of an individual during vertical wayfinding. In that study, 46 adults observed the floor plan of a mall and chose a path between shop A (on the first floor) and shop B (on the second floor) with three routes of similar length (~70 m) but different stair positions



(near the start of the path in route 1, near the middle of the path in route 2, and near the end of the path in route 3). Approximately 76% of the participants chose route 1 to go upstairs. Li et al. (2019) also found the potential navigation function of stair settings. Specifically, the research was conducted in a two-story shopping mall, and the participants were asked to start from the second floor and arrive at the designated location on the first floor of the

mall. As a result, most pathfinders tend to move vertically (via stairs) first rather than horizontally during wayfinding.

### Corner Curvature

Smooth curves at intersection corners usually facilitate safe and quick turns. In an outdoor environment, building intersections usually have cut or rounded corners because pedestrians or

drivers need sufficient sight distance to decide whether it is safe to turn. The corner curvature at junctions was suggested to be calculated according to the sight triangle principle, which depends on the reflection time and moving speed of the people (**Supplementary Figure 2**; Harwood et al., 1996; Easa, 2000). In an online survey involving floor plan images (Veeraswamy et al., 2011), 1,166 participants were instructed to imagine themselves escaping from a maze and needing to choose between two corridors with the same length but different corner types (curved versus orthogonal). Approximately 60% of the participants chose the path with a curved corner rather than an orthogonal corner, despite knowing that both routes have the same length.

As suggested above, several studies have used the route choice frequency to evaluate the wayfinding performance (an index that reflects the effectiveness of the wayfinding design; **Supplementary Table 1**). These studies predicted that the wayfinding performance improved with higher route selection proportions (Wiener et al., 2012; Vilar et al., 2013). On the other hand, a higher percentage of directional choices may not necessarily correspond to a better wayfinding performance. As Symonds et al. (2017) suggested, “although both walking and driving can reach the destination, the experience is entirely different.” Even if pathfinders choose the same route, they may differ in terms of their wayfinding performance because some choices may be firm, but others may be indecisive. Wayfinding is considered a complex cognitive process where the time spent is also a crucial issue. The process includes information processing, decision-making, and decision execution (Ruddle and Lessels, 2006; Süzer and Olguntürk, 2018). Accordingly, studies have suggested that two indicators determine the wayfinding performance during turn-taking: the route choice results that reflect the preferred route of an individual (Vilar et al., 2013) and the time costs (during decision-making) that influence the degree of preference (Ruddle and Lessels, 2006; Süzer and Olguntürk, 2018).

## MATERIALS AND METHODS

### Modeling

Recent years have seen the rise of virtual roaming as an essential virtual reality (VR) technology branch, through intelligent hardware and open-source game engine platforms, such as UE4 or Unity 3D (Liang, 2015). Unlike studies that used images, virtual roaming focuses on human–space interactions, i.e., participants can move, jump, or turn freely in a virtual scene as if they were playing a game. VR technology is more suitable for a wayfinding simulation because it provides an immersive real-world experience for the experimental participants (Liang, 2015; Süzer and Olguntürk, 2018).

Based on a literature review (Section “Spatial Configuration and Wayfinding”), the four corridor configurations, i.e., width, length, height, and angle, were combined to generate 11 different intersections, and 3Dmax and UE4 were used to produce virtual underground malls that included all the intersections. With reference to the International Building Code (International Code Council, 2000), which is an essential tool that addresses both

health and safety concerns for buildings, the corridor height shall not be less than 2.4 m in underground malls (typically, around 3 m), and the length of the corridor should be no less than twice its width. Accordingly, the spatial differences were increased to ensure that they were noticeable while keeping the corridor spaces within a reasonable range (**Supplementary Table 2**) to avoid discomfort. In essence, the aisle height was set to 3 m (approximately 10 ft); the narrowest corridor was set to 6 m (approximately 20 ft); the widest corridor was set to 8 m (approximately 26 ft); the shortest corridor was set to 11 m (approximately 36 ft); the longest corridor was set to 22 m (approximately 72 ft). The radius of the corner fillet was set to 3 m (approximately 10 ft).

To simulate a realistic wayfinding environment as much as possible and improve the probability of wayfinding information being recognized in a complex social environment (Iftikhar et al., 2020), some everyday items, including artworks (e.g., ceramics and paintings), crafts, and sundries, were arranged neatly in the shops on both sides of the corridors with customers leisurely walking or chatting with salespeople (**Supplementary Figure 3**). In particular (**Supplementary Table 2**), the population flow was controlled to less than 10 pedestrians/m<sup>2</sup>/minute (service level-A) to avoid retail crowding based on the level of service standard developed by Fruin (1971). In addition, to avoid glare due to the purely white walls, some green decorative panels were set to cover the walls, making the entire corridor look less monotonous. Moreover, the background sounds of the virtual malls (cf., Stewart et al., 2016) and lighting conditions (brightness and color temperature) were considered carefully to produce a comfortable atmosphere (cf., Şener Yılmaz, 2018).

## Experimental Conditions

### Control Condition

Although the nonspatial cues in virtual malls have been controlled to avoid any effective wayfinding information besides the four spatial configurations, individuals may have an innate directional bias when facing a two-directional path. This type of directional clue (left or right) was suggested as a variable that affects the route choices of the participants (Veeraswamy et al., 2011). Therefore, it should be controlled before the experimental tests.

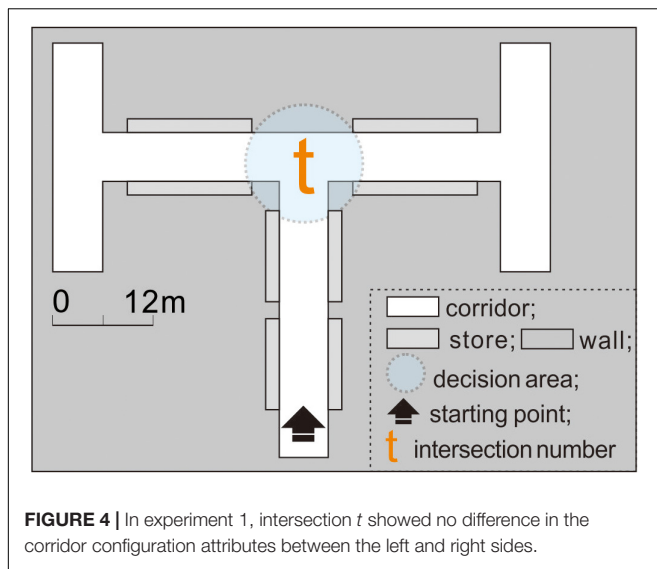
To examine if the participants in this study have a directional bias, experiment 1 was first conducted in the control condition environment (which showed the same corridor length, width, height, and angle between the left and right sides; **Figure 4**). All the turn-taking results of the participants and the time costs were recorded after each experiment.

### Experimental Condition 1

Experiment 2 was conducted under experimental condition 1 to examine if the turn-taking of exit-finders was influenced by changing the corridor width, length, height, or angle (**Figure 5**).

Taking intersection *t* as the standard, intersections *a–d* were created by separately adjusting the corridor width, length, height, and angle. For intersection *a*, the corridor width was increased on the right side (from 6 to 8 m). At intersection *b*, the length of the left corridor was reduced from 22 to 11 m. At intersection *c*, an





arc with a 3 m radius was added to the corner of the left corridor. For intersection *d*, stairs were set on the left side corridor.

The side with different features remained the same during the experiment (e.g., the wider path was always on the right at the intersection during experiment 2). Otherwise, a comparison between the test results would be meaningless because the spatial and directional clues influence the results alternately.

## Experimental Condition 2

Experiment 3 was conducted under experimental condition 2 (Figure 6), with various complex building environments to explore better corridor plans. Specifically, based on intersection *t*, the configurations on the left and right sides were changed simultaneously, and intersections *e–j* were obtained to compare each side with different features at intersections *a–d* in pairs, thereby obtaining spatial validity ranking information on turn-taking.

## Participants

G-Power 3.1.9.2.2 was used to obtain good statistical significance (G-Power is a tool to compute statistical power analyses for *t*-tests and *F*-tests), and a 0.5 effect size, a 0.05  $\alpha$  value, and a 95% confidence level were achieved. To properly implement the one-sample and paired *t*-tests, this study used a convenience sample comprising 124 college students, aged 18–32 years (half male and half female) from Pusan National University in Korea ( $M = 25.23$ ,  $SD = 5.14$ ). To improve the smoothness of the virtual experiments, the participants were required to have VR gaming experience when recruited. All the participants were recruited via campus e-mails and posts on the college bulletin board, and the wayfinding simulation experiments were conducted in the department laboratory. The study was approved and conducted in accordance with the standards of the Institutional Review Board of the university, and all participants completed an informed consent form before the study. Shopping vouchers were provided as an incentive for participation.

## Experimental Procedure

Owing to the potential influence of individual differences on the experimental results, the entire experiment followed a within-subject design to mitigate participant-to-participant variations (Gravetter and Forzano, 2018). This meant that each participant performed virtual wayfinding under both the control (Figure 4) and experimental conditions (Figures 5, 6). The experimental process was designed carefully to minimize the potential influences of the order effects (i.e., practice effects, fatigue effects, boredom effects, and carryover effects) as follows: (1) Familiarization with the process: Before conducting the experiments, the research purpose, time cost, and procedures were elucidated through a simple 3D game to help participants familiarize themselves with the VR equipment. (2) Simplifying the steps: To prevent the resistance of the participants due to cumbersome experimental processes, the 11 intersections were integrated into three virtual scenes (experiments 1–3; Figures 4–6, respectively). The experiments were conducted in order. (3) The use of counterbalancing: The turn-taking tests could start from any intersection in the same experiment. That is, the test sequence was not restricted by the intersection number. (4) Setting the interval: After each experiment, the participant was instructed to rest for at least 5 min to prevent the previous experiment from interfering with the next one.

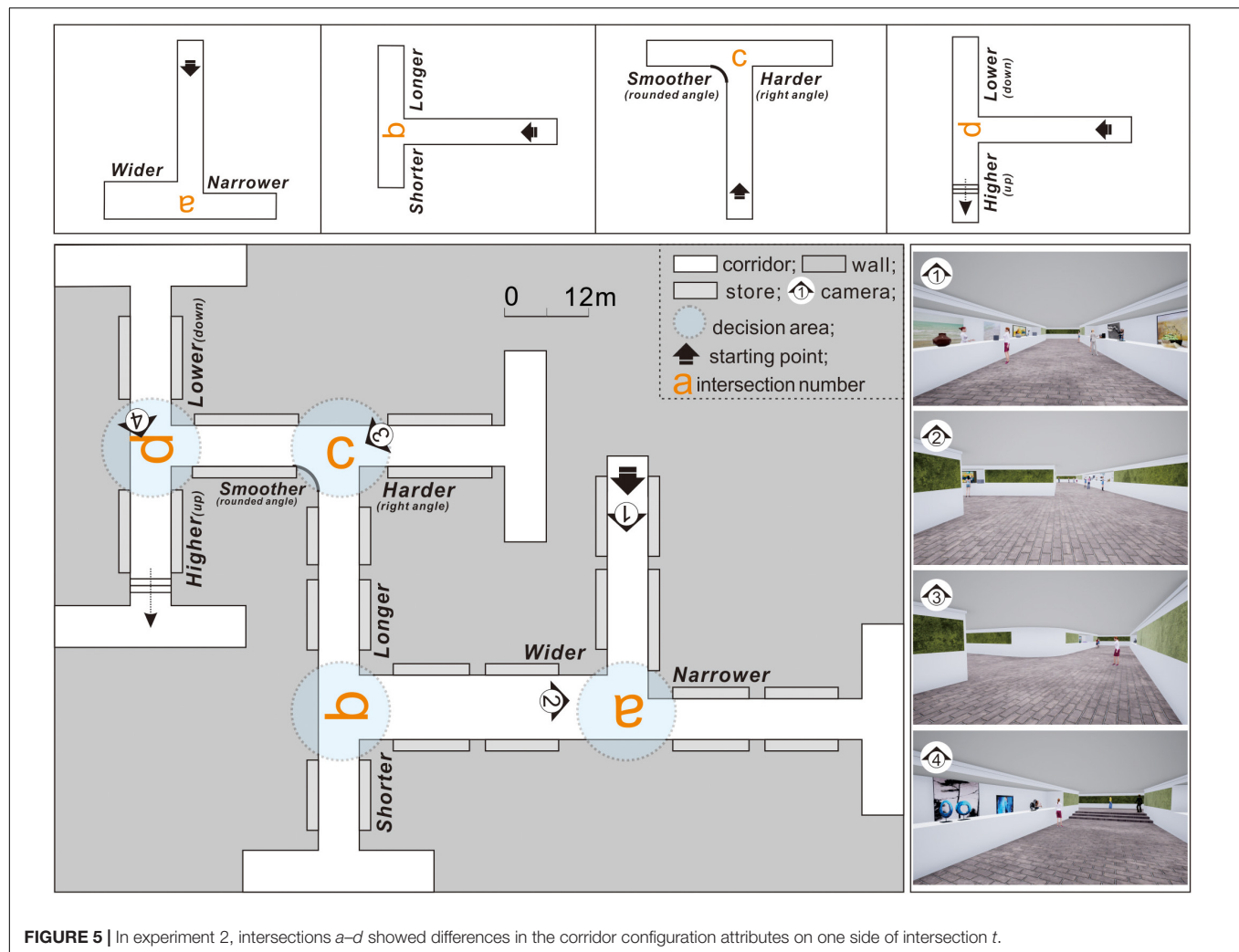
As the experiments started, the scenario to each participant was described as follows: “You have finished shopping and need to leave the underground mall. Please find the exit according to your judgment of the spatial configurations of each intersection.”

Without external distractions (through blueprint coding, the game system will automatically prompt the participants when the test starts, how to proceed, and when it ends; Supplementary Figure 4), the participants used a joystick combined with VR head-mounted equipment to perform the wayfinding task in the following sequence: (1) The participants started walking along the corridor first. (2) As they entered a decision area with a 6 m radius, the background program began timing their decision-making. (3) The participants observed and compared the spatial information of the two paths and then decided on an action. (4) The timer ended when the participants left the decision area and recorded the time within an accuracy of 0.1 s. (5) The participants saw each intersection once only.

During the experiments, the time costs of the participants were recorded using the blueprint function of UE4 (written in C++) (cf., Zhang et al., 2018). Specifically, the decision area was a transparent “box trigger” with an added timer function, and two commands were given (cf., Supplementary Figure 5) as follows: (1) The timer started running when the pathfinder entered the decision area by touching the edge of the trigger for the first time. (2) When the pathfinder exited the area by touching the edge of the trigger again, the computer automatically recorded the route choice result and the time spent in the decision area.

## Analysis

When pathfinders faced a bidirectional path decision, their left- or right-turn preference should be complementary in theory



**FIGURE 5 |** In experiment 2, intersections a–d showed differences in the corridor configuration attributes on one side of intersection *t*.

(Raubal and Egenhofer, 1998). Simply put, the likelihood of turning right decreased with increasing preference to turn left. To facilitate understanding and statistical calculations, 100% was used as the maximum wayfinding performance score to indicate when pathfinders turned right or left with the least hesitation (time spent in the decision area was used to reflect the degree of hesitation, and a score of 100% corresponds to the participant who spent the least time from entry to leaving the area). A score of 50% indicated the minimum score of the left or right wayfinding performance, indicating that the participants were quite hesitant and experienced difficulties in choosing (cf., **Supplementary Figure 6**).

Considering the inverse relationship between the time spent and wayfinding performance (Ruddle and Lessels, 2006; Süzer and Olguntürk, 2018), if *t* is the time spent in the decision area, then the wayfinding performance *p* can be expressed as follows (1):

$$p = -a * t + b \quad (1)$$

After all the 11 virtual tasks (one control condition and all the experimental conditions), 120 cases (1,320 total indicators)

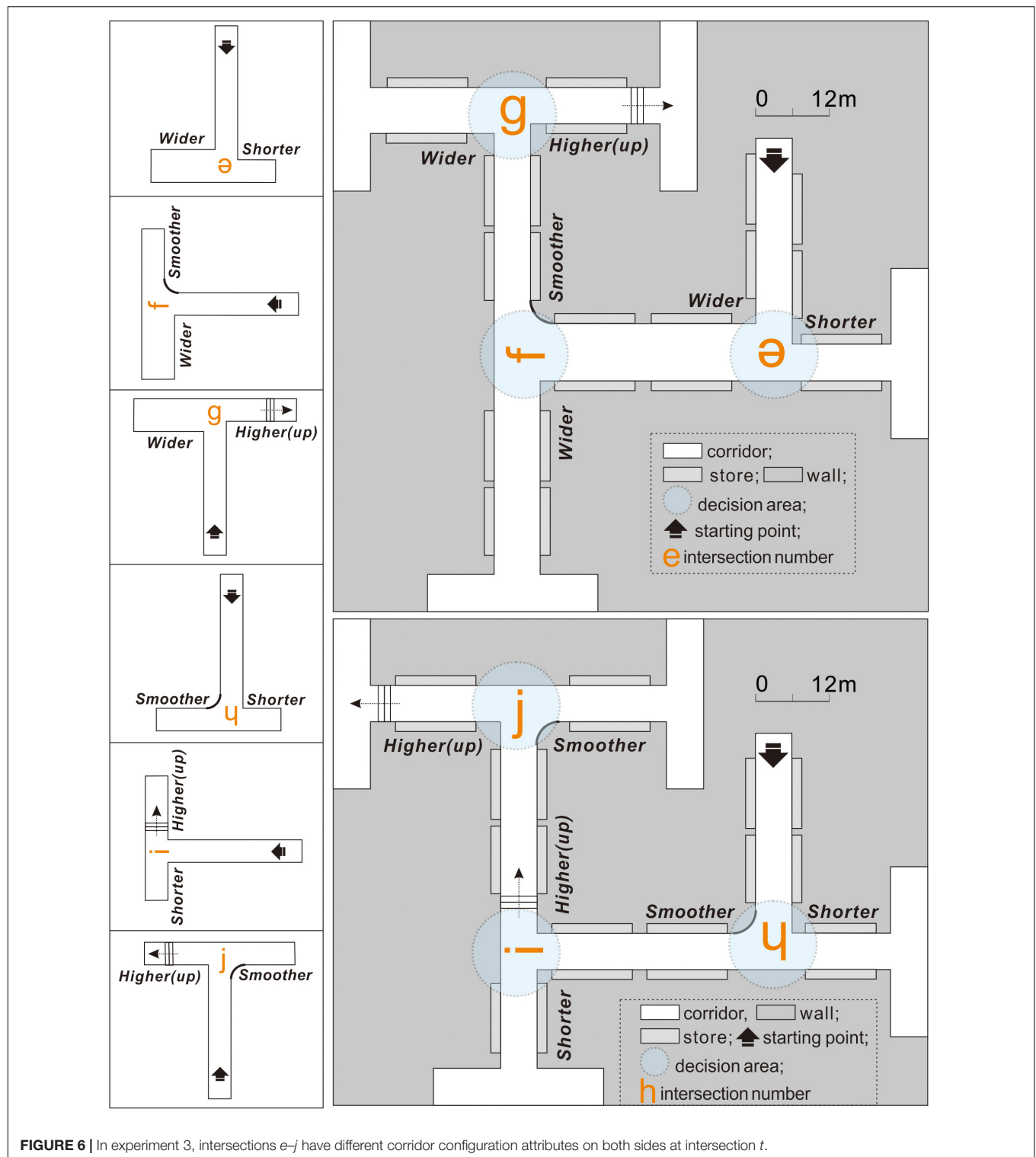
remained after removing the outliers and technical errors. The time that the participants spent in the decision-making area ranged from 3.5 to 14.6 s. Hence, the two extreme points “i” (3.5 s, 100%) and “ii” (14.6 s, 50%) were substituted into formula (1), and  $a = -0.045$  and  $b = 1.1577$  were obtained (**Supplementary Figure 7**). The wayfinding performances of the participants in each intersection (regardless of the left or right turn) were then calculated. Finally, to facilitate statistical calculations, the “right-turn performance” was used for data analysis. For those who turned left, their right-turn performance was 100% minus the version of a left turn.

## Hypotheses

Based on the literature in Section “Spatial Configuration and Wayfinding”, five hypotheses were formulated to explore the relationship between the corridor configuration attributes (width, length, height, and angle) and turn taking of the exit-finders:

H0: At intersection *t*, the exit-finders prefer to turn right.

H1: At intersection *a*, the exit-finders prefer to turn right (wider path).



**FIGURE 6 |** In experiment 3, intersections e–j have different corridor configuration attributes on both sides at intersection *t*.

H2: At intersection *b*, the exit-finders prefer to turn right (longer path).

H3: At intersection *c*, the exit-finders prefer to turn left (path with a curved corner).

H4: At intersection *d*, the exit-finders prefer to turn left (path with steps on the floor).

A one-sample *t*-test was conducted to verify the tendency of the participants to turn right after the control condition experiment (experiment 1). A paired sample *t*-test was performed

after experiment 2 to determine if the configuration of the intersection, rather than the innate left- or right-turn preference of the participants, affected their turn taking. A paired sample *t*-test was conducted after experiment 3 to compare each side with different features at intersections *a*–*d* in pairs, thereby obtaining spatial validity ranking information on turn taking.

## RESULTS

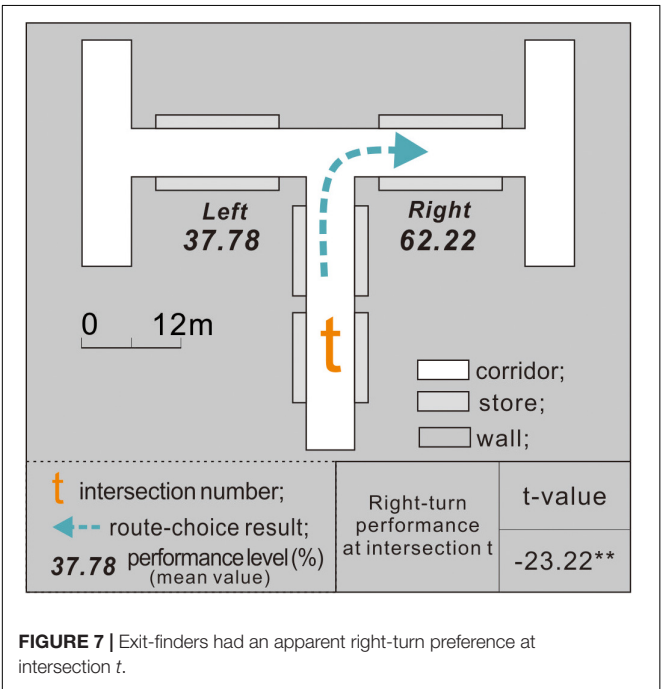
### Right-Turn Preference of Participants During Exit-Finding

When the participants finished the wayfinding task under the control condition (experiment 1), the right-turn performance of all 120 participants at intersection *t* was calculated using formula (1). The results in **Figure 7** indicate that at intersection *t*, with the same corridor configuration attributes, the exit-finders exhibited a mean right-turn performance of 62.22% (> 50%). This suggests that the participants may have preferred to turn right while attempting to find an exit; those who turned right spent less time in the decision area than those who turned left.

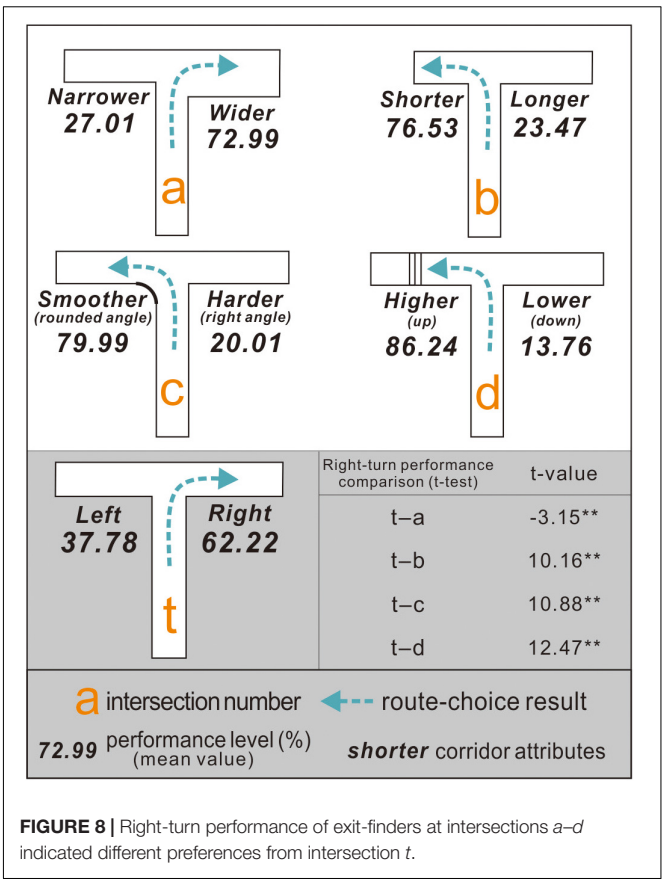
The one-sample *t*-test confirmed that at intersection *t*, the participants exhibited an apparent right-turn tendency while looking for an exit (*p* = 0.05). Therefore, *H*<sub>0</sub> was supported.

### Participants Preferred a Taller, Wider, Smoother, and Shorter Path

After experiment 2, the right-turn performance of the 120 participants at intersections *a*–*d* was computed. To illustrate (**Figure 8**), for intersection *a*, the corridor width was adjusted on the right side (from 6 to 8 m), which increased the right-turn performance of the participants (mean value) from 62.22%



**FIGURE 7 |** Exit-finders had an apparent right-turn preference at intersection *t*.



**FIGURE 8 |** Right-turn performance of exit-finders at intersections *a*–*d* indicated different preferences from intersection *t*.

(at control condition intersection *t*) to 72.99%. Such an increase in the right-turn performance indicated that broader corridors increased the original preference of exit-finders for right turns. At least three factors may have contributed to an increase in right turn performance: (1) the number of participants who turned right increased; (2) the number of participants who turned right did not change, but the participants who turned right spent less time at intersection *a* than at intersection *t*; (3) both the number of participants who turned right and their time spent did not change, but the participants who turned left were more hesitant and took longer to make a decision.

At intersection *b*, when the length of the left corridor was reduced from 22 to 11 m, the right-turn performance of the exit-finders decreased from 62.22 to 23.47% (< 50%). This means that a shorter corridor disrupted their original preference for turning right and increased their likelihood of turning left. While some maze design studies have found that people prefer longer or deeper corridors when finding exits (Buchner et al., 2009; Frankenstein et al., 2010; Wiener et al., 2012), these results indicated that this theory is unsuitable for situations similar to the virtual underground malls here.

At intersection *c*, an arc with a 3 m radius was added to the corner of the left corridor, which decreased the right-turn performance of the participants from 62.22 to 20.01%. Unlike the case in intersection *t* (control condition), the stairs on the left side of intersection *d* were set. As a result, the average



right-turn performance of the exit-finders was reduced further to 13.76%, as they finally chose to turn left despite their original right-turn preference.

The *t*-test results of all the experimental conditions (*a–d*) and control conditions exhibited significant differences ( $p = 0.05$ ). This finding supported H1, H3, and H4 but not H2.

## Participants Preferred the Upward Pathway via Stairs the Most

After experiment 3, the right-turn performance of each participant was calculated separately at intersections *e–j* (Figure 9): (1) At intersection *e*, the participants had a right-turn preference with a mean performance value of 61.63%. (2) At intersection *f*, their right-turn performance was 67.86%. (3) At intersection *g*, the participants preferred to turn right, with a mean performance of 85.24%, which indicated that people might prefer a taller corridor to a wider configuration. (4) At intersection *h*, the participants chose to turn right with a mean performance of 72.87%. This indicated that exit-finders were more likely to choose a smoother corridor to a shorter configuration. (5) At intersection *i*, the participants preferred to turn right, with a mean performance of 85.15%, suggesting that people were more inclined toward a taller corridor over a shorter configuration. (6) At intersection *j*, the participants chose to turn left with a mean performance of 76.26%.

The results of the paired sample *t*-test between the experimental condition intersections (*e–j*) and control condition intersection *t* indicated that the right-turn performance of the participants at intersections *e* and *f* was similar, suggesting that they had difficulty choosing between shorter and wider corridors, and between wider and smoother corridors. Nevertheless, further research is warranted because some participants stated that they hardly noticed the width discrepancy in the two routes despite their 2-m difference.

## DISCUSSION AND CONCLUSION

Overall, this study addressed two issues to improve wayfinding at T-type intersections in underground malls: whether the turn taking of exit-finders was influenced by adjustments in corridor configurations, i.e., width, length, height, or angle, and how much these spatial configuration attributes influenced the turn-taking decisions of the exit-finders and enhanced the practicality of the study.

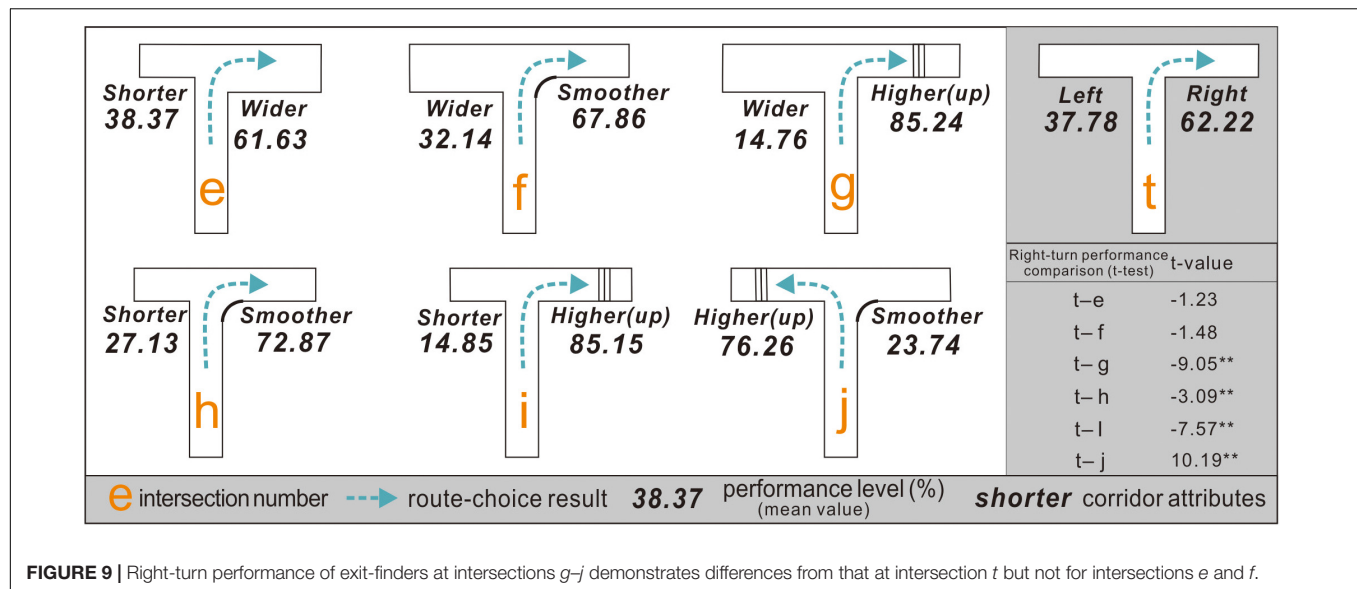
This study showed that the exit-finders had an apparent right-turn preference when facing a T-type intersection. This kind of directional bias during exit finding appears to be a universal factor. Veeraswamy et al. (2011) once used online questionnaires combined with maze pictures to obtain feedback from 1,166 participants from 36 countries, where 67.1% believed that the exit might be on the right side of the T-type intersection. On the other hand, no further experimental research or discussion has been provided. Although the wayfinding simulation conducted using images lacked consistency, these results support the following findings. (1) Experiment 1 indicated that those who eventually chose to turn left at the T-type intersection were more hesitant,

and they spent more time in the decision-making area than those who chose to turn right. In contrast, those who turned right were more confident about turn taking. The cause of this right-turn tendency could not be determined because the participants in this study were recruited *via* random sampling. On the other hand, according to Veeraswamy et al. (2011), there may be a cultural component (left- or right-hand traffic) to wayfinding, and according to Shaki et al. (2009), the reading direction, i.e., whether a culture reads from left to right or right to left, may influence the spatial representation of the individual. Hence, further research will be needed. (2) The route choices of the exit-finders can be modified by adjusting the corridor length or width, setting stairs, or adding an arc at the corner. In particular, exit-finders in malls tend to link the exit path logically with “taller,” “wider,” “smoother,” or “shorter” features. Experiment 2 indicated that exit-finders preferred the shorter path to the longer path in situations, such as intersection *b*, which is a departure from previous views. This is because Frankenstein et al. (2010) and Wiener et al. (2012) stated that when people were lost in a maze, they preferred a longer or deeper path to obtain more wayfinding information. These studies indicated that pathfinders had different preferences for spatial attributes in different locations, even when they had the same goal (e.g., finding an exit or an office room). (3) Exit-finders had a stable preference for upward pathway with visible stair settings (near the decision area that can be noticed), regardless of the wider, shorter, or smoother opposite path, followed by corridors with broader width or rounded angles, with shorter corridors exhibiting visible but relatively small affinity. A visible difference in height between corridor spaces appears to be important information (directional clue or otherwise) when pathfinders are looking for an exit. Accordingly, the challenge faced by designers or managers is the exploration of how to use the space design methods in addition to stairs to imply “you can go up from here.” Furthermore, the intersection layout in underground malls should avoid intersections *e* and *f*. Although exit-finders are more inclined to turn right than left at intersections *e* and *f* (Figure 6), the spatial information did not provide a practical navigational function.

Our findings have also some limitations, as they are based on a single experimental set in one specific country, conducted in a virtual reality simulation, in a specific behavioral setting (i.e., the mall), and with specific subjects (students). To enhance the external validity of our findings, future replications are needed using different participants (i.e., not only students but also adults or elderly people), different countries and cultures, different settings (such as, for example, residential buildings, offices, hospitals, metro stations, outdoor spaces, green areas, sport stadiums, and theaters, etc.).

## IMPLICATIONS

If the exit paths in underground shopping malls simultaneously fulfill the features of being “wider,” “shorter,” “taller,” and “smoother,” they will be considered “more attractive.” In other words, people will find these exits more natural and efficient. In



practice, however, it is difficult for the corridor configurations of underground malls to fulfill all four requirements due to the constraints of the built environment or other factors. Therefore, mall managers need to make optimal choices according to their judgment.

Based on these results, this paper provides the following suggestions. First, creating visible spatial differences in a vertical direction, such as setting steps, slopes, or other exit path facilities, is important for guiding people toward exits. Steps or slopes need to be near decision points within the sight of people. The usability of stairs should also be considered, for example, whether they have gentle slopes and handrails to facilitate passage for the elderly or disabled individuals. In cases where the existing environment does not allow steps to be added, other architectural methods, such as the addition of vaulted ceilings or atrium spaces that introduce natural light, may be employed to remind people that they can go up from here. Second, visually shorter corridors also have an apparent guiding function associated with the time cost. Generally, setting exits relatively close to intersections helps improve wayfinding performance. If building structure restrictions require an exit to be located far from a decision area, an autowalk could be installed, or some horizontal or vertical structures could be added, such as beams or pillars, to divide the passage into segments, which can reduce the stress caused by long distances. Third, the width of an exit corridor should be increased to help pathfinders find exits more efficiently and prevent accidents, such as stampedes, during an emergency. If the width of a corridor is fixed and cannot be changed, the path space can be expanded by adding a curved corner at the intersection, and reflective metals or panels can be used for corridor decoration. Finally, setting a specific arc at the intersection corner also helps guide people toward an exit, as curved wall corners can help improve the sight of the pathfinders, thereby improving their perception of safety and confidence when turning.

Although these recommendations are not fully applicable to aboveground buildings, they may have specific reference value for improving the spatial layouts of hospitals, schools, and nursing homes. For example, at T-type intersections, if the exit follows a higher, shorter, wider, or smoother direction according to the spatial preferences of the exit-finders, the opposite direction will inevitably be “unpopular” or “unreachable” but will increase spatial privacy. A corridor in a direction opposite to the exit is appropriate when organizing spaces, such as lounges, reading rooms, and other areas requiring privacy and silence. In contrast, a corridor in the direction of an exit is more appropriate for planning relatively popular spaces, such as entertainment and conference rooms, thereby ensuring that crowds can evacuate in the event of a wayfinding problem.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Pusan National University Institutional Review Board, PNU IRB. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

SZ and SP have made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work. SZ have drafted the work or revised it critically for important intellectual content. Both

authors have approved the final version to be published, we agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.631531/full#supplementary-material>

**Supplementary Figure 1** | Green elements act as landmarks to guide exit-finders in interior space (cf., Lee et al., 2017).

**Supplementary Figure 2** | Curved corners improve driver confidence when cornering or going straight (cf., Easa, 2000).

**Supplementary Figure 3** | Details of the operational procedures.

**Supplementary Figure 4** | Blueprint code used to guide the wayfinding simulation.

**Supplementary Figure 5** | Blueprint timing function code of UE4.

**Supplementary Figure 6** | 50% is a theoretical threshold between left- and right-turn performance (Raubal and Egenhofer, 1998).

**Supplementary Figure 7** | Time cost versus right-turn performance.

**Supplementary Table 1** | Wayfinding empirical studies involving corridor configurations.

**Supplementary Table 2** | Specific parameters of the virtual scene.

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# The Mediating Role of Place Attachment Dimensions in the Relationship Between Local Social Identity and Well-Being

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Well-functioning communities provide a range of material and psychological resources that enhance well-being. The degree to which individuals see themselves as part of the local social group, or local social identity, i.e., the social identification with the community of the place where people are living, may play an important role in enhancing happiness and well-being, as well as relationships of people with their own living environment, i.e., place attachment. We hypothesized that local social identity influences well-being *via* specific components of place attachment to the residential city/town, i.e., place identity, social relations, and lack of resources (which is the opposite of place dependence). We measured local social identity, individual well-being, interdependent happiness, and place attachment in a sample of  $N = 375$  participants. We tested our hypotheses by conducting a series of mediation analyses with local social identity as an independent variable, individual well-being and interdependent happiness as dependent variables, and place attachment subfactors, i.e., place identity, social relations, and lack of resources, as mediators. Results showed that the relation between local social identity and both individual well-being and interdependent happiness was positively mediated by place identity and social relations, while the lack of resources emerged as a negative mediator only in the relation between local social identity and individual well-being (not for interdependent happiness). Practical implications and future developments are discussed.

**Keywords:** well-being, interdependent happiness, place attachment, social relations, lack of resources, place identity

## INTRODUCTION

Well-functioning social communities provide a range of material and psychological resources that enhance well-being. Recent research in social psychology has shown that a variety of physical and mental health outcomes are derived from meaningful belonging in social groups within a varied range of contexts, and the local community is one of them (Bowe et al., 2020). Belonging to social groups is a basic psychological need of people because it allows them to preserve security, well-being, and high self-esteem (Baumeister and Leary, 1995). Therefore, people are strongly motivated to belong to social groups, and when their belongingness is threatened, for example, by exposure to ostracism episodes, strong negative consequences follow (see Paolini, 2019).

As postulated by the Social Identity Theory (SIT, Tajfel and Turner, 1979), individuals may thus define themselves either in terms of their belongingness, emphasizing what makes them similar and interchangeable with others, or in terms of their individual characteristics, emphasizing what makes them unique (Tajfel and Turner, 1979). A recent approach, the Social Identity Approach to well-being (Jetten et al., 2017; Haslam et al., 2018), stemming from SIT and Self-Categorization Theory (Turner et al., 1987), suggested that the social dimensions of the self (i.e., the multiple effects—cognitive, emotional, and behavioral—of the sense of “we-ness” derived from group membership) are fundamental in shaping our social world and that the pivotal psychological process connecting social relationships with health and well-being is meaningful social identification, i.e., a subjective sense of belonging (Sani et al., 2012). Social cure research (Haslam et al., 2018) has provided a valuable framework for the study of local community processes. The group with which people identify is a social aggregate most people can claim some access to, and it is as valuable in terms of life satisfaction as other important social identifications (e.g., family; Wakefield et al., 2017). Social identity plays a crucial role at least on two levels of well-being: on the one hand, it is related to the individual well-being level (e.g., satisfaction with life; Diener et al., 1985), and on the other hand, it also could impact the interdependent happiness level, i.e., the happiness based on social relationships, that is, on the relational nature of human beings (Hitokoto and Uchida, 2015; Kryś et al., 2019).

We want to underline that the concept of local social identity is different from community attachment, a construct proposed by Hummon (1992) that can be conceptualized as subjective interpretation and the affective reaction of a person to the place in which he/she resides. Hummon (1992) described five ways in which people may relate to their places of residence: two types of rootedness (every day and ideological), which are described in positive terms, and three types of sentiments (alienation, relativity, and placelessness), which are described in negative terms, like estrangement, dislike, and indifference (Lewicka, 2011a,b). People–place relations indeed can have either a positive valence or a negative valence, implying not only a “salutogenic” role but also harmful effects on well-being. On the other hand, well-being, as well as happiness, represents a high value and an important goal of society (Lu and Gilmour, 2004), and it is the result of the accommodations that occur over time and through dynamic interactions of personal, social, and environmental structures and processes (White, 2017; Maricchiolo et al., 2021).

Thus, the social relationships that people establish with closer individuals, social structures, physical environments, as well as with the communities in which people are living (Maricchiolo et al., 2020), represent the “social core” that contributes to maintaining an adequate level of their health and well-being (Haslam et al., 2009; Haslam and Loughnan, 2014; Jetten et al., 2014, 2017).

In order to analyze the connection between individuals, groups, communities, and their living environments, we have focused on the key construct of place attachment, which has been developed in the environmental psychology domain. It concerns those affects, emotions, and feelings that arise from our

experience of places (e.g., see Low, 1992; Hidalgo and Hernandez, 2001; Korpela, 2012; Lewicka, 2014; Manzo and Devine-Wright, 2020), where the “place” includes both a physical and a social component (Brown and Perkins, 1992; Hidalgo and Hernandez, 2001; Scannell and Gifford, 2010). Moreover, place attachment also concerns the extent to which the environment satisfies personal needs (Giuliani, 2003), i.e., a functional aspect that has to do with the availability of resources (Scopelliti and Tiberio, 2010). This latter aspect is included in the construct of place dependence, which has been defined as a “functional” connection reflecting the degree to which the physical setting provides conditions to support an intended use (Raymond et al., 2010).

In this study, we followed the conceptualization of place attachment consisting of place identity and place dependence (e.g., Williams and Vaske, 2003) and also social bonds (e.g., Kyle et al., 2005). About place identity, it refers to a substructure of the self that encompasses cognitions, emotions, and behavioral tendencies related to socialization of people with their physical environment (Proshansky et al., 1983).

In most literature on the topic, the analyzed place of attachment is the residential place, with a spatial focus ranging from micro- to macro-levels, i.e., home, the neighborhood, the town/city, or even broader levels. Among such levels, the residential neighborhood has been the prominent place of analysis (Lewicka, 2011b), while less attention has been devoted to the town or city level.

There are also some studies addressing the relationship between place attachment and community participation and well-being. Manzo and Perkins (2006) identified place attachment and participation in neighborhood protection as affective and behavioral place-related community dimensions, respectively. Keyes (1998) showed that social contribution (i.e., the feeling of being a vital member of society, with something of value to contribute) is a specific dimension of social well-being. Similarly, Rollero and De Piccoli (2010) found that attachment to the city is a positive predictor of social well-being and of the social contribution dimension. A positive perception of the living place is a powerful predictor of well-being also for specific populations, such as mentally ill persons (Wright and Kloos, 2007) and the elderly (Fornara et al., 2019), as well as college students, who have to face relocation problems (Scopelliti and Tiberio, 2010). A mediation role of place attachment in the relationship between local civic engagement and personal neighborhood connectedness was found by Buta et al. (2014) with residents living in the area of a national park and also emerged with adolescents (Lenzi et al., 2013). More recently, Larson et al. (2018) found that a stronger place attachment promotes both higher community involvement and higher engagement in place-protective behaviors among hunters, bird-watchers, and property owners. These studies suggest that individuals more attached to the place in which they live are likely to contribute more to the local well-being, through civic activism and the protection of their environment.

The aforementioned literature yields some mixed insights on the connection between place and well-being and shows a relationship between place attachment and satisfaction with life and social well-being. Since the Interdependent Happiness Scale

was proposed only in recent years (Hitokoto and Uchida, 2015), to our knowledge, there are no existing studies addressing the relationship between place attachment and happiness based on social relationships. It is important to incorporate a relational-oriented approach to happiness and well-being that complements the individualistic approach to well-being (i.e., based on individualistic-centered measures like the Satisfaction with Life Scale) in people–environment studies. Moreover, empirical evidence on the link between local social identity and different forms of well-being is still substantially lacking. Uncovering the impact on different types of well-being of successful community identities, through place attachment components, is therefore essential to progressing the community development agenda (Bowe et al., 2020).

## THE PRESENT STUDY

Based on these premises, this study aimed to understand whether the relation between social identification of people toward their local community and their level of well-being, in terms of life satisfaction and interdependent happiness, is mediated by place identity, place dependence, and social bonds, i.e., those place attachment components, included in many studies addressing this construct (e.g., Kyle et al., 2005; Raymond et al., 2010; Scopelliti and Tiberio, 2010; Ramkissoon et al., 2013; Chen et al., 2018).

Therefore, as a first step, we verified the three-factor structure of place attachment, and then, in an explorative vein, we tested their mediational role on the relation between local social identification of people and their levels of individual and interdependent well-being. Thus, we explored whether and how the components of place attachment mediate the relationship between local social identity and well-being.

## MATERIALS AND METHODS

### Sample

#### Participants

We recruited 375 Italian participants (219 females, 156 males; mean age = 34.44; SD = 13.58, age range 18–87), living in cities (more than 5,000 inhabitants, 56%), small towns (<5,000 inhabitants, 26%), or rural areas (18%), by spreading an online survey. Participants took part in the survey on a voluntary basis.

### Procedure

An online questionnaire was implemented by using the Google Forms platform. Participants were recruited from different regions of Italy (mainly Lazio and Sicily) by university students for their Master's or Bachelor's thesis. Data were collected from March to November 2019.

The questionnaire took approximately 30 min to fill in. According to the ethical standards included in the Declaration of Helsinki (World Medical Association, 2001), participants were informed about all relevant aspects of the study (e.g., methods and institutional affiliations of the researchers) before they started to fill in the questionnaire. The research protocol was

approved by the local ethics committee of the University of Rome “Sapienza” (October 29, 2018).

## Materials

The questionnaire included the following measures.

- *Satisfaction with Life*. Individual well-being of participants was assessed by using the *Satisfaction with Life Scale* (SWLS; Diener et al., 1985). The scale is comprised of five items that range from 1 (= It does not describe me at all) to 9 (= It describes me completely), (e.g., “Your life conditions are excellent”;  $\alpha = 0.87$ , SWLS). Higher ratings indicate higher individual satisfaction with life.
- *Interdependent Happiness Scale* (IHS; Hitokoto and Uchida, 2015; Italian version, Mosca et al., 2021). The scale measures a relational aspect of well-being and consists of nine items that range from 1 (= It does not describe me at all) to 9 (= It describes me completely) (e.g., “You feel that you are positively evaluated by the others around you”;  $\alpha = 0.82$ ). Higher ratings indicate higher individual-interdependent happiness.
- *Place Attachment*. We have administered a slightly modified version of the PAHS (*Place Attachment to the Hometown Scale*) (Scopelliti and Tiberio, 2010). It included a 16-item self-report scale addressing physical, social, and functional aspects of attachment to the town or city of residence. Participants had to fill in the questionnaire referring to the city/village in which they lived and to indicate their opinion using a Likert scale ranging from 1 (= It does not describe me at all) to 9 (= It describes me completely). As described below, we carried out a factorial analysis to individuate the subdimensions of attachment to the city/village where people live measured on a sample not constituted only of university students, like in the originally published scale (Scopelliti and Tiberio, 2010). After having eliminated four items for statistical problems (see below), we extracted three subfactors<sup>1</sup>: (a) place identity (five items), measuring the degree of attachment with physical attributes of the attachment to city/village in which people live (e.g., The landscape of my city/village always makes me feel a strong emotion,  $\alpha = 0.81$ ); (b) social relations (three items), measuring a social aspect of the attachment to the place of residence (e.g., People I am attached to are mostly from my city/village,  $\alpha = 0.68$ ); (c) lack of resources (four items) (i.e., the reverse of place dependence), measuring a (dis)functional aspect of the attachment to the city/village in which people live (e.g., I often get bored there,  $\alpha = 0.54$ , mean inter-item correlation = 0.32<sup>2</sup>). Higher ratings indicate higher levels of

<sup>1</sup>For consistency reasons, we use in the Method and Results sections the factor labels used by the PAHS proposers (i.e., Scopelliti and Tiberio, 2010); nevertheless, we remind where appropriate along such sections that the subfactor “lack of resources” refers to “place dependence” in the theoretical approach we explicitly followed. It is to note that the factor label “lack of resources” has a negative sense; thus, high scores mean low “place dependence,” and low scores mean high “place dependence.”

<sup>2</sup>Due to the fact that Cronbach's alpha values are sensitive to the number of items of the scale, when such a number is low, it is common to find quite low Cronbach's alpha values as in this case. For this reason, we have reported the mean inter-item correlation of the items, and those results are included in the optimal range for the

place identity, quality of social relations in the place, and perception of lack of resources.

- **Local Social Identity Scale.** We administered a social identification *ad hoc* built scale (adapted from Paolini et al., 2020), composed of seven items to measure identification with the local community (e.g., Being part of the community of the people living in the city/village in which I live; is an important component for the image I have of myself; reflects well who I am; has to do with what I think about myself; bothers me; makes me feel good;  $\alpha = 0.83$ ). Participants had to report their answers on a Likert-type scale ranging from 1 (It doesn't describe me at all) to 9 (It describes me exactly). Higher ratings indicate stronger social identification with the local community.

## Statistical Analysis

Data analyses were performed with SPSS version 25, including the PROCESS model macro (Hayes and Preacher, 2014). PROCESS is a modeling tool that calculates the direct and indirect effects of mediation models, as well as the calculation of interactions and conditional indirect effects in moderation and moderated mediation models (see <http://www.processmacro.org/index.html> for more details). We conducted an exploratory factor analyses on the Place Attachment Scale because the original scale was validated on a student sample, while our sample was a community sample. Then, we calculated descriptive statistics and zero-order correlations between variables. Then, we conducted a series of mediation analyses with local social identity as an independent variable, satisfaction with life and interdependent happiness as dependent variables and place

attachment subfactors, i.e., place identity, social relations, and lack of resources (i.e., reverse of place dependence) as mediators.

## Results

A principal components analysis with Promax rotation with Kaiser normalization was performed on the Place Attachment Scale. Scree plots were also used to confirm the expected number of factors and the factorial loading of each item in the expected component (i.e., subscale).

Four items saturated identically on two factors so they were removed for subsequent analysis (i.e., “I always know where to find what I look for there”; “I know how to feel relaxed there”; “The climate there makes me feel good”; “I feel proud to be part of my city/village”), and a new PCA with Promax rotation was conducted on 13 items. The Kaiser–Meyer–Olkin sampling adequacy measure attained fairly high values ( $= 0.86$ ), demonstrating that communalities were high and the correlation matrix of the sample was appropriate for the analysis to proceed (Mundfrom et al., 2005). It yielded a three-factor solution explaining 57.1% of the variance (see **Table 1**). The factors were labeled according to the study of Scopelliti and Tiberio (2010), i.e., respectively, place identity, lack of resources, and social relations.

Descriptive statistics and zero-order correlations are reported in **Table 2**. Local social identity, place identity, and social relations were correlated positively with both satisfaction with life (Pearson's  $r$  ranging from 0.25 to 0.39, indicating a medium effect size) and interdependent happiness (Pearson's  $r$  ranging from 0.27 to 0.36, indicating equally a medium effect size). Lack of resources was correlated negatively with both SWL and IHS ( $r = -0.27$ ,  $p < 0.01$ ;  $r = -0.20$ ,  $p < 0.01$ , respectively).

inter-item correlation (i.e., between 0.20 and 0.40) recommended by Briggs and Cheek (1986).

**TABLE 1 |** Factor analysis for the place attachment scale.

Items	Factor 1	Factor 2	Factor 3
	Place identity	Social relations	Lack of resources
I like to know the history and traditions of my city/village	0.874		
My city/village is surrounded by many beautiful natural places	0.807		
I like to speak about my city/village to people which they don't know	0.731		
The landscape of my city/village always makes me feel a strong emotion	0.681		
Even if I would leave my city/village, it will be always a part of me	0.479		
People I am attached to are mostly from my city/village		0.892	
When I am away, I look forward coming back there to my friends		0.737	
When I am in my city/village I never feel alone		0.596	
I often get bored in my city-village			0.766
I always wanted to leave my city-village			0.759
I hardly found there people sharing my interests			0.641
My city/village offers lots of opportunities (R)			0.459
Eigenvalues	4.07	1.46	1.23
Explained Variance	33.92%	12.21%	10.24%

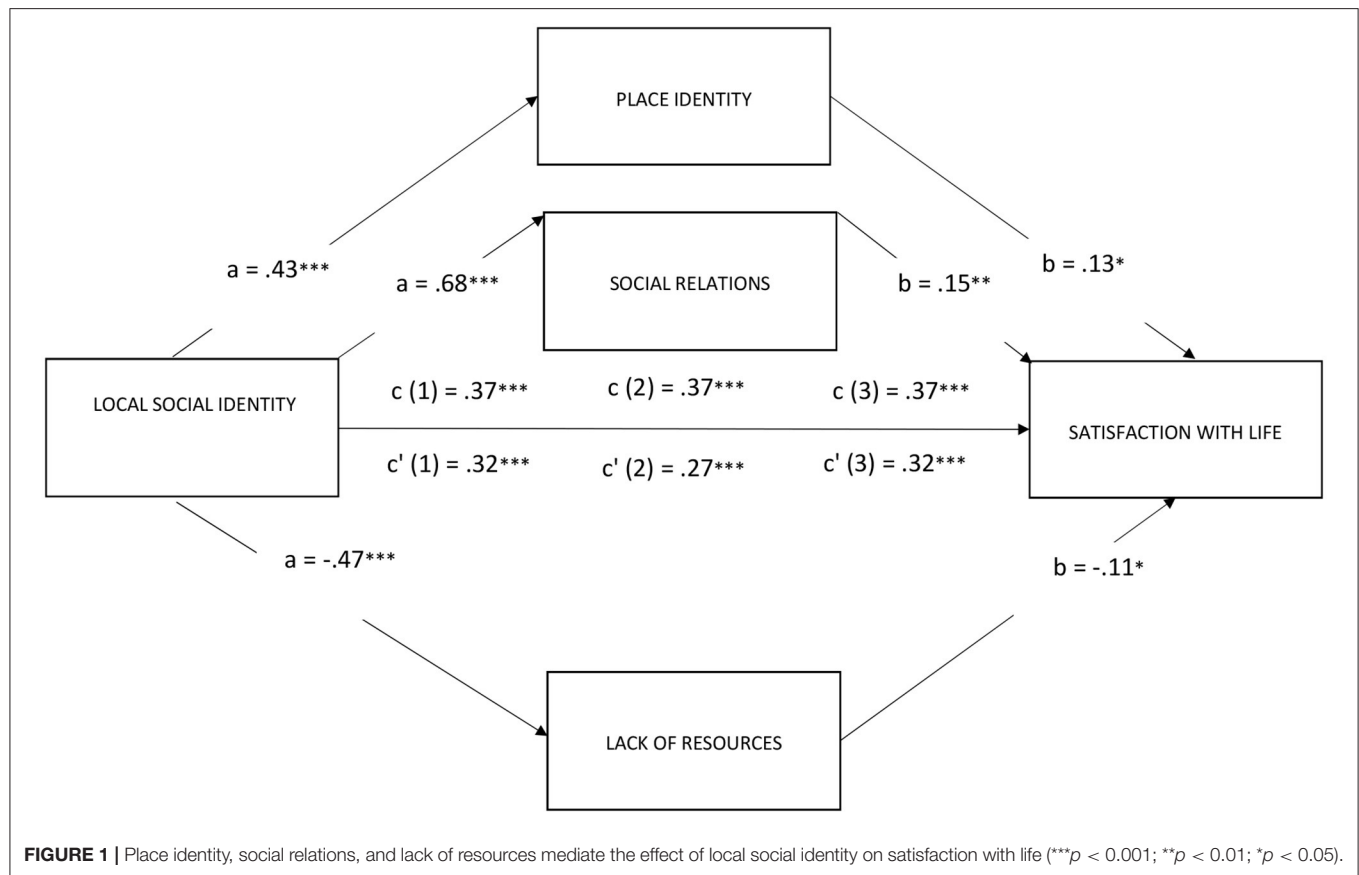
R, reverse-coded.



**TABLE 2 |** Means, SD, skewness, kurtosis, and zero-order correlations (Pearson's  $r$ ) between variables ( $N = 375$ ).

	Minimum	Maximum	Mean	SD	Sk	C	1	2	3	4	5	6
1. SWLS	1.40	9.00	6.31	1.45	−0.72	0.53	1					
2. IHS	2.11	8.78	5.98	1.28	−0.32	−0.26	0.57***	1				
3. Local social identity	1.00	9.00	5.69	1.52	−0.30	0.30	0.39***	0.33***	1			
4. Place identity	1.40	9.00	7.34	1.43	−0.97	0.63	0.28***	0.27***	0.46***	1		
5. Social relations	1.00	9.00	6.14	1.87	−0.51	−0.19	0.32***	0.33***	0.53***	0.58***	1	
6. Lack of resources	1.00	9.00	4.88	1.59	0.09	−0.22	−0.27***	−0.20***	−0.45***	−0.30***	−0.30***	1

$N = 375$ ; \*\*\* $p < 0.001$ ; SWLS, Satisfaction with Life Scale; IHS, Interdependent Happiness Scale; Sk, skewness; C, kurtosis.



## Mediation Analyses

In order to test our exploratory hypotheses, we tested different mediation models (PROCESS model number 4) with local social identity as the independent variable, satisfaction with life and interdependent happiness as the dependent variables, and place identity, social relations, and lack of resources (i.e., the subcomponents of Place Attachment) as mediators. Models 1, 2, and 3 tested the relationship between local social identity and satisfaction with life through place identity, social relations, and lack of resources, respectively. Models 4, 5, and 6 tested the relationship between local social identity and interdependent happiness through the same mediators of the previous analysis.

Models with satisfaction with life as dependent variable (see **Figure 1**).

**Model 1:** The overall equation was significant [ $R^2 = 0.16$ ;  $F_{(2, 372)} = 34.89$ ,  $p < 0.001$ ; see **Figure 1**]. The bootstrap analysis with 5,000 resampling showed the indirect effects of the local social identity of participants on their level of satisfaction with life via place identity ( $b = 0.0547$ ; 95% CI:  $LLCI = 0.0073$ ;  $ULCI = 0.1025$ ) were significant. The direct effect considering the mediator was still significant ( $b = 0.3181$ ; 95% CI:  $LLCI = 0.2106$ ;  $ULCI = 0.4255$ ). In other words, local social identity had a positive impact on satisfaction with life even after controlling for the indirect effects through place identity.

Model 2: The overall equation was significant [ $R^2 = 0.17$ ;  $F_{(2, 372)} = 40.13$ ,  $p < 0.001$ ; see **Figure 1**]. Indirect effects of the local social identity of participants on their level of satisfaction with life via social relations ( $b = 0.1033$ ; 95% CI:  $LLCI = 0.0293$ ;  $ULCI = 0.1768$ ) were significant. The direct effect considering the mediator was still significant ( $b = 0.3728$ ; 95% CI:  $LLCI = 0.2775$ ;  $ULCI = 0.4680$ ). In other words, local social identity had a positive impact on satisfaction with life even after controlling for the indirect effects through social relations.

Model 3: The overall equation was significant [ $R^2 = 0.16$ ;  $F_{(2, 372)} = 33.24$ ,  $p < 0.001$ ; see **Figure 1**]. Indirect effects of the local social identity of participants on their level of satisfaction with life via lack of resources ( $b = 0.0503$ ; 95% CI:  $LLCI = -0.042$ ;  $ULCI = -0.0994$ ) were significant. The direct effect considering the mediator was still significant ( $b = 0.3225$ ; 95% CI:  $LLCI = 0.2122$ ;  $ULCI = 0.4328$ ). In other words, local social identity had a positive impact on satisfaction with life even after controlling for the indirect effects through lack of resources.

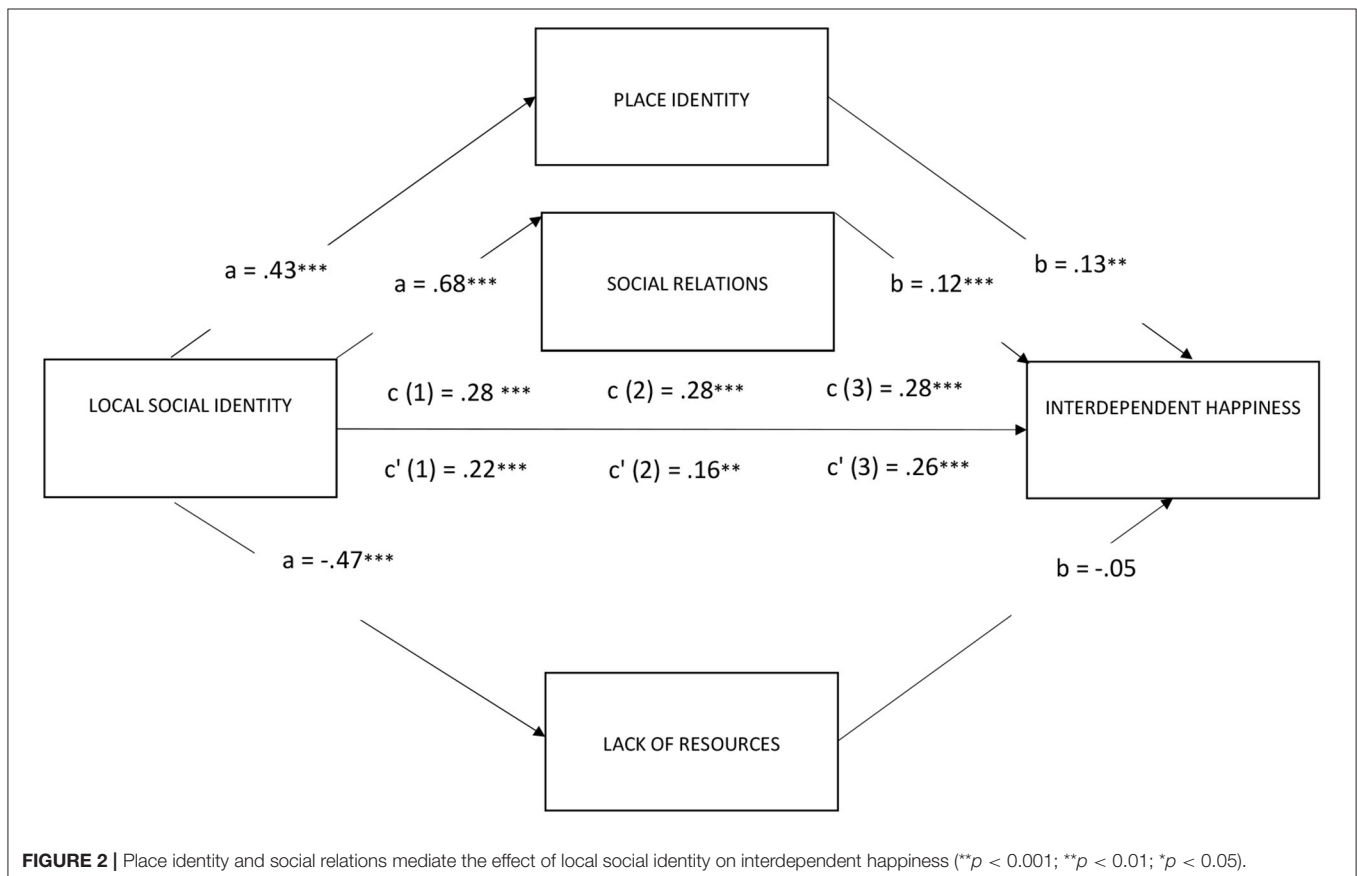
Model 4: The overall equation was significant [ $R^2 = 0.13$ ;  $F_{(2, 372)} = 27.11$ ,  $p < 0.001$ ; see **Figure 2**]. The indirect effects of the local social identity of participants on their level of interdependent happiness via place identity ( $b = 0.0565$ ; 95% CI:  $LLCI = 0.0204$ ;  $ULCI = 0.0167$ ) were significant. The direct effect considering the mediator was still significant ( $b = 0.2251$ ; 95%

CI:  $LLCI = 0.1279$ ;  $ULCI = 0.3223$ ). In other words, local social identity had a positive impact on interdependent happiness even after controlling for the indirect effects through place identity.

Model 5: The overall equation was significant [ $R^2 = 0.15$ ;  $F_{(2, 372)} = 32.99$ ,  $p < 0.001$ ; see **Figure 2**]. The indirect effects of the local social identity of participants on their level of interdependent happiness via social relations ( $b = 0.1211$ ; 95% CI:  $LLCI = 0.0611$ ;  $ULCI = 0.1809$ ) were significant. The direct effect considering the mediator was still significant ( $b = 0.1604$ ; 95% CI:  $LLCI = 0.0561$ ;  $ULCI = 0.2646$ ); in other words, social identification with the local community had a positive impact on interdependent happiness even after controlling for the indirect effects through social relations. Model 6: The overall equation was significant [ $R^2 = 0.11$ ;  $F_{(2, 372)} = 21.32$ ,  $p < 0.001$ ; see **Figure 2**]. The indirect effects of social identification of participants with the local community on their level of interdependent happiness via lack of resources ( $b = 0.0242$ ; 95% CI:  $LLCI = 0.0194$ ;  $ULCI = 0.0675$ ) were not significant.

## DISCUSSION

The results of this study provide further evidence to the tripartite model of place attachment, consistent with other studies (Williams and Vaske, 2003; Scopelliti and Tiberio,



2010), and also to the consideration of place identity, place dependence, and social bonds as the key components of place attachment (e.g., Raymond et al., 2010; Ramkissoon et al., 2013; Chen et al., 2018). The study also corroborates the positive relationship between place attachment, local social identity, and relational and individual well-being. It is also shown how the dimensional distinction better explains the mediating role of place attachment factors in the relationship between local social identity and well-being.

Previous studies showed the links between social identification and well-being (e.g., Paolini et al., 2020), place attachment and well-being (e.g., Ratcliffe and Korpela, 2016, 2018), and community connectedness and activism (e.g., Rollero and De Piccoli, 2010). Moreover, previous studies demonstrated the mediating role of place attachment in the relationships between these variables (Buta et al., 2014). In this study, it is confirmed from the high relation between group identification and well-being (satisfaction with life and interdependent happiness), and from the importance of place attachment in connecting the strong identity bond of individuals with the local community which they belong to with their own well-being. This emerged taking into account not only the independent individual well-being, given by satisfaction with life (Diener et al., 1985), but also considering well-being as interdependent happiness, which is achieved with social relationships and harmony with others, in particular with the reference group of an individual (Hitokoto and Uchida, 2015).

Specifically, this study found that the relationship of local social identity with individual well-being (in terms of satisfaction with life and interdependent happiness) passes through the positive relationship with two dimensions of place attachment, i.e., place identity and social relations, while the perception of lack of resources (i.e., the reverse of place dependence) in the place where a person lives negatively mediates the relationship only between local social identity and satisfaction with life. This means that people with high local social identity develop a high identification with the place in terms of both the physical aspects of the place where they live (i.e., place identity) and the social relationships that they establish there; both these subdimensions of place attachment are positively related to individual well-being and interdependent happiness. Similarly, people with high local social identity have highly negative perceptions of the absence of resources in their place of living (in terms of functional attachment to the place), and this is negatively related to life satisfaction (but not to interdependent happiness). In other words, a high local social identity promotes a high place dependence, and this, in turn, is positively associated with life satisfaction but not with interdependent happiness.

## Limitations, Implications, and Future Research

This study has some limitations. In particular, it is a cross-sectional study (like most studies on place attachment and

well-being), so it is not easy to clarify whether there is a causal direction of the relation between local social identity and place attachment. As pointed out in the literature review, these two psychosocial aspects are certainly highly interrelated. Future studies could manipulate the local identity degree of individuals to better understand the impact of place attachment on well-being. It is possible to think that these have a positive impact on the individual and relational well-being of people. That is, if one lives in a place with which she/he does not identify with or feels she/he does not belongs to, or to which she/he does not feel emotionally attached, then she/he does not experience satisfaction, well-being, or happiness either. On the other hand, social identification, place attachment, and well-being are psychological factors that mature over time, are bound to places, and are related to the social community. The merit of the present study lies in highlighting the role of place attachment in the relationship between local social identity and well-being, above all by investigating the different dimensions and facets of place attachment and their different impact on happiness and life satisfaction of people. Finally, most of our participants were female, not allowing us to test for the moderating role of the gender of participants. Future research would warrant a more in-depth investigation in this direction.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors upon request.

## ETHICS STATEMENT

This study was reviewed and approved by the Ethical Committee of the Department of Social and Development Psychology of Sapienza, University of Rome (October 29, 2018). Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

FM and OM contributed to data collection. OM and DP contributed to data analysis. FM and FF contributed to the interpretation and discussion of results. All the authors equally contributed to develop the project of the present research and to writing the paper.

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# Cuteness or Coolness—How Does Different Anthropomorphic Brand Image Accelerate Consumers' Willingness to Buy Green Products?

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Green consumption is an important component of environmental protection behavior. The behaviors of individual consumers are having unprecedented impacts on the sustainable development of a green society. Previous research has discussed how anthropomorphic beneficiaries of environmental behavior (e.g., nature/earth) impact green consumption behavior and compared the influence of anthropomorphic presence and absence on consumers. However, few have examined the impact of different types of anthropomorphic carriers with environmental benefits (e.g., green product/brand) on consumers. This research explores the matching effects on the willingness of consumers to buy green products between the anthropomorphic image of the brand (cute vs. cool) and advertising appeals (self-interest vs. altruism); in addition, the underlying mechanisms of matching effects are revealed. The results show that, under the self-interested advertising appeal, the cool anthropomorphic image can lead to higher purchase intention of green products due to the mediating role played by the brand capacity trust. However, when exposed to altruistic advertising appeal, the cute anthropomorphic image can enhance brand goodwill trust of consumers and make consumers more willing to buy green products. Finally, this paper discusses the contributions and limitations.

**Keywords:** green consumption, anthropomorphism, advertising appeal, brand trust, sustainability, purchase intention

## INTRODUCTION

Environmental problems are related to the sustainable development of mankind. On the one hand, the human demand for environmental resources is increasing rapidly, and resources of the earth are overexploited; on the other hand, the environmental pollution caused by human activities is becoming more and more serious. In the relationship between humans and the environment, humans play an important role. Environmental problems are largely caused by human behavior (Dong et al., 2017), especially consumption behavior. If people convert traditional marketing behavior into green consumption, these problems will be alleviated. Although the relationship between marketing and green consumption has attracted the attention of people (Anderson and Cunningham, 1972; Kilbourne and Beckmann, 1998; Kotler, 2011), scholars of this field are still calling for studies on predictors of green consumption

(Menon and Menon, 1997; Mick, 2006; White et al., 2019). By paying attention to the green consumption behavior of consumers in marketing practice, marketers can find new green consumption territory and finally expand the market for the long-term mutual benefit of enterprises and the ecological environment.

Marketing communication (green advertising, brand image, etc.) is an important means to promote the success of green product marketing. For example, many studies suggested that green product advertisements often focus on highlighting one of the dual attributes of green products (self-interest and altruism) to promote consumer purchase (Schuhwerk and Lefkoff-Hagius, 1995; Peloza et al., 2013; Kareklas et al., 2014; Yang et al., 2015). In addition to considering the attribute of green products, the brand attribute of green products cannot be ignored. Some studies show that brand-perceived value, brand trust, and brand awareness can all positively predict the purchase intention of consumers to green products (Rahbar and Abdul Wahid, 2011; Alshura and Zabadi, 2016; Ranjan and Kushwaha, 2017). Consumers often lack trust in products and advertisements that claim to be environmentally friendly, even for those consumers who have a high degree of environmental concern or master certain environmental knowledge. They will also doubt the environmental protection claims and motives of enterprises, which hinders them from further adopting green consumption behaviors (Tung et al., 2012; Nittala, 2014). Therefore, in the marketing of green products, it is particularly important to improve the trust of consumers in green products and brands through appropriate means of marketing communication. Some research show that the application of anthropomorphic images helps to enhance the trust of consumers in products and brands. Specifically, anthropomorphic product design and brand image can reduce the perceived risk of consumers (Jarvenpaa and Leidner, 1999; Kim and McGill, 2011); the lower the perceived risk, the higher the brand trust (Lau and Lee, 1999); thus, the inner conflict during purchase is reduced, and the purchase intention is strengthened (Hur et al., 2015).

As an effective communication element, anthropomorphism has become vitally important not only in the field of traditional marketing but also in the practice of environmental protection, including green consumption (Waytz et al., 2010). Previous studies have focused on the impact of environmental protection beneficiaries (nature and animals) as anthropomorphic objects. For example, various environmental activities often personify the earth as “Mother Earth.” At present, anthropomorphic elements have been used in the brand image and appearance design of some green products, for example, White Cat’s latest British black tea flavor environmental detergent uses the cute white cat anthropomorphic image (as shown in the lower right corner of **Figure 1A**), and some new energy environmental vehicles are designed with anthropomorphic elements in front-face modeling, such as a cute electric car of Honda (**Figure 1B**) and cool Model S series of Urban EV Tesla (**Figure 1C**).

It is worth noting that the anthropomorphic images of these green products use two popular subculture elements—cuteness and coolness. They can all serve as the direction for the personified image of the brand. Cute itself is a specific form of

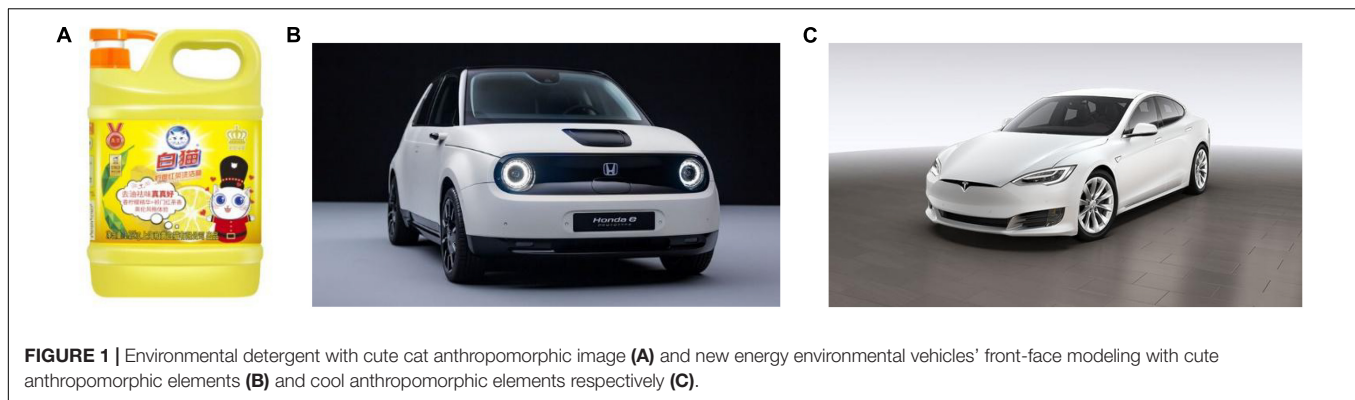
anthropomorphism (Epley et al., 2007; Chang et al., 2017), while cool can also be used as a personality trait to describe people, and existing studies have integrated it into brand personality (Warren et al., 2019), so it can also be used as a specific form of brand personification. More importantly, extant work often concentrates on the influence of anthropomorphism presence or absence on the attitude and behavior of consumers in the context of green consumption, but the research on whether different anthropomorphic image types can produce different effects is quite limited, so which element can achieve better marketing promotion effect in what situation is worth investigating.

Extending research show that the corresponding marketing communication effect playing by different anthropomorphic images is largely affected by context factors (Puzakova et al., 2013; Puzakova and Kwak, 2017; Reavey et al., 2018). As mentioned above, enterprises producing green products design a brand image through cuteness and coolness in ways that extend different types of a brand anthropomorphic image. Thus, whether these different anthropomorphic images of the brand will have different effects on green product marketing promotion (e.g., matching with different advertising appeal types) is to be discussed in this paper.

## LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

### Brand Anthropomorphic Image Types: Cute vs. Cool

Academically, the concept of cuteness was first proposed by Austrian zoologist Konrad Lorenz to generalize a series of visually perceived infant appearance or behavior characteristics (Lorenz, 1943), that is, “kindchenschema cuteness.” Because cuteness is often associated with those young children or things, thanks to this positive stereotype, the perception of cuteness can induce consumers to generate positive inferences such as innocence, kindness, and honesty (Keating et al., 2003). From the aspect of anthropomorphic marketing, elements of cuteness are considered to be a concrete way of anthropomorphic image design for brands or products (Epley et al., 2007; Chang et al., 2017). Based on consumer perception, cuteness is a positive perception that will make consumers feel compassion (Hellén and Sääksjärvi, 2013). Cuteness can be a unique marketing tool. That is to say, through product design, brand image, market positioning, and other ways, enterprises make consumers feel cute to their products or brands to initiate the positive evaluation of consumers of these products or brands, and thus promote the purchasing behavior of consumers (Desmet et al., 2001; Norman, 2004; Chitturi, 2009). For example, the study of Windhager et al. (2008) showed that, compared with the general automobile appearance features, cars with cute infant features would be perceived as friendlier and more easygoing, and the products would be evaluated correspondingly higher. Cheok (2010) also found that product image spokesmen with some infant characteristics can often lead consumers to have a higher evaluation of the product.



**FIGURE 1 |** Environmental detergent with cute cat anthropomorphic image (A) and new energy environmental vehicles' front-face modeling with cute anthropomorphic elements (B) and cool anthropomorphic elements respectively (C).

Furthermore, one common aspect of the research on cuteness is that people decide to engage in prosocial behavior, for instance, consumers are willing to help others or participate in donations and waste recycling (Bellfield et al., 2011; Miesler et al., 2011; Sherman and Haidt, 2011; Chang, 2012; Wang and Anirban, 2015; Wang et al., 2017). A cuteness schema can enhance the altruistic tendency of people and even make people start thinking about the interest of enterprises on account of the empathic tendency stimulated by cuteness (Sherman et al., 2009; Miesler et al., 2011). Similarly, research demonstrates that the response of people to cuteness is a kind of moral emotion because the sociality induced by cuteness can expand the moral circle of people and urge people to give more moral care (Sherman and Haidt, 2011). The willingness of consumers to buy green products is also affected by the diverse brand image. Pieces of research have classified brand anthropomorphic images, such as servant and partner (Aggarwal and McGill, 2012; Kim and Kramer, 2015; Alvarez and Fournier, 2016), competence and warmth based on the stereotype model (Aaker et al., 2010). The cute image may also evoke a perception of warmth, so there is a link between the cute and the warm stereotype (Sprengelmeyer et al., 2009). However, it is worth noting that the consumption behavior of green products is different from the general consumption behavior, which has a certain degree of moral and prosocial attributes (Griskevicius et al., 2010; White and Simpson, 2013). Although both cute and ordinary warm images (which do not give consumers a high perception of cuteness) can give consumers a warm perception, the difference is that consumers may not be able to generate such strong moral emotions for warm anthropomorphic images. Therefore, this study will mainly investigate the role of the cute brand anthropomorphic image in the purchase of green products, instead of the warm brand anthropomorphic image.

Likewise, coolness is also an increasingly common subcultural phenomenon (Gerber and Geiman, 2012). In the pursuit of personalized consumption of today, cool products and brands are always sought after by consumers, especially for young consumers who want to look cool (Nancarrow et al., 2002; Belk et al., 2010; Warren et al., 2018). More and more enterprises are trying to make their products, services, and brands cool to make consumers have perceived coolness. Specifically, enterprises establish cool brand images, employ cool brand spokesmen, design cool advertisements, and integrate cool elements into

products or services (Rahman, 2013; Sundar et al., 2014). From the perspective of personality trait research, coolness is defined as a complex of personality traits that contain one or more personality traits (Belk, 2006; Dar-Nimrod et al., 2012). Studies have shown that coolness is positively correlated with traits such as Big Five, self-orientation, and emotional stability (Dar-Nimrod et al., 2018). As a style of personality characteristics, coolness can also be used for brand personification and shaping the brand personality of coolness (Warren et al., 2019). From the perspective of consumer perception, coolness is a kind of emotion or perception with both hedonism and functionality (Runyan Rodney et al., 2013). Coolness can be a sort of positive evaluation of products or services that include judgments of consumers on uniqueness, attractiveness, subculture, and other aspects (Sundar et al., 2014). A series of studies have shown that making consumers feel cool can significantly affect the psychology and behavior of consumers. According to the research results of Im et al. (2015), cool perception can enhance the hedonistic value of new products and then positively influence consumer attitude. Warren et al. (2018) found that cool brand spokesmen can enhance the favorable degree of the brand to consumers. In addition, the brand can enhance attitude of consumers toward the brand by displaying its cool personality, and thus increase the purchase intention of consumers to the products of the brand (Warren et al., 2019).

More importantly, existing studies have shown that initiating cool perception of consumers also increases the likelihood of taking prosocial behaviors (Nancarrow et al., 2002; Bird and Tapp, 2008; AS Mohiuddin et al., 2016). While coolness has features such as rebellion and self-centeredness that appear to contradict prosocial behavior, studies have found that prosocial behavior and coolness may be perceived as signals of maturity and social justice by consumers (Nancarrow et al., 2002; Bird and Tapp, 2008). Meanwhile, some dimensions of coolness are positively related to prosocial values (Dar-Nimrod et al., 2018). Similarly, consumers are more willing to take positive word-of-mouth communication behavior in virtue of the initiation of cool conception (Moldovan et al., 2011).

To sum up, both cuteness and coolness could make consumers have positive perceptions and be used as the anthropomorphic image development direction. According to the above studies,



cuteness and coolness are still a pair of concepts that can be distinguished and relative. In particular, cuteness tends to evoke impressions of innocence, naivety, kindness, and warmth of consumers (Keating et al., 2003), while coolness often implies a high degree of autonomy, maturity, deviation from conventional norms, and innovation (Dar-Nimrod et al., 2018). The relationship between cuteness and coolness is similar to the warmth-competence dimension of the stereotype content model. Cuteness and coolness also promote prosocial behavior in certain contexts, so they can be used in green consumption studies. For other anthropomorphic categories (e.g., companion vs. servant and warmth vs. competence), there is little research to suggest that they can also play a positive role in promoting prosocial behavior, except for warm anthropomorphic images, which show that anthropomorphic characteristics of money can enhance warmth perception and promote charitable giving (Zhou et al., 2019). Moreover, dropping contextual factors to compare the effects of different anthropomorphic types on consumer cognition and decision-making would be difficult (Williams et al., 2015; Han et al., 2019; Ketron and Naletelich, 2019; Zhu et al., 2019). This paper aims to compare the roles of the cute brand anthropomorphic image and the cool brand anthropomorphic image in improving purchase intention under the green consumption context based on the characteristics of cuteness and coolness.

### The Advertising Appeal Type: Self-Interested vs. Altruistic

Advertising appeal is the content that should be emphasized in advertising (Holbrook and Batra, 1987). In commodity advertising, it refers to a variety of creative ways to capture the attention of the advertising audience, then transmitting the beneficial attributes of a product or service to stimulate their potential demand for this product or service and affect their attitude toward products or services and promote the occurrence of corresponding buying behavior ultimately (Schuhwerk and Lefkoff-Hagius, 1995). Appropriate green product advertising appeals can positively affect the attitudes of consumers toward green products and enhance the willingness of consumers to buy. The commonly used appeals in green product advertising include abstract appeal and concrete appeal, rational appeal and perceptual appeal, self-interest appeal and altruistic appeal, guilt appeal, and the gain-and-loss messages framework. To better explore the matching effect of green product advertising appeals and brand anthropomorphic image type on improving purchase intention, this research adopts altruistic and self-interest green product advertising appeal classification as well because green products themselves have altruistic and self-interested attributes (Mazar and Zhong, 2010).

In the field of green consumption, considerable studies are based on the assumption that consumers believe that altruism and self-interest cannot coexist and customarily value utility attributes (whether the efficacy is powerful or not) rather than ethics (whether it is beneficial for environmental protection). But as a matter of fact, the finite moral hypothesis and the finite self-interest hypothesis, which take into account the dual properties in the framework of green consumption, are closer to reality

(White et al., 2019). The finite moral hypothesis and the finite self-interest hypothesis hold that individuals will consider both personal interests and social welfare in their behavioral decisions (Schlaile et al., 2018; White et al., 2019). However, consumers will focus primarily on either personal or social interests, which will be guided and influenced by the advertising appeal. Altruistic advertising appeal that is beneficial to the environment highlights the ethical attributes of green products and pays attention to the interests of the whole ecological environment and society to increase the prosocial tendency of consumers to a certain extent. Self-interested advertising appeal that is beneficial to individuals invariably highlights the utility attributes of green products and concentrates on the interests of consumers (such as economic cost and health) to make consumers more inclined to consider personal interests (Schuhwerk and Lefkoff-Hagius, 1995). Moreover, scholars have found that it is best to highlight only one kind of interest appeal in the advertising of green products, which means that we should not mix self-interest and altruism in order not to affect the promotion effect (Feiler et al., 2012).

### The Matching Effect of Brand Anthropomorphic Image Type and Advertising Appeals

Existing studies have shown that information processing fluency can, indeed, have a positive impact on the cognition of consumers, including the evaluation of products and brands. The stronger the perceived fluency is, the more likely it is to produce a better evaluation (Lee and Labroo, 2004; Labroo and Rucker, 2010). In a similar vein, proper matching between the various elements (symmetry, color, and background) in the promotion of advertising can enhance consumer information processing fluency, and proper matching can promote the fluency of consumer information processing and enhance consumers' attitude towards advertising (Reber et al., 2004).

Based on the theory of information processing fluency, consumers will search for relevant clues to prove that brands can meet their interests when they come into contact with self-interest advertising demands. When the brand anthropomorphic image is cool, consumers who perceive cool perception will consider that the product will bring some benefits to themselves, such as hedonic or functional value, and even help them realize themselves (Holbrook and Batra, 1987; Sundar et al., 2014; Im et al., 2015), thus aligning with the content of self-interested advertising. When consumers are exposed to altruistic advertising appeals, they will subconsciously look for clues to prove that brands benefit society and help others. If the brand anthropomorphic image is cute at this time, the initiation of cute perception will induce consumers to infer positively that the brand is kind, warm, and honest (Keating et al., 2003; Gorn et al., 2008; Windhager et al., 2008). These characteristics are often highly correlated with prosocial behavior; thus, the cute brand anthropomorphic image and altruistic advertising appeal are more consistent. If the advertising appeal of the product and the anthropomorphic image match accurately, it will improve the perception information fluency of the consumer and reduce the perceived risk in ways of increasing the trust in the brand and

then improve the purchase intention. Taken together, we propose the following hypotheses:

**Hypothesis 1.** Advertising appeal type and brand anthropomorphic image type interact to affect the willingness of consumers to buy green products.

**Hypothesis 1a.** For consumers who are exposed to self-interest advertising appeals, a cool brand anthropomorphic image (vs. cute) can stimulate a higher willingness to buy green products.

**Hypothesis 1b.** For consumers who are exposed to altruistic advertising appeals, a cute brand anthropomorphic image (vs. cool) can stimulate a higher willingness to buy green products.

## The Mediating Role of Brand Trust

Studies have shown that consumers often lack trust in advertising that claims to be green and they tend to doubt the authenticity and motivation of their environmental advocacy, which hinders them from further adopting green consumption behaviors (Tung et al., 2012). Fournier (1996) suggested that brand trust is the degree of confidence and dependence on brands of consumers. Hess (1995) divided brand trust into three dimensions: altruism, sincerity, and reliability. According to the peculiarities of the trusted side, McAllister (1995) and Mayer et al. (1995) put forward three influencing factors of trust, namely capacity, goodwill, and integrity. Capacity is a set of skills, abilities, and characteristics that performs tasks professionally and have a large influence in a certain field. Goodwill is the degree to which the trusted side is likely to do a good deed (the motivation for doing good is not a self-centered interest), while altruism contributes to the degree of goodwill trust. Integrity is the belief that the trusted side will follow a set of established principles. Each dimension of brand trust is independent of each other and can be separate and act as an independent variable (McAllister, 1995), which means that consumers may have different brand trust due to different properties of the brand. According to the traits of cuteness and coolness, this study chooses goodwill trust and capacity trust to explain the matching effect between brand anthropomorphic image type and advertising appeal type. Specifically, brand goodwill trust means that consumers believe that brands are not just profit oriented but altruistic as well. Brand ability trust refers to consumers who believe that the brand has certain competence and technology to produce products with specific functions to meet the interests of individuals.

Corresponding to the combination of different brand anthropomorphic images and advertising appeals, the more specific hypotheses of this study are derived as follows. Self-interested appeals provide consumers with utilitarian motives (Lantos, 2015), which will lead consumers to pay more attention to the efficacy of green products when evaluating them. The exclusive value that the cool anthropomorphic image of brands can provide (such as hedonic benefit or practical benefit) is more consistent with the self-interested advertising appeal, which enables consumers to process information more fluently and have a higher perception of the authenticity of the product information so that consumers are more likely to trust in the ability of a brand and believe that the brand can truly bring them

the benefits promised in the advertising appeal. On the other hand, Sherman and Haidt (2011) pointed out that the reaction of people to cuteness is a moral emotion. Compared with the cool brand anthropomorphic image, which makes consumers feel rebellious, highly independent and mature, the cute brand anthropomorphic image has a higher internal consistency with the altruistic advertising appeal. In a similar vein, consumers would be more fluent in information processing and more inclined to believe that the brand of cute anthropomorphism will truly fulfill the altruistic content in advertising to care for the welfare of the whole society, which result in greater brand goodwill trust and higher willingness to adopt the green products. Taken together, the following hypotheses are proposed:

**Hypothesis 2.** Brand trust mediates the interactive effect of brand anthropomorphic image type and green product advertising appeals on green product purchase intention.

**Hypothesis 2a.** Brand capacity trust mediates the interaction of cool brand anthropomorphic image and self-interest advertising appeals on the purchase intention of consumers of green products.

**Hypothesis 2b.** Brand goodwill trust mediates the interaction of cute brand anthropomorphic image and altruistic advertising appeals on the purchase intention of consumers of green products.

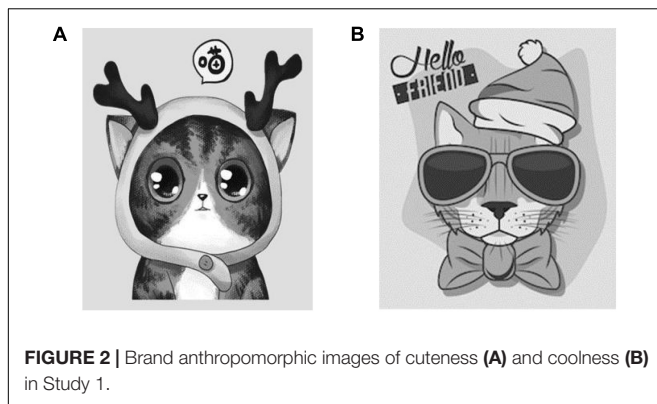
## STUDY 1: THE INTERACTION EFFECT OF BRAND ANTHROPOMORPHIC IMAGE TYPE AND ADVERTISING APPEALS ON GREEN PRODUCT PURCHASE INTENTIONS

Study 1 is mainly to test whether the type of brand, anthropomorphic image, and advertising appeals interact to influence the purchase intention of consumers of green products, namely H1.

### Pretest

Before the study, the appropriate brand anthropomorphic images (cool vs. cute) were selected as the experimental materials through the pretest. The cute brand anthropomorphic image selected a cat with a round face and big eyes as shown in **Figure 2A** (Gorn et al., 2008; Wang et al., 2017), which added tautology and a modal particle into the description of advertising to better initiate cute perception (Argo et al., 2010). The cool anthropomorphic image was a cat with dark glasses and a neutral expression as shown in **Figure 2B** (Wang et al., 2014; Warren et al., 2018). Autonomous and rebellious descriptions were added in its advertising material to initiate the perception of coolness (AS Belk et al., 2010; Warren and Campbell, 2014).

This pretest recruited participants from Credamo, a Chinese online group similar to Mturk. Thirty-five participants from different backgrounds completed the survey (men, 54.3%; women, 45.7%,  $M_{\text{age}} = 22.74$ ). The measurement of cute



perception drew on Nenkov and Scott's scales (three items: the brand image is cute/the brand image is adorable/the brand image is endearing,  $\alpha = 0.817$ ) (Nenkov and Scott, 2014). The measure of cool perception referred to the scales proposed by Sundar et al. (2014) and Warren et al. (2019), which mainly measures five dimensions of autonomy, rebelliousness, complexity, originality, and vitality (five items: the brand image is mature and capable/the brand image is dared to break the convention/the brand image will act following their own will/the brand image is full of vitality/the brand image is creative,  $\alpha = 0.890$ ); the above scales were all seven-point scales. The results show that the cool perception of the cool anthropomorphic image was significantly higher than that of cute anthropomorphic image ( $M_{\text{cool}} = 4.824$  vs.  $M_{\text{cute}} = 3.367$ ;  $t = 8.016$ ,  $p < 0.001$ ,  $d = 2.834$ ); the cute perception of the cute anthropomorphic image was significantly higher than that of the cool anthropomorphic image ( $M_{\text{cute}} = 4.907$  vs.  $M_{\text{cool}} = 3.353$ ;  $t = -6.634$ ,  $p < 0.001$ ,  $d = 2.345$ ). The above results indicated that the type of brand anthropomorphic image is successfully manipulated, and these materials could be used in further experiments.

## Experimental Design and Subjects

A between-subject design of 2 (brand anthropomorphic images: cute vs. cool)  $\times$  2 (advertising appeals: altruistic vs. self-interested) was used in Study 1, and the participants were randomly assigned to one of the four groups. The participants were recruited on the questionnaire platform Credamo by offering cash rewards. One hundred four valid questionnaires were received (men, 47.1%; women, 52.9%;  $M_{\text{age}} = 23.08$ ).

## Experimental Procedures

First, the participants were required to imagine meeting advertising for an environmentally friendly water cup made of wheat straw when shopping online. The anthropomorphic images selected in the pretest were used as brand logos in the advertising, and the specific manipulation was the same as the pretest. The manipulation of advertising appeals referred to the design of Kareklas et al. (2014) and Yang et al. (2015). The altruistic advertising appeals group mainly expressed that the use of environment-friendly water cups was conducive to protecting the nature and ecological environment, specifically the contents of the altruistic group are as follows: "The water cup is made

of wheat straw, natural and non-toxic, ecologically degradable, environmentally friendly, and pollution free. Come and protect the lovely nature." While the self-interested advertising appeals group highlighted the impact of environment-friendly water cups on consumer health, the specific contents are as follow: "The water cup is made of wheat straw, healthy and non-toxic, the wheat fragrance is thick, and the ecology is safe. Let us drink to the health." The length of all advertising words in Study 1 was balanced to avoid unnecessary interference.

Second, the participants were required to rate brand anthropomorphic images on cute and cool scales as a manipulation test. Then, the participants needed to rate perceived self-interest (three items: advertising content based on environmental protection considerations/resource conservation considerations/social overall interest considerations,  $\alpha = 0.833$ ) and perceived altruism (three items: advertising content based on personal health considerations/personal use considerations/personal interest considerations,  $\alpha = 0.868$ ) of advertising appeals (Kareklas et al., 2014). The participants reported their willingness to purchase the green product (1 = not at all probable, 7 = very probable;  $\alpha = 0.846$ ) (Tezer and Bodur, 2019). The above-mentioned measurement scales are all seven-point scales and have been adjusted and adapted to the situation of this experiment.

Finally, the participants also completed the relevant test items in consideration of the influence of brand familiarity on purchase intention and demographic messages (Campbell and Keller, 2003).

## RESULTS

### Manipulation Check

The first is to test the manipulation effect of brand anthropomorphic type. *T*-test results showed that the cute perception of the cute anthropomorphic image was significantly higher than that of the cool anthropomorphic image ( $M_{\text{cool}} = 2.969$  vs.  $M_{\text{cute}} = 5.405$ ;  $t = -21.269$ ,  $p < 0.001$ ,  $d = 4.211$ ); the cool perception of the cool anthropomorphic image was significantly higher than that of the cute anthropomorphic image ( $M_{\text{cool}} = 5.438$  vs.  $M_{\text{cute}} = 3.055$ ;  $t = 18.839$ ,  $p < 0.001$ ,  $d = 3.731$ ), indicating that the manipulation of the anthropomorphic image is successful and then conducted a *t*-test on the manipulation of advertising appeals; the results showed that the perceived altruism of the altruistic advertising appeal group was significantly higher than that of the self-interested advertising appeal group ( $M_{\text{altruistic}} = 4.660$  vs.  $M_{\text{self-interested}} = 3.327$ ;  $t = -12.092$ ,  $p < 0.001$ ,  $d = 2.395$ ), and the perceived self-interested of self-interested advertising appeal group was significantly higher than that of the altruistic advertising appeal group ( $M_{\text{self-interested}} = 4.566$  vs.  $M_{\text{altruistic}} = 3.379$ ;  $t = 11.955$ ,  $p < 0.001$ ,  $d = 2.367$ ), indicating that the manipulation of advertising appeals is successful.

### Hypothesis Test

Firstly, an analysis of variance (ANOVA) with the brand anthropomorphic image type and advertising appeals as



independent variables and purchase intention of green products as the dependent variable revealed a significant interaction effect ( $F = 40.610$ ,  $p < 0.05$ ,  $\eta^2 = 0.289$ , see **Figure 3**). Further analysis showed that, in the altruistic appeal condition, the participants were more likely to buy green products with cute anthropomorphic images ( $M_{\text{cool}} = 4.077$  vs.  $M_{\text{cute}} = 4.590$ ;  $F = 19.049$ ,  $p < 0.001$ ). In contrast, in the self-interested appeal condition, the participants were more willing to buy green products with cool anthropomorphic images ( $M_{\text{cool}} = 4.556$  vs.  $M_{\text{cute}} = 4.019$ ;  $F = 21.631$ ,  $p < 0.001$ ).

Next, we added brand familiarity for covariance analysis. It revealed the interaction between the advertising appeals and brand anthropomorphic image type on the purchase intention of green products was still significant ( $F = 40.081$ ,  $p < 0.001$ ,  $\eta^2 = 0.288$ ), indicating that the influence of brand familiarity on the matching effect can be excluded. Therefore, H1, H1a, and H1b were supported in Study 1.

## Discussion

Study 1 investigated the interaction effect of advertising appeals and brand anthropomorphic images on purchase intention of green products, and successfully verified H1a and H1b. However, Study 1 still has some deficiencies, such as the relationship between the brand anthropomorphic image and the product is not strong enough, and the gender perception of different brand anthropomorphic images is not taken into account. Actually, some scholars suggested that cuteness is often associated with feminine designs that may affect the robustness of experimental results (Locher, 2007; Moeran and Skov, 2013), for instance, using the favorite colors or styles of females.

In view of this, different product categories (environmentally friendly juice) were used to design brand anthropomorphic images to further strengthen the connection between brand anthropomorphic images and products, and the interference of perceived gender was excluded in Study 2. In Study 2, the robustness of the experimental results was also enhanced by adding a choice situation, that is, asking consumers to choose the products represented by different brand anthropomorphic images in different groups of advertising appeal types, and the

mediating role of two kinds of perceived brand trust (goodwill trust and capacity trust) was verified in Study 2.

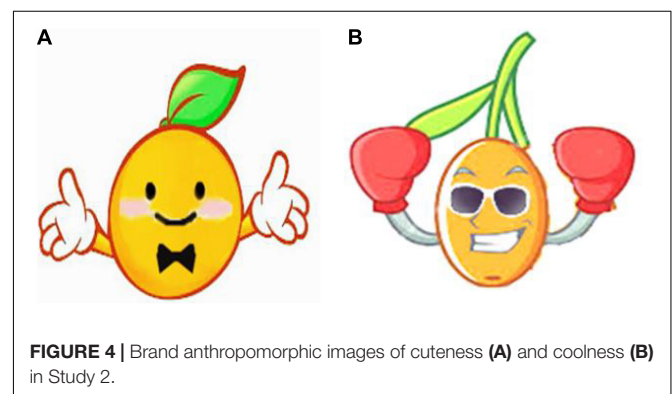
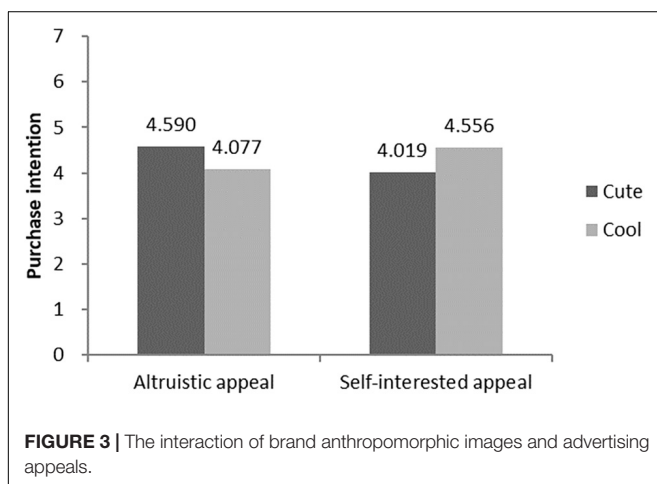
## STUDY 2a. THE INTERACTION EFFECT OF BRAND ANTHROPOMORPHIC IMAGE TYPE AND ADVERTISING APPEALS ON GREEN PRODUCT PURCHASE INTENTIONS

Study 2 adopted a new green product category (juice) and redesigned the brand anthropomorphic images (orange) that were different from Study 1 to strengthen the linkages between images and products. Meanwhile, Study 2 also excluded the interference of gender perception to enhance the robustness of the experimental results. In addition, Study 2a did not adopt the measurement method of purchase intention used in Study 1. Instead, the consumers were asked to make a choice between two green products with anthropogenic images to measure their purchase intention.

### Pre-test

The anthropomorphic image selected a sort of fruit (orange) as the object to ensure it could be well connected with the green products (juice). As for image design, the colors of both anthropomorphic images are orange, and the character posture, accessories and painting styles are similar as well (see **Figure 4**). The design of advertising text materials still followed the information framework that has been adopted in Study 1, except that it was conveyed in the first person to enhance the anthropomorphic effect.

The pretest obtained 34 valid questionnaires from Credamo (men, 52.9%; women, 47.1%,  $M_{\text{age}} = 22.5$ ). The results showed that the cool perception of the cool anthropomorphic image was significantly higher than that of the cute anthropomorphic image ( $M_{\text{cool}} = 4.459$  vs.  $M_{\text{cute}} = 3.424$ ;  $t = -6.604$ ,  $p < 0.001$ ,  $d = 2.335$ ). Likewise, the cute perception of the cute anthropomorphic image was significantly higher than that of the cool anthropomorphic image ( $M_{\text{cute}} = 4.824$  vs.  $M_{\text{cool}} = 3.412$ ;  $t = -7.155$ ,  $p < 0.001$ ,  $d = 2.53$ ). Since cute anthropomorphic images may be intuitively considered more feminine, and cool anthropomorphic images





may be considered more masculine, this may also affect the results of subsequent experiments. However, the results revealed that there was no significant difference in male perception between the two anthropomorphic images ( $M_{cool} = 4.444$  vs.  $M_{cute} = 3.875$ ;  $t = -1.656$ ,  $p = 0.111 > 0.05$ ), and there was no significant difference in female perception between the two anthropomorphic images as well ( $M_{cool} = 3.667$  vs.  $M_{cute} = 4.063$ ;  $t = 1.868$ ,  $p = 0.072 > 0.05$ ). Therefore, these materials could be used in Study 2.

## Experimental Design and Subjects

Study 2a recruited participants through the online questionnaire platform Credamo by offering cash rewards. Product selection scenarios were used to measure the willingness of the participants to buy green products. In study 2a, 69 valid questionnaires were received (men, 47.8%; women, 52.2%,  $M_{age} = 22.75$ ).

## Experimental Procedures

In study 2a, the participants were randomly assigned to one of the two groups: the altruistic advertising appeal group or the self-interested advertising appeal group. For the manipulation of brand anthropomorphic images, the participants were asked to imagine buying juice online and then encountered two advertisements about ecological juice from the northwest ecological orchard. The advertising contained the brand logos, which were the two anthropomorphic images tested in the pretest. More importantly, the product introduction in the advertisement was narrated in the first person to initiate perceptions of cute and cool. Besides, different advertising slogans were used to manipulate the type of advertising appeal (Kareklas et al., 2014; Yang et al., 2015). In the altruistic advertising appeal group, the content of advertising emphasized the contribution of the ecological orchards to control the harsh ecological environment, such as desert, while the self-interested advertising appeal group highlighted that the juice was organic, which is beneficial to the health of individuals. After viewing ads, the participants made a choice about which product they were more willing to buy. Then, the participants answered the manipulation test of the brand anthropomorphic image and the advertising appeal (the scales were the same as Study 1, only a little adjustment according to the context). Finally, the questionnaire measured the demographic variables of the participants, and the scales above were all seven points.

## Results

### Manipulation Check

In study 2a, the results of the  $t$ -test revealed that, in the self-interested advertising appeal group, the cool perception of the cool anthropomorphic image was significantly higher ( $M_{cool} = 5.159$  vs.  $M_{cute} = 3.047$ ;  $t = 14.835$ ,  $p < 0.001$ ,  $d = 5.165$ ). Likewise, the cute perception of the cute anthropomorphic image was significantly higher ( $M_{cute} = 5.226$  vs.  $M_{cool} = 2.971$ ;  $t = -12.548$ ,  $p < 0.001$ ,  $d = 4.369$ ). In the altruistic advertising appeal group, the results showed that the cool perception of the cool anthropomorphic image was higher ( $M_{cool} = 5.286$  vs.  $M_{cute} = 3.310$ ;  $t = 21.333$ ,  $p < 0.001$ ,  $d = 7.32$ ), and the cute perception of the cute anthropomorphic image was higher

( $M_{cute} = 5.324$  vs.  $M_{cool} = 3.267$ ;  $t = -18.602$ ,  $p < 0.001$ ,  $d = 6.38$ ), which indicated that the manipulation of the anthropomorphic image was successful. Next, the manipulation of the advertising appeal was tested. The results indicate that the perceived altruism of the altruistic advertising appeal group was significantly higher than that of the self-interested advertising appeal group ( $M_{altruistic} = 4.648$  vs.  $M_{self-interested} = 3.324$ ;  $t = -10.391$ ,  $p < 0.001$ ,  $d = 2.539$ ), and the perceived self-interested of self-interested advertising appeal group was significantly higher than that of the altruistic advertising appeal group ( $M_{self-interested} = 4.647$  vs.  $M_{altruistic} = 3.420$ ;  $t = 10.206$ ,  $p < 0.001$ ,  $d = 2.494$ ). The advertisement appeal in Study 2a was successfully manipulated.

### Hypothesis Test of Interaction Effect

For Study 2a, 20 of the 34 participants in the self-interest advertising appeal group chose the product of the cool brand anthropomorphic image, accounting for 58.8%, and 14 participants chose the product of the cute brand anthropomorphic image, accounting for 41.2%. In the altruistic advertising appeal group, 12 (34.3%) of the 35 participants were willing to choose products with the cool brand anthropomorphic image; the rest of the participants chose the product with the cute brand anthropomorphic image. Chi-square test results showed that the preference for the product with cute or cool anthropomorphic images between the two groups was significant ( $\chi^2 = 4.176$ ,  $p = 0.041 < 0.05$ ). Specifically, the altruistic advertising appeals group was more likely to choose products with a cute brand anthropomorphic image, while the selfish advertising appeals group preferred to choose products with a cool brand anthropomorphic image. Study 2a proved H1a and H1b again.

## STUDY 2b. THE MEDIATING ROLE OF BRAND TRUST

The main purpose of Study 2b was to test the mediating role of perceived brand trust (goodwill trust and capacity trust) providing ways of explaining the results of Study 1.

### Experimental Design and Subjects

Study 2b recruited participants through the online questionnaire platform Credamo by offering cash rewards and 107 valid questionnaires were received in Study 2b (48.6% men, 51.40% women,  $M_{age} = 23.15$ ).

### Experimental Procedures

A between-subject design of 2 (brand anthropomorphic images: cute vs. cool)  $\times$  2 (advertising appeals: altruistic vs. self-interested) was used in Study 2b, and the participants were randomly assigned to one of the four groups. The experimental conditions and variable manipulation methods were the same as those used in Study 2a on the whole. The difference was that, after watching the advertisement, the participants would complete the following five parts rather than making a choice about the products: the purchase intention of green products, manipulation

test of brand anthropomorphic image and advertising appeal, brand familiarity, and perceived brand trust. The demographic variables were measured at the end as before. All variables except perceived brand trust were measured by the scales used in Study 1 (adjusted only slightly according to the context). This study drew on the trust scale proposed by Mayer and Davis (1999) to measure brand capacity trust (five items: the brand is capable of producing the product very much/is aware of its product very much/can always achieve its goals/has considerable professional competence/is particularly good at improving consumer health,  $\alpha = 0.926$ ) and brand goodwill trust (five items: the brand is attentive to others/thinks the needs and expectations of others are important/never intentionally damages the interests of others/thinks it is important to really care for others/will make every effort to help others,  $\alpha = 0.916$ ).

## Results

### Manipulation Check

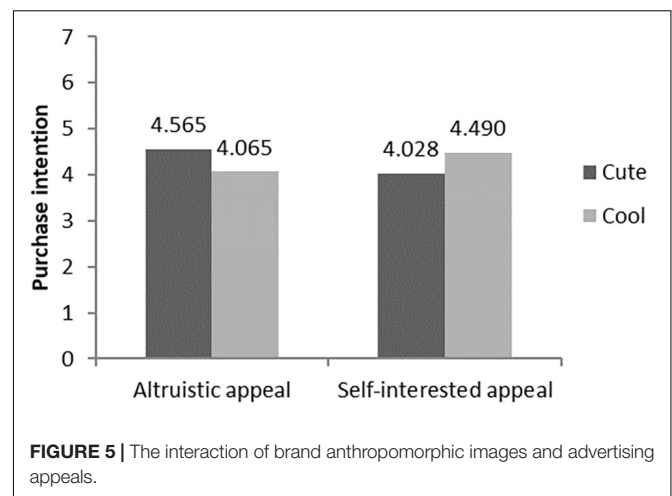
In Study 2b, the cool perception of the cool anthropomorphic image was higher ( $M_{\text{cool}} = 4.513$  vs.  $M_{\text{cute}} = 3.496$ ;  $t = 10.314$ ,  $p < 0.001$ ,  $d = 2.013$ ). Also, the cute perception of the cute anthropomorphic image was higher ( $M_{\text{cute}} = 4.636$  vs.  $M_{\text{cool}} = 3.264$ ;  $t = -12.092$ ,  $p < 0.001$ ,  $d = 2.36$ ). The anthropomorphic image in Study 2b was successfully manipulated. As for advertising appeals, the perceived altruism of the altruistic advertising appeal group was significantly higher ( $M_{\text{altruistic}} = 4.482$  vs.  $M_{\text{self-interested}} = 3.447$ ;  $t = -9.418$ ,  $p < 0.001$ ,  $d = 1.838$ ), and the perceived self-interest of self-interested advertising appeal group was significantly higher ( $M_{\text{self-interested}} = 4.465$  vs.  $M_{\text{altruistic}} = 3.407$ ;  $t = 11.091$ ,  $p < 0.001$ ,  $d = 2.165$ ). This suggested that the manipulation of advertising appeals in Study 2b was successful.

### Hypothesis Test of Interaction Effect

For Study 2b, two-factor ANOVA found that advertising appeals and brand anthropomorphic images had a significant interaction effect on the purchasing intention of green products ( $F = 54.306$ ,  $p < 0.001$ ,  $\eta^2 = 0.345$ , see **Figure 5**). Further analysis indicated that, in the altruistic advertising condition, the participants were more willing to buy green products with the cute brand anthropomorphic image ( $M_{\text{cute}} = 4.565$  vs.  $M_{\text{cool}} = 4.065$ ;  $F = 24.848$ ,  $p < 0.001$ ); when it came to self-interested advertising appeals, the participants had higher willingness to buy green products with the cool anthropomorphic brand image ( $M_{\text{cool}} = 4.490$  vs.  $M_{\text{cute}} = 4.028$ ;  $F = 29.585$ ,  $p < 0.001$ ). Then, we added brand familiarity for covariance analysis. It revealed that the interaction between the advertising appeals and the brand anthropomorphic image on the purchase intention of green products is significant as before ( $F = 53.629$ ,  $p < 0.001$ ,  $\eta^2 = 0.345$ ). Therefore, H1, H1a, and H1b were supported again in Study 2b.

## The Mediation Analysis of Brand Capacity Trust and Brand Goodwill Trust

Next, we examined the role of brand capacity trust and brand goodwill trust in explaining the observed interaction. First, a



mediation analysis with 5,000 bootstrap samples (model 8) with the brand anthropomorphic image as the independent variable, advertising appeal as the moderator, brand capacity trust as the mediator, and purchase intention of green products as the dependent variable was conducted to test H2a (Preacher et al., 2007). The result revealed a significant mediating effect of brand capacity trust when the advertising appeal is self-interested [ $\beta = -0.309$ , 95% CI (-0.499, -0.148)]. However, the mediating effect of brand capacity trust was no longer significant once the advertising appeal was altruistic [ $\beta = -0.009$ , 95% CI (-0.100, 0.092)]. Therefore, H2a was supported. Similarly, we used the same approach to examine the mediating role of brand goodwill trust; conditional indirect effects supported our predictions: When the advertising appeal was altruistic, the mediating effect of brand goodwill trust was significant [ $\beta = -0.112$ , 95% CI (0.005, 0.250)]. However, when the advertising appeal was self-interested, the indirect effect was not significant anymore [ $\beta = -0.013$ , 95% CI (-0.013, 0.118)], indicating that H2b was supported.

## Discussion

Study 2 modified the stimulus material to increase the validity and applicability of experimental findings. Under different product types (ecological juice) purchase scenarios, the matching effect of brand anthropomorphic images and advertising appeals was demonstrated again through two sub-experiments in Study 2. Moreover, Study 2 further investigated the underlying mechanism of the matching effect. Study 2b particularly confirmed the mediating role of brand trust in the matching effect. Specifically, brand capacity trust mediated the interaction of the cool brand anthropomorphic image and self-interest advertising appeals on the purchase intention of green products of consumers, whereas brand goodwill trust mediated the interaction of cute brand anthropomorphic image and altruistic advertising appeals on the purchase intention of green products of consumers.

## CONCLUSION AND DISCUSSION

### Conclusions

The current research advances our understanding of how brand anthropomorphic images (cute/cool) and advertising appeals (self-interested/altruistic) affect the purchase intention of green products of consumers. Across two experiments, we found that there was a matching effect between brand anthropomorphic images and advertising appeals. To be specific, when using self-interested advertising appeals, consumers prefer green products with a cool anthropomorphic image. When it comes to altruistic advertising appeals, consumers are more inclined to purchase green products with a cute anthropomorphic image. Furthermore, we repeated the effect found in Study 1 under different experimental contexts and explored the potential mechanism of the matching effect by examining the mediating roles of brand capacity trust and brand goodwill trust as well. For self-interested advertising appeals, the cool anthropomorphic image of the brand (vs. cute) can lead to higher brand capacity trust, thus stimulating higher purchase intention of green products. As for altruistic advertising appeals, the cool anthropomorphic image of the brand (vs. cute) can result in higher brand goodwill and trust in ways of improving the willingness of consumers to buy green products.

### Theoretical Implication

The current research provides several theoretical implications. First, this research enriches the literature on anthropomorphism in the field of green consumption. At present, studies have investigated the impact of anthropomorphism on the beneficiaries of green consumption behavior (such as earth, nature, forest, animals, etc.) on environmental protection behavior, including green consumption behavior. Few studies have focused on how anthropomorphic products or brands affect the willingness to buy green products. Recent research on green products has hinted at the possibility that different anthropomorphic images may play different roles in product purchase and other consumption behaviors (Puzakova et al., 2013; Puzakova and Kwak, 2017; Reavey et al., 2018). In the field of environmental protection and green consumer behavior, more studies examined the impact of the existence or absence of anthropomorphic on green consumer behavior (Tam et al., 2013; Ahn et al., 2014; Williams et al., 2015; Han et al., 2019; Zhu et al., 2019). However, the literature about the effect that different types of anthropomorphic images have different effects on green consumption behavior is still limited. This study mainly discusses the impact of two different brand anthropomorphic images on green consumption, focusing on the anthropomorphism of the green product brand itself rather than the beneficiaries of green consumption (nature, earth, etc.). Specifically, the current research presents an effect of the cute and cool brand anthropomorphic images on the purchase intention of green products under different types of advertising appeal.

Secondly, this research contributes to the literature of purchasing decisions of green consumption. Same as the general consumption behavior, the green consumption behavior includes the following stages as well: generating needs, collecting

information, evaluating plans, making decisions on purchase, and post-purchase behavior. Previous studies mostly concentrated on post-purchase behaviors of green consumption, such as disposal and recycling (Tam et al., 2013; Ahn et al., 2014; Han et al., 2019; Ketron and Naletelich, 2019), which are different from the purchasing behaviors of green products concerned in this paper. The current study extends research on green consumption by moving the focus to the stage of making a purchase decision. Purchasing green products is a kind of prosocial behavior in terms of the self-interest attribute and altruistic attribute simultaneously existing in the green products (Mazar and Zhong, 2010). In view of this, consumers tend to trade-off between self-interest and altruistic attributes of green products, which are clearly influenced by marketing context factors, such as anthropomorphism. Therefore, it is worth discussing what effect anthropomorphic factors will have on the specific behaviors of green product purchases. Thus, this research particularly explored how the anthropomorphic image of a brand and advertising appeals promote consumers to make purchasing decisions of green products.

Thirdly, this paper extends the research of different types of anthropomorphism for the field of marketing. A study about anthropomorphism has divided brand anthropomorphism into two types: warmth and competence according to the stereotype model (Aaker et al., 2010). If consumers consider the efficacy of products, the competent brand anthropomorphic image would make consumers have a better evaluation and purchase intention, while the warm brand anthropomorphic image was preferred when consumers had strong attribution needs (Aaker et al., 2010). The research that divided brand anthropomorphic images into partner and servant found that consumers have different image preferences and interaction rules in different situations (P and L, 2012; Alvarez and Fournier, 2016). The current research divided the brand anthropomorphic image into cool and cute and further found that these two types of the anthropomorphic image can play a better role in the marketing and promotion of green products only when they match appropriate advertising appeals.

Finally, this research also enriches the literature on the influencing factors of green consumption behavior. Previous pieces of research on green consumption focused on how to reduce or even eliminate the attitudes and behavior inconsistency of consumers in green consumption behavior through their internal and external factors. Internal factors include positive or negative emotions (Young et al., 2009; Kanchanapibul et al., 2014), degree of environmental concern of consumers (Wang et al., 2014; Zhao et al., 2014), consumer values (Young et al., 2009; Chen and Lobo, 2012; Eze and Ndubisi, 2013; Wang et al., 2014), external factors, such as advertising messages (Sheehan and Atkinson, 2012; Kareklas et al., 2014), advertising appeals (Green and Peloza, 2014; Yang et al., 2015), and product type (Luchs et al., 2010). Recent research on green consumption has hinted at the possibility that brand-attributes products, such as brand-perceived value, brand trust, and brand awareness, may have a positive influence on the purchase intention of consumers (Rahbar and Abdul Wahid, 2011; Zabadi et al., 2016; Ranjan and Kushwaha, 2017). Different from these studies, we mainly investigated the influence of brand anthropomorphism as a marketing communication element on green consumption.

Specifically, this research examines the impact of matching different types of brand anthropomorphic images with other approaches of communication (advertising appeal) on green consumption. Therefore, in terms of exploring the relationship between brand attributes and purchasing intention of green products, the content of this research can provide some new inspirations.

## Practical Implication

This study also provides some enlightenment for the practice of green marketing. First of all, the current research provides more choices for the brand image design of enterprises producing green products. In addition to the common competence (vs. warmth) and servant (vs. partner) anthropomorphic image categories, enterprises can also choose to adopt the cool brand anthropomorphic image or the cute brand anthropomorphic image according to their own needs to improve the purchase intention of consumers.

Secondly, in the green marketing promotion, when enterprises use the cool or cute brand anthropomorphic image to attract the attention of consumers, they also need to pay attention to the correct combination of brand images and advertising appeals to achieve a better marketing communication effect. If an enterprise adopts a cute brand anthropomorphic image, it can highlight more altruistic aspects of green products in the design of advertising appeals, improve the goodwill trust of consumers in the brand to achieve a better promotion effect. And if the enterprise chooses to show the cool brand anthropomorphic image, then, in the design of advertisement appeal, it can highlight more self-interested aspects of green products and improve the capacity trust of consumers in the brand, which can also make the promotion effect better.

Finally, this research is of great significance for those green product enterprises whose environmental protection propositions are questioned by consumers to enhance brand trust. Studies have found that even consumers with a high degree of environmental concern are hesitant to buy green products because they tend to doubt the authenticity of green claims of enterprises (Nittala, 2014). According to the influence of information fluency on perceived authenticity, the better the information fluency, the more likely consumers are to believe the authenticity of the information, the lower the perceived risk, and the greater the brand trust. On the contrary, consumers will doubt the authenticity of information and have a low level of brand trust, which will hinder the occurrence of purchasing behaviors (Reber et al., 1998; Lau and Lee, 1999). Therefore, enterprises whose environmental protection claims are questioned can consider improving the matching degree between advertising claims and the brand image in the marketing communication to enhance brand trust. For example, combining with altruistic advertising appeals when choosing a cute brand anthropomorphic image can effectively improve brand goodwill trust of consumers to reduce doubts of consumers about the environmental protection propositions of enterprises.

## Limitation and Future Research Direction

There are still some limitations in this research. First of all, the context factors of green consumption are complex; some

of them may influence the results but are not taken into account. For example, from the perspective of an individual, environmental protection concepts, values, self-construction, and other personal factors of consumers may be added to this study as moderator variables. Some external factors, such as communication, advertising framework, the level of specificity of advertising (vs. abstraction), the type of product (self-interest vs. altruism, pleasure vs. utility, durable vs. expendable), and even the price level of the product may also play a moderating role, which could be explored in future research.

Second, the mediation mechanism can be further demonstrated. Due to the space limitation of this paper, only brand trust is selected as the mediating variable in the research process, but there may be other intermediaries, such as the concern of consumers for the environment. Thus, we can test whether there are other mediation mechanisms in research and then provide corresponding insights for the further development of green consumption.

Lastly, whether there are different influences on green consumption between other anthropomorphic types and the anthropomorphic images of current research remains to be investigated. This research did not compare the two brand anthropomorphic images of competence and warmth with the two types of brand anthropomorphic images proposed, but it is noteworthy that they are similar to a certain extent. It is expected that warmth (the degree of cuteness is low, but consumers can still perceive warmth) may not have such a strong effect. Even matching altruistic advertising appeals may not easily lead to a stronger perception fluency of consumers, thus leading to higher brand trust; whereas the effect of the competent brand anthropomorphic image may be similar to the cool brand anthropomorphic image. These all need to be verified by future research.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethics Committee of the School of Management, Jinan University, China. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

SY and YLu conceived and designed the experiments. SY and YLi carried out the experiments, analyzed the experimental results,



and wrote the manuscript. LT edited the manuscript. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.599385/full#supplementary-material>

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# Environmental Concern Priming and Social Acceptance of Sustainable Technologies: The Case of Decentralized Wastewater Treatment Systems

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According to a report by the World Economic Forum, the water crisis is the fourth most serious global risk to society. The apparent limitations of the hydraulic paradigm to solving this crisis are leading to a change in water management approaches. Recently, decentralized wastewater treatment systems have re-emerged as a partial solution to this problem. However, to implement these systems successfully, it is necessary not only to design this technology but also to have social support and willingness among citizens to use it. Previous studies have shown that these technologies are often perceived as being too costly, and people often do not consider the need for adopting them. However, it has also been pointed out that thinking about these technologies as a sustainable endeavor to reduce human impact on the environment can help to overcome the barriers to usage. Thus, we test whether priming environmental concerns before presenting information about decentralized wastewater treatment plants will increase acceptance of those technologies. In this study, we test whether priming environmental concerns can enhance the acceptance of decentralized wastewater treatment plants even when presenting disadvantages of the technology. In order to do so, we designed an experimental study with a sample of 287 people (85.7% women,  $M_{age} = 20, 28$ ). The experimental design was 2 (priming the environmental concern vs. no priming)  $\times$  2 (type of information: only advantages vs. advantages and disadvantages). The results showed that those in the environmental concern priming condition had more positive attitudes and behavioral intentions toward decentralized wastewater treatment plants than those in the control condition group. Participants who received only advantages information had a more positive perception toward the decentralized wastewater systems than in the condition, where disadvantages were present, but in the priming condition this difference was not significant. This implies that priming environmental concern helps to overcome the possible disadvantages that act as barriers to acceptance.

**Keywords:** environmental concern priming, type of information, social acceptance, sustainable technologies, decentralized wastewater treatment plants, water problems



## INTRODUCTION

According to the World Economic Forum (2020), the water crisis is one of the top five global problems. The water crisis is related to both the scarcity of this resource and its quality due to pollution and eutrophication (Ganoulis, 2009; World Water Assessment Programme, 2020). Solving this crisis depends partly on changing people's behavior. Various campaigns have tried to reduce water consumption and make the population aware of the limited nature of this resource (Syme et al., 2000; Katz et al., 2016). However, the demand for water continues to increase. For this reason, the United Nations warns that there is an urgent need to address the crucial challenges caused by water stress, since current water management is failing to respond to this problem (Cosgrove and Loucks, 2015; Seemha and Ganesapillai, 2017).

An alternative approach to address this crisis is to use technologies that facilitate the reuse of water (Fielding et al., 2018) and better use of the nutrients in wastewater, thus preventing untreated waste from causing the deterioration of freshwater resources (Lam et al., 2020). One such technology is decentralized wastewater treatment plants. This technology challenges the current approach to disposing of waste far from home; it involves local treatment of wastewater (in buildings, neighborhoods, or small communities), favoring the local recovery of water and nutrients for new uses, thus promoting the circular economy (Lens et al., 2005; Roefs et al., 2017).

Nevertheless, despite the advantages of decentralized plants, they can also result in installation, maintenance, and location-based costs (Mankad and Tapsuwan, 2011). Therefore, people may be reluctant to install this type of technology unless advantages over the current centralized system are apparent. In other words, the traditional resistance to change (Petty et al., 2003) could be present in this case. Some may have a reactive response to a technology that is unfamiliar, externally imposed, and may have unclear implications from their perspectives. This is especially prevalent in places where water issues, and environmental sustainability more generally, are not perceived as a problem (Gómez-Román et al., 2020).

Given this situation, providing information to citizens can improve acceptance of these technologies (Mankad and Tapsuwan, 2011; Mankad, 2012). However, what kind of information will have the most impact on social acceptance? To answer this question, there are two important things one must consider. On the one hand, what is the level of concern about the issue that this technology aims to solve? On the other hand, what kind of information should be offered to the public about the new technology?

### Environmental Concern

Decentralized plants serve as an alternative to an environmental problem: water stress. Therefore, a necessary – although not sufficient – condition for the acceptance of that technology is the existence of some public awareness or concern about environmental issues. If the public does not feel environmental issues are a problem, strategies to

solve the problem of water stress will receive little or no support.

In recent years, concern about environmental issues has grown significantly (Liu et al., 2014; Currie and Choma, 2018; Lewis et al., 2019). Environmental policymaking has become part of the agenda of nearly all political bodies around the world (Krosnick et al., 2006; Fairbrother, 2017), and it is also a subject on which there is broad social consensus (Steg and Vlek, 2009; Eurobarometer, 2019). All of these favor the acceptance of environmental sustainability and circular economy policies. Studies on the perception of environmental risk clearly show how concern for the environment is one of the antecedents of pro-environmental attitudes and behaviors (O'Connor et al., 1999, 2002; Heath and Gifford, 2006; Hidalgo and Pisano, 2010).

In accordance with the above, the activation and accessibility of the environmental issue, insofar as it evokes the problems in this area, could translate into attitudes, emotions and behaviors more favorable to decentralized plants; that is, in a greater acceptance of this technology. This leads us the concept of priming. Studies on priming analyze how exposure to prior information affects a subsequent decision or behavior (Jonas and Sassenberg, 2006; Custers and Aarts, 2010). So, according to this, making accessible or priming the environmental concern could make more accessible information that already exists in memory or associated processes (the environmental problem), so that it becomes salient in subsequent decision-making (Kay et al., 2004; Scheufele and Tewksbury, 2007), in this case being more favorable to accept decentralized plants.

Nevertheless, in addition to concern for the environment, which in this case would be activated through priming, there are other possible factors involved in the acceptance of decentralized wastewater treatment plants. Among them, the cost-benefit calculation is of importance; here, it includes not only economic issues but also elements such as loss of comfort or aspects related to technology maintenance (Mankad and Tapsuwan, 2011).

### Information About Technology: Focusing Only on the Positive?

As discussed previously, providing the population with information assists in overcoming barriers to acceptance (Mankad and Tapsuwan, 2011; Fielding et al., 2018), especially in places where public opinion has not yet been able to form an impression about it (Jacoby, 2000). However, when presenting information to the public, one must take into account that several elements may influence (to a greater or lesser extent) the effect that information may have. One of these factors is related to the unilateral or bilateral nature of the arguments presented to the public. The first consists of expressing only the advantages and positive aspects, while the latter also includes weak or negative aspects of a technology.

There is mixed evidence on the efficacy of presenting unilateral or bilateral arguments (Allen, 1991). The effectiveness of including disadvantages in persuasive messaging is not entirely clear, especially when the public does not yet have an elaborate opinion on the subject under study (Rosenberg, 2001). Presenting positive messages while also discussing some

disadvantages or less positive elements improves source credibility, and the public may have more confidence in the veracity of such messaging (Crowley and Hoyer, 1994; Schlosser, 2011). Nevertheless, the persuasiveness of messaging will also depend on whether the disadvantages that are presented (and refuted) are relevant to the people receiving the message (O'Keefe, 1990). The effect may also be different depending on the recipient of the message. One-sided messages (unilateral) appear to be more effective when the audience is initially in favor of the message's content (Petty and Cacioppo, 1986). However, if the recipients are well-informed, two-way (bilateral) messages are more effective.

## Study Aims and Hypothesis

This exploratory study analyzes the influence that environmental concern priming and different types of messages (unilateral vs. bilateral) about decentralized plants have on the social acceptance of this sustainable technology. Our hypotheses are as follows:

*H<sub>1</sub>*: The activation of environmental concern priming will favor the acceptance of decentralized wastewater plants.

*H<sub>2</sub>*: Public perception of decentralized plants will be more positive when the information presented relates only to the plant's advantages.

*H<sub>3</sub>*: An interaction between priming and information will occur when messaging relates only to the plant's advantages or advantages and disadvantages. When environmental concern priming is not activated, public perception of the plants will be most negative when discussing the disadvantages (as opposed to the condition where only advantages are discussed). However, there will be no significant difference in technology acceptance between participants when the environmental concern priming is activated (irrespective of presentation of the advantages or both advantages and disadvantages).

## MATERIALS AND METHODS

### Participants and Design

Using GPower software (v 3.1.9.4), a power analysis was conducted to calculate the ideal sample needed for this study (Faul et al., 2009). In order to detect an effect size  $f^2(V) = 0.06$  with 95% power ( $\alpha = 0.05$ ), G\*Power suggests we would need 208 participants to carry MANOVA analysis. The aim was to recruit a group of participants larger than the ideal sample size in anticipation of potential missing responses or deficient data. Those who responded too quickly were automatically screened out. The sampling procedure resulted in a final sample of 287 students from the faculties of Psychology and Education at the University of Santiago de Compostela (Spain; 85.7% women, age = 20.28;  $SD = 2.19$ ).

The experimental design was 2 (priming the environmental concern vs. no priming)  $\times$  2 (type of information: only advantages

vs. advantages and disadvantages). All data and materials used in this research are publicly accessible at [osf.io/97v45](https://osf.io/97v45). No studies in this manuscript were preregistered.

## Procedure

Students were asked to participate in a research project that was taking place at the University. To participate, they were required to fill out a questionnaire using the Qualtrics platform on their mobile device or laptop. Participants were randomly assigned to each of the experimental conditions. Participants took an average of 13 min to complete the task.

Participants answered a questionnaire that consists of five parts: an introduction, a priming section (with two conditions), an information section (with two conditions), another information section with a series of questions about acceptance of the decentralized plant, and a final section relating to sociodemographic information and debriefing.

The introduction of the questionnaire includes an acknowledgement of their participation and asks participants to be honest in their responses. The introduction states that the Bioethics Committee of the University of Santiago de Compostela has approved the study, guaranteeing anonymity and data protection. Participants could interrupt or abandon their participation at any time if they wished. Before fulfilling the questionnaire, students were required to provide informed consent to participate in the research.

Once the students accepted the commitment, the program randomly assigned the participants to the different experimental conditions. First, participants were told that they would be asked a few questions from another ongoing research project, making additional use of their involvement. This opening allowed the opportunity to present priming information before presenting the decentralized plants information.

### Priming Conditions

Half of the participants were randomly assigned to one of two conditions: the environmental concern priming group or the control group. In the environmental concern priming group, participants were required to consider environmental problems before they were presented with information about the decentralized plant. To do this, participants answered two questions. First, they were asked to rank a series of environmental challenges by importance: climate change, water scarcity, air pollution, water pollution, deforestation, soil degradation, energy consumption, and waste. Next, participants had to rate the degree of importance of those environmental issues from 1 (none) to 9 (a lot).

In the control condition group, to keep the participants as cognitively active as those in the experimental group, participants were required to order a series of musical styles by affinity. They were then asked to indicate how much they like each of these musical styles, from 1 (none) and 9 (a lot).

### Information Conditions

In the next section, participants were shown a message that thanked them for their participation in the other investigation

and informed them that they were to answer the investigation questions for the second study. In this section, they were required to imagine that their faculty was developing a project to install a plant to treat wastewater in the faculty's basement. Participants were provided an explanation as to the plant's functioning. Then, participants received a set of randomized information. Half of the participants read information about the plant that presented its advantages, while the other half read information about the advantages and the possible disadvantages of the plant (see the **Annex** for complete information).

Next, all participants were required to answer the substantive questions. The purpose of these questions was to determine whether the acceptance of a decentralized wastewater treatment plant differed among the participants after they were randomly exposed to priming and the information presented.

To finalize the questionnaire, participants answered one block of sociodemographic questions. They were then shown a goodbye message, again thanking them for their participation. Participants read that this was a hypothetical situation for research purposes; their faculty would not install a decentralized wastewater treatment plant. Participants could provide their email to obtain a report with the results of the investigation. Furthermore, they were also provided a contact email if they wanted to report, solve, or discuss any issue about the research project.

## Measures

We used several different types of measures to determine the level of acceptance of decentralized plants: attitudes, strength of attitudes, emotions, and behavioral intention.

### Attitudes Toward Decentralized Plants

Participants were required to answer on a 9-point semantic differential scale (1 = nothing and 9 = a lot) to what extent they thought that the faculty's decentralized plant project was: "very bad-very good," "I do not like it at all-I like it very much," "very negative-very positive," "very unnecessary-very necessary," "very useless-very useful," "very unacceptable-very acceptable," "very inappropriate-very appropriate," or "extremely harmful-extremely beneficial" ( $\alpha = 0.91$ ).

### Strength of Attitudes

Participants assessed their opinions about the installation of the plant in the faculty. On a 9-point semantic differential scale (1 = nothing and 9 = a lot), they had to answer additional questions about their previous answers including how convinced they were about their opinions, how confident they were in their answers, the relevance of their answers, and how easily they would change their opinion in a discussion ( $\alpha = 0.87$ ).

### Emotions

Participants responded to what extent thinking about the installation of the plant in the faculty makes them feel a number of emotions (1 = nothing and 9 = a lot): worried, disgusted, angry, fearful, helpless (negative emotions,  $\alpha = 0.78$ ), relieved, proud, optimistic, enthusiastic, and comfortable (positive emotions,  $\alpha = 0.84$ ).

## Behavioral Intention

Participants indicated their degree of agreement (1 = no agreement and 9 = totally agree) with the following statements: they would support the installation of the plant in the faculty, they would campaign in favor of the installation of the plant in the faculty, they would recommend that these plants be installed in other buildings of the University and the city, and they would install a plant in their building or house ( $\alpha = 0.88$ ).

## Priming Control

In order to draw valid conclusions, participants should not identify the connection between the priming task and the subsequent task (Bargh, 2006). In this study, participants had to answer an open question asking them what they believed the objective of the research is.

## RESULTS

In the open response question, none of the participants identified the relationship between both tasks. Participants referred to questions about "assessing/checking the degree of acceptance of the technology presented," "how people perceive a new technology after presenting information about it," and "assessing opinions that can be controversial anonymously." No one referred to the effect that the questionnaire's first task had on the second part of the questionnaire, demonstrating that they were not aware of the priming task.

After verifying that the participants were not aware of the experiment's manipulation, we analyzed the effect that environmental concern priming had on the acceptance of decentralized plants. Specifically, we considered how the inclusion or exclusion of information about plant disadvantages influenced the participants' perceptions. **Table 1** shows the MANOVA results for each of the variables under study in each of the conditions.

As one can see in **Table 1**, the effect of priming is significant. Having participants think about environmental issues before being presented the information about decentralized plants affected their level of acceptance. Thus, those participants who received the environmental concern priming obtained significantly higher scores than the control group in the measures: attitudes ( $F = 8.10$ ,  $p = 0.005$ ,  $\eta^2 = 0.028$ ), strength of attitudes ( $F = 9.97$ ,  $p = 0.002$ ,  $\eta^2 = 0.034$ ), behavioral intention ( $F = 6.32$ ,  $p = 0.013$ ,  $\eta^2 = 0.022$ ), and positive emotions ( $F = 8.14$ ,  $p = 0.005$ ,  $\eta^2 = 0.028$ ). There were no significant differences between the control group and the experimental group regarding negative emotions ( $F = 0.73$ ,  $p = 0.394$ ,  $\eta^2 = 0.003$ ).

Regarding the informative content of the message, presenting the advantages and disadvantages of the plant produced attitudes that were significantly more negative than those who only received information about the advantages ( $F = 7.27$ ,  $p = 0.007$ ,  $\eta^2 = 0.025$ ). Those who read information about disadvantages experienced slightly stronger negative emotions than those who read only advantages ( $F = 5.33$ ,  $p = 0.022$ ,  $\eta^2 = 0.019$ ). However, reporting advantages and disadvantages did not create significant

**TABLE 1** | MANOVA results.

Condition	Variables	Condition level	<i>M</i>	<i>SD</i>	<i>F</i>	Sig.	$\eta^2$
Priming	Attitudes	Control	7.19	1.13	8.10	0.005**	0.028
		Environmental	7.48	1.07			
	Attitudes strength	Control	6.06	1.54	9.97	0.002**	0.034
		Environmental	6.64	1.55			
	Behavioral intention	Control	7.09	1.44	6.32	0.013**	0.022
		Environmental	7.50	1.32			
	Positive emotions	Control	6.06	1.34	8.14	0.005**	0.028
		Environmental	6.53	1.43			
	Negative emotions	Control	3.02	1.41	0.73	0.394	0.003
		Environmental	2.87	1.47			
	Attitudes	Advantages	7.54	1.10	7.27	0.007**	0.025
		Advantages + disadvantages	7.19	1.10			
Information	Attitudes strength	Advantages	6.41	1.55	0.29	0.589	0.001
		Advantages + disadvantages	6.30	1.60			
	Behavioral intention	Advantages	7.45	1.40	3.53	0.061	0.013
		Advantages + disadvantages	7.14	1.38			
	Positive emotions	Advantages	6.25	1.53	0.44	0.501	0.002
		Advantages + disadvantages	6.36	1.26			
	Negative emotions	Advantages	2.75	1.37	5.33	0.022*	0.019
		Advantages + disadvantages	3.15	1.49			
	Attitudes	Control	7.46	1.08	2.91	0.089	0.010
		Advantages	6.90	1.12			
		Advantages + disadvantages	7.61	1.11			
		Environmental	7.48	1.02			
	Strength of attitudes	Control	6.08	1.61	0.090	0.764	0.001
		Advantages	6.04	1.48			
		Advantages + disadvantages	6.72	1.43			
		Environmental	6.56	1.68			
Priming x information	Behavioral intention	Control	7.27	1.44	0.105	0.746	0.001
		Advantages	6.91	1.44			
		Advantages + disadvantages	7.63	1.34			
		Environmental	7.37	1.28			
	Positive emotions	Control	6.05	1.53	0.294	0.588	0.001
		Advantages	6.07	1.12			
		Advantages + disadvantages	6.43	1.51			
		Environmental	6.63	1.33			
	Negative emotions	Control	2.92	1.42	1.17	0.280	0.004
		Advantages	3.13	1.41			
		Advantages + disadvantages	2.59	1.30			
		Environmental	3.17	1.57			

\*\* $p < 0.01$ ; \* $p < 0.05$ .

differences in the strength of attitudes ( $F = 0.29$ ,  $p = 0.589$ ,  $\eta^2 = 0.001$ ), behavioral intention ( $F = 3.53$ ,  $p = 0.061$ ,  $\eta^2 = 0.013$ ), or positive emotions measures ( $F = 0.44$ ,  $p = 0.501$ ,  $\eta^2 = 0.002$ ).

The interaction of the two conditions (i.e., the priming task and type of information) was not significant for any of the variables under study.

## DISCUSSION

Decentralized wastewater treatment plants allow recovery and reuse of water and nutrients from wastewater, promoting the circular economy (Lens et al., 2005; Roefs et al., 2017). Although this technology may be a possible solution to the global water crisis, the truth is that implementation of the technology depends on having social acceptance (Mankad, 2012; Gómez-Román et al., 2020).

Although numerous studies have shown that providing information is a facilitating factor for acceptance (Mankad and Tapsuwan, 2011; Rolland et al., 2020), the way such information is presented is not a trivial question. It can have decisive consequences for the development of public opinion (Valentin and Bogus, 2015). How that message is presented is key to gaining broad consensus (Wiest et al., 2015). Consequently, the communication processes in the formation of interpretive frameworks on this technology are critical, especially when public opinion on this technology is not yet clear.

In this study, our goal was to determine whether asking people to think about environmental problems (through environmental concern priming) before presenting information about decentralized wastewater treatment plants influences their acceptance of the technology. Moreover, we wanted to test whether including bilateral arguments about the technology's disadvantages influenced the degree of acceptance.



The results partially confirm the hypotheses of this study. As expected, those who think about environmental problems before receiving the information about plants had a more positive perception of the technology. However, the effect of presenting unilateral or bilateral arguments is less clear. Mentioning only the plants' advantages led to more positive attitudes and fewer negative emotions relating to these technologies, but there were no significant differences in the rest of the acceptance indicators. Although the trend in the acceptance indicators, strength of attitudes, and behavioral intention were similar, those who received arguments only about the advantages had a more positive perception of the technology. That being said, the difference was not significant compared to those who received information about both the advantages and disadvantages.

Even though the priming and information interaction was not significant, acceptance was more favorable even where the disadvantages were presented so long as participants were primed through questions about environmental concern. As expected, environmental concern priming reduced differences in acceptance between those who received information about advantages only and those who received information about both the advantages and disadvantages. Therefore, activating environmental concern improved participants' perception of information about decentralized wastewater treatment plants, even when the technology's disadvantages were explicitly presented.

Considering that this is an exploratory study, these results need to be considered cautiously, and they are only an initial approximation. Firstly, because of the sample, the study relied on university students as participants to test this exploratory hypothesis. Now there is a need to replicate these results in a more general population sample, also in different contexts. Secondly, because the effect sizes were relatively small, so future studies should replicate these findings to make stronger statements about the trend of this exploratory study. Although the effect sizes found were modest, this research provides encouraging evidence for its value as an explanatory mechanism to launch communication campaigns and catalyze other research studies with larger samples. The purpose of this research implies that it is necessary to examine public opinion about an issue that is not yet up for debate on the public agenda. It is necessary to consider carefully how we present the information even in the control condition. The first impression on a new topic establishes the framework from which one will process the rest of the information on that issue (Wilson et al., 1989, 2000), so it is necessary to be cautious when launching a broader population study. Moreover, when doing so, researchers must use "debriefing" strategies to avoid unleashing a possible social debate on the topic that is not yet on the public agenda.

The results of this study indicate that, although the unilateral condition pertaining to advantages with environmental priming shows the most promising results, there were no significant differences between the unilateral and bilateral information scores in the condition of environmental concern priming. In both cases, results were very positive. One can thus conclude that environmental concern priming is a necessary element

in improving social acceptance of decentralized wastewater treatment plants. However, it is not as straightforward if the type of arguments presented (i.e., only advantages or also the disadvantages of the technology) play a role. Perhaps the key question is not the type of arguments that are presented, but who provides the arguments (depending on the trust or credibility given to the source). Alternatively, audience characteristics may be critical. Therefore, these questions should be explored (and even combined) to determine which elements are critical when encouraging acceptance of these technologies.

This study is a first step to demonstrate experimentally that acceptance of decentralized wastewater treatment plants depends not only on reporting the qualities of this technology but also on providing the information within the context of global environmental problems.

## DATA AVAILABILITY STATEMENT

All data and materials used in this research are publicly accessible at [osf.io/97v45](https://osf.io/97v45).

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Bioethics Committee of the University of Santiago de Compostela. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

J-MS: funding. CG-R, J-MS, and MA: conceptualization and methodology. CG-R and J-MS: writing original draft, review, and editing. MA and BM: writing – review and editing. All authors contributed to the article and approved the submitted version.

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## ANNEX

### Information about decentralized wastewater treatment plants (advantages and disadvantages)

Imagine that the Faculty has a project to install a plant to treat the wastewater in the Faculty's basement.

Until now, the wastewater from the Faculty and the rest of the buildings and houses in Santiago are channeled through the sewerage networks to the centralized treatment plant in Silvouta, just over 6km from the city center.

The Faculty is proposing treating *in situ* the wastewater in the building. That is, the different types of water: gray (from the sinks) and black (from the toilets) that are generated in the Faculty would be collected separately and once treated and purified in the basement floor, used for different uses, such as filling cisterns or watering green areas.

That would save a large amount of drinking water. Each time the cistern is flushed, 8–10 liters of drinking water are used. Considering the number of people who work/study at the Faculty, that would mean saving about 19,200 liters of drinking water every day.

Another advantage is that this plant would recover the phosphorus in the wastewater and use it as fertilizer. Phosphorous is a rare mineral, which is why it has become a strategic priority for food production.

Nevertheless, that plant also has some drawbacks. One of them is that every now and then, and due to failure, it can produce unpleasant odors.

Its installation would also entail a significant economic cost that the Faculty would have to be borne to build a new pipes system that would separate the gray water from the black, to build the plant, and to maintain it.





# Disruptive Communication as a Means to Engage Children in Solving Environmental Challenges: A Case Study on Plastic Pollution

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Environmental degradation and how we care for our planet are some of the greatest challenges the world is up against at this moment. These challenges have received increased focus in both, research and the public sphere. So far, most of this attention revolved around adult's attitudes and behavior. However, environmental engagement amongst the younger generation gains in popularity. Using plastic pollution as a case, this qualitative study aims to acquire insights into the mental models of children. We collected qualitative data during an innovative, structured workshop according to the "Nature In Your Face" (NIYF) framework. The approach challenges the assumption that the societal change can be achieved gradually, with non-invasive techniques. Instead, we explore the potential of disruption to push citizens out of their comfort zone, thereby making room for co-creation. The disruption was performed by confronting 36 fifth graders from a Norwegian primary school, with disturbing images of plastic contaminating their local shorelines. The data was obtained by using the workshop framework, combined with semi-structured group interviews. The interview data was analyzed by means of thematic analysis. We found that the disruptions triggered emotional reactions like anger and fear. With these emotions as a driving force, the first workshop step was introduced, the Framing of the problem. The next step, Twisting the problem, was reflected in the children developing their own, creative solutions and creatively engaged with them in groups. The last step, Using, was only touched upon in the workshop and is therefore beyond the scope of this paper. Our results indicate that there are three prominent themes reflecting how children discuss plastic pollution. The children talked about their (1) Emotions related to plastic pollution, (2) Attitudes related to plastic, and (3) Perceptions of plastic pollution. These themes were further subdivided into different types of emotions, characteristics of plastic as a material as well as perceptions on different locations of unnecessary plastic. Psychologically, the mechanisms underlying the identified themes were linked to eco-anxiety, denial, self-efficacy, and cognitive dissonance. We conclude that disruptive eco-visualization can create an emotional response amongst children, which can be transformed into co-creation of ideas.

**Keywords:** children, environmental communication, disruptive communication, plastic pollution, co-creation activities, human and environment

## INTRODUCTION

We are currently finding ourselves in what the UN General Assembly calls the “Decade of action and delivery for sustainable development” (United Nations General Assembly, 2019). At the same time, we are experiencing a global inertia to act on environmental challenges (Hornsey and Fielding, 2020). Calls get louder for local initiatives on city and community level, which are recognized in their critical role in implementing and realizing the Sustainable Development Goals (United Nations General Assembly, 2019).

So far, countless strategies have been developed attempting to carefully and gradually nudge people toward a more sustainable way of life. Most of these strategies aim to raise awareness, strengthen environmental attitudes or increase motivation for sustainable behaviors (Feola, 2015). Examples for these strategies are prompts, social marketing, nudging, foot-in-the-door, door-in-the-face or reward and punishment (Cialdini, 2009; McKenzie-Mohr et al., 2011; Klöckner, 2015). Unfortunately, these strategies only lead to slow change and are prone to fail because of hardwired routines, salient social norms, situational factors or other “dragons” of inaction (Gifford, 2011).

With less than 10 years to meet greenhouse gas emission targets, predictions that more plastic than fish will be in the ocean by 2050 (Ellen MacArthur Foundation, 2016) and alarming rates of biodiversity loss (Mace et al., 2018), changes in our lifestyles are necessary immediately. We are currently facing a mismatch between the acknowledgment of environmental challenges and actual change processes to mitigate these challenges (Kollmuss and Agyeman, 2002; Fennis et al., 2011; Moser and Dilling, 2011; Sheeran and Webb, 2016). Immediate change can be elicited by disruptive forces which open windows of opportunity for change (Birkmann et al., 2010; Schäfer et al., 2012; Thomas et al., 2016; Verplanken and Roy, 2016). This disruptive force can manifest in many ways: natural disasters, dynamics in global leadership or diseases as we are currently experiencing with the COVID-19 pandemic (Ibn-Mohammed et al., 2020; Lambert et al., 2020; Shih, 2020). As a consequence people have to sharply adapt their way of life, and overcome habits, form new social norms and change behavior on a large scale. This change, however, is not necessarily in line with sustainable targets, often rather the opposite.

We believe that it is possible to artificially evoke disruption and thereby induce change processes. This is a novel approach and based on various strain of literature pointing toward the role of emotions as catalysts of action (Pooley and O'Connor, 2000; Salama and Aboukoura, 2018; Landmann and Rohmann, 2020) and the power of disruption as opportunity (or *window*) for change (Birkmann et al., 2010; Verplanken and Roy, 2016; Richter et al., 2021). The advantage of artificially induced disruption is, however, that we can channel the energy of change in a sustainable direction and thereby avoid the feeling of helplessness (Bamberg, 2002).

In this article we present an innovative approach, combining disruptive communication with creative engagement for sustainable change. We present qualitative data derived from a first pilot study trialing this approach. We then evaluate success

and discuss potential modifications of the method before we conclude with future directions and implications.

## Power of Eco-Visualizations

In environmental communication, the use of visuals is one of the core recommendations (Nicholson-Cole, 2005; Sheppard, 2012; Moser, 2014; Corner et al., 2015; Klöckner, 2015) as it refers to the human preference of visual information processing. Visuals steer our attention, trigger strong emotions as compared to textual information (Gardner and Stern, 1996; E. A. Holmes and Mathews, 2010), are fast to process and cost-effective to implement (Pahl et al., 2016). Zlatev et al. (2010) even claim that visualizations provoke our motivation by activating relevant goals.

Applying these afore mentioned principles for environmental conservation, eco-visualizations are traditionally used to raise awareness or knowledge around environmental problems such as climate change (Löfström and Pettersen, 2011) or sustainable management of local environments (Richter et al., under review)<sup>1</sup>. In most cases, eco-visualizations make the invisible visible (Pahl et al., 2016); they show resource use in real time or showcase the amount of melting sea ice during the last century (Holmes, 2009; Sheppard et al., 2011).

Eco-visualizations can occur in many different forms. To make sure they are successfully transmitting their message, it is important to always consider four aspects namely the technology with which they are expressed, the physical context and location, the social context including social media and their potential to shape the future (through political discourse or public debate) (Löfström, 2008; Löfström and Svanæs, 2017). Previous examples for eco-visualizations are the power aware cord (Gustafsson and Gyllenswärd, 2005; Löfström, 2007), the mobile application Ducky (Löfström and Svanæs, 2017), the art project “7,000 oaks and counting” (Holmes, 2009) or the Pollution Pods (Sommer et al., 2019).

## Role of Emotions in Environmental Behavior

The gap between acknowledging environmental problems and doing something about them could potentially arise from a lack of emotional involvement according to Roeser et al. (2012). Emotions are the drivers for advocacy behavior that can result from facing climate change information (Nabi et al., 2018) and they account for a large part of variance explaining environmentally relevant behavior, together with cognitions (Pooley and O'Connor, 2000). The downside of emotions as behavioral drivers is that they are only temporarily and lose their power to change long-established behaviors when they ebb off (Schwartz and Loewenstein, 2017). Channeling emotions into solution development or collective engagement can perpetuate the dynamic (Landmann and Rohmann, 2020).

<sup>1</sup>Richter, I., Pahl, S., Sumeldan, J., Gabe-Thomas, E., Avillanosa, A., and Creencia, L. (under review). Future scenarios as a tool to communicate sustainable development in coastal communities in Palawan, Philippines. *Front. Psychol. Environ. Psychol.*

So far, research has not found consensus if positive or negative emotions are more effective in facilitating climate action. Negative emotions like fear and anger can work as catalysts for climate action as long as the emotions are neither too weak, not too overwhelming (O'Neill and Nicholson-Cole, 2009) and as long as the communication contains an element that guarantees a sense of self-efficacy (Tannenbaum et al., 2015; Nabi et al., 2019). However, Schoenmaker (2020) did not find evidence for fear appeals to be effective, with or without coping appraisals. Positive emotions such as hope can increase acceptance of threatening information, facilitate strategy development and mobilize resources for adaptation (Das and Fennis, 2008). Especially when the threat is overwhelming as it is for many environmental challenges, hope can act as a motivational force and should be instilled (Ojala, 2012). Positive emotions might, however obscure the need for change and prevent people from becoming active. Combining fear and hope strategically (Nabi and Myrick, 2019), for example throughout a workshop format, and thereby creating an emotional flow (Nabi, 2015; Nabi and Green, 2015), is a promising pathway.

## Nature in Your Face

The NIYF framework uses disruptive communication strategies as a means to evoke strong emotions which do not have to—but may well be—negative. These emotions are used as a catalyst for engagement and elicit self-efficacy via creative work on solutions as part of a three-step vision workshop structure; framing-twisting and using, which is led by trained researcher(s). Theoretically, the NIYF concept is built on social practice theory (Shove et al., 2012) which assumes that peoples' behavioral practices are rooted in a complex interaction of physical structures, regulations, and attached meanings. Hence, NIYF does not aim to elicit change at a personal level, but to contribute to societal transformation Feola (2015). NIYF also builds on elements of social influence and group processes (Cialdini, 2003; Abrahamse and Steg, 2013). Furthermore, by introducing an initial disruption (eco-visualization) that is in line with what has been defined as an imposed transformation, we enable a group process that allows for a reconceptualization of some elements of the societal system (Folke et al., 2010; O'Brien, 2012) which contributes to active transformation. For a more detailed description of the theoretical framework please see the more conceptual paper by Löfström et al. (2020).

The rationale behind the framework is to use the emotional response during the vision workshop as an entrance point for co-creation (Dunne and Raby, 2013). Collaboratively working on solutions shall stimulate (long-term) engagement on the issue. The latter is not, however, explored in this study, but will be included in the further NIYF work. The collaborative focus on solutions during group work shall induce the feeling of hope and belonging which consequently elicits emotional flow from negative to positive emotions (Nabi and Green, 2015). This community spirit and flow can serve as a springboard for further studies and NIYF project activities, which will be part of the recently awarded funding from the Norwegian Research Council (NFR, project No 302111).

The different stages of the project have been defined to provide structure and standardization during this, still mainly exploratory, process. The first stage, *framing*, is meant to limit the scope and magnitude of the problem (in this case plastic pollution) and make it more manageable (Rosso, 2014). We did this by framing the problem geographically by giving the children a “room” in which they were able to brainstorm in small groups. For stage two, *twisting*, the groups were presented with a zero plastic challenge for their respective room. This represents creative stage of the methodology which shall elicit innovative, solution-oriented thinking (Gray et al., 2010). Twisting is introduced after framing the problem, hence after it has been made manageable, which enables the participants to comfortably explore the problem and take on the challenge of solving it. The last stage, *using*, is meant to take the solutions and ideas further, for example discuss them with local decision makers and eventually implement at least part of the ideas. However, in this study, this stage was only touched upon due to lack of resources and time. This will be explored in future studies and is the aspired outcome for the main NIYF project.

## Plastic Pollution as Focus Area

The historic area we find ourselves in at the moment is often referred to as the plastic age (Thompson et al., 2009). Despite increasing awareness of the negative environmental consequences, production and consumption of plastic are on the rise and with it, the amount of plastic ending up in the environment (Jambeck et al., 2015). Compared to other environmental problems such as climate change, plastic pollution is more visible (Anderson et al., 2016; Pahl et al., 2017). Despite the fact the plastic pollution in Norway is not as severe as it is in some other countries (Lebreton et al., 2017), it still is a challenge that needs addressing. We selected plastic pollution as a case for this study as it is a popular problem that is often discussed in the media (Henderson and Green, 2020), most people are concerned about it (Pahl et al., 2020) and it is relatively easy to create disruptive communication in form of visuals.

## Involvement of Children

Not much research has been done yet that involves children into the discourse around environmental problems. It is not only very likely that children are aware of environmental problems such as climate change and plastic pollution, they are also showing signs that they are confused by the magnitude of the threat, feel anxious or concerned (Fritze et al., 2008). Some studies have looked at how children handle information about climate change, and some studies looked at how children approach environmental problems and develop solutions (Desjardins and Wakkary, 2011; Banerjee and Horn, 2014; Hartley et al., 2015; Richter et al., under review, see footnote 1).

Banerjee and Horn (2014) show that children can learn and understand energy use through a game. Desjardins and Wakkary (2011) shows that children know a lot about sustainability even if they might lack the correct terminology, Hartley et al. (2015) and Richter et al. (under review, see footnote 1) show that children can develop creative solutions, and that this creative engagement itself might have significant effects on their motivation to act.

The relevance of involving children into the discourse about environmental challenges as well as into the development of solutions is crucial, not only because experiences like this potentially makes them environmentally conscious adults (Molinario et al., 2020) but also because we can learn a lot when we listen to the creative ideas provided by younger generations.

## MATERIALS AND METHODS

### Sample

As the main interest of this project was to involve children into the discussion around plastic pollution, 36 fifth grade pupils from Kristiansund primary school were recruited via convenience sampling in January 2020. Kristiansund is a coastal community with a long and scattered shore line where plastic litter has started to become a visible problem. The children (15 boys, 21 girls) were between 9 and 10 years old and belonged to two different classes, together representing the full 5th grade of the school. For the workshop, eight groups of 4–5 children each were formed randomly.

### Study Design

The study design was guided by the NIYF framework consisting of an eco-visualization followed by the three phases framing, twisting and using as described before. With the help of their teachers, a 4 h workshop was conducted with the selected children. The split of work and break times was identical to the children's normal school days in order to provide a familiar structure. The workshop was co-led by researchers (EL and IN) with the support of the ordinary school teachers.

Three simplified forms of eco-visualizations were presented to the children in form of photographs. The photographs represented three different cases of plastic pollution: two from the children's local beaches polluted by litter (Edvardsen, 2018; Löfström and Klöckner, 2019), and one showing a turtle that is about to feed on a plastic bag (Mayne, 2020). Subsequently, the children were divided into eight groups. To save time, the group membership was randomly allocated by the teachers before the workshop.

The first step, framing, was realized by defining four different frames in which the children were supposed to work: their classroom, the grocery store, their bedroom and the school playground. Each group was assigned one frame, which results in two groups per frame.

The second step, twisting, was realized by presenting the children with a scenario in which all plastic production around the world would be stopped. Their task was to imagine how their frame would be affected and to come up with solutions under this vision. To facilitate creativity, every group received different colored paper, colored pens, glue, scissors, and magazines.

The third and last step, using, could only be partly implemented due to the lack of time and resources in this pilot study. Each group presented their results and a group discussion was held. All children received a diploma at the end of the workshop. The three interdependent steps are illustrated in **Figure 1**.

### Semi-Structured Interviews

With each of the eight groups, semi-structured interviews were conducted by the researchers (EL and IN) during the workshop. This method was supposed to help our participants to open up about their experiences and thoughts about plastic pollution (Mason, 2017; Howitt, 2019). The interviews also provided an opportunity to make sure the children engage with the theme or to answer open questions. The decision for a semi-structured interview was made to allow for flexibility and follow-up questions we did not anticipate beforehand. We interviewed the children within their groups to allow for interpersonal interaction and discussion as well as to give them a feeling of confidence which is particularly important in a children sample (Tjora, 2017).

The interview guide consisted of three parts which were (1) general knowledge about plastic pollution, (2) frame-specific questions about plastic pollution, and (3) thoughts on how the plastic problem could be solved. The group interviews were consensually recorded on an audio device to allow for content transcription later on.

### Data-Analysis

According to the guidelines for qualitative data analysis (Big Q) by Braun and Clarke (2006) the interviews were thematically clustered. This method of analysis allows for flexibility in data interpretation and combines deductive and inductive approaches. In the case of NIYF, the theoretical background is still in development and results in this study being partly exploratory and data driven and partly deduced from research produced by Desjardins and Wakkary (2011) and Banerjee and Horn (2014); as well as Löfström and Klöckner (2019).

The analysis process was started in February 2020 and followed the Braun and Clarke (2006) six steps for thematic data analysis. These six steps are (1) get to know the material, (2) generate codes, (3) find distinct themes, (4) evaluate themes, (5) decide for and define themes, and (6) write a report. Despite the guidelines sounding like a linear process, the practice is more circular during which the researcher moves back and forth between the steps.

To get to know the data, the audio recording was transcribed and the researchers familiarized themselves with the transcriptions by reading them through several times as well as taking notes. In step two, as many meaningful codes as possible were generated to ensure that no valuable parts of the data are omitted (Braun and Clarke, 2006). To generate the codes, we used the software nVivo 12. Step two resulted in identifying 60 distinct codes representing meaningful units. An example is illustrated in **Table 1**.

In step three, the codes were synthesized into overarching themes with the help of nVivo 12 software which provided information of popular codes and codes that only appeared once and potentially could merged together. So were for example the codes "Unsure about the future," "Scared of the end of the world" and "Nature is being destroyed" merged into the theme "Worry about the planet." The codes with very low prevalence that could not be merged were taken out and saved into a separate





**FIGURE 1 |** Illustration of the three interdependent steps of the NIYF methodology (by Löfström).

**TABLE 1 |** Example for meaningful unites and their codes (translated from Norwegian by IR).

Meaningful unit transcription	Code
"For example am I scared when there is a lot of different weather, for example hale and snow, then I think of the climate and I am scared of the future and that the planet is destroyed. Then I think that this must have something to do with the plastic"	Climate change in relation to plastic litter
"We talk about discarding paper and plastic in the right bins and where they should not go. ... for example of plastic ends up in the paper bin, this is not right"	Correctly discard plastic waste

folder. To visualize the relationships between codes, mind maps were created to connect the codes with each other and with the overarching theme. An example for a mind map can be found in **Figure 2**. Step three resulted in nine overarching themes, representing a varying number of subthemes and codes.

Step four consisted of thoroughly revisiting all themes and making sure the codes are internally and externally homogeneous. Furthermore, it was validated if the themes represent the dataset as a whole. The aim of this step is to conclude with a small number of themes that express the content of the dataset well. We concluded with three themes that represent the content of our dataset as well as the research question comprehensively. In step five each of the three themes have been defined and described in a separate document. Parts of step six, the wiring of a report, will be presented in the results section of this paper.

## RESULTS

It is important to mention that the results presented here are subject to our interpretation, which was shaped by our theoretical framework, our research question and experience. The results section will be divided into two parts. First we will present the results retrieved via the thematic analysis of the semi-structured interviews. At this stage, we will provide some interview excerpts if relevant. All interview excerpts have been translated from Norwegian (IR). Subsequently, we will present the solutions the children developed during the disruptive communication workshop.

## Themes

The themes synthesized via the thematic analysis are presented in **Table 2**.

### Emotions Related to Plastic Pollution

The most apparent theme throughout the interviews was emotional reactions related to plastic pollution, mainly worry, anxiety, frustration and helplessness, hence, negative emotions. The theme was further subdivided into two categories which was worry and anxiety in relation to the future of the planet and frustration in relation to past generations, who caused the plastic pollution which the current generation has to deal with. In addition, many children emphasized as well how important it is to take care of nature and the environment.

The children explained that they are worried about the future of the planet if humanity continues the current course. Their worry relates to their own future on the one hand, but also to the future of the planet as a whole (Stine). Several statements evolved around the insecurity to predict future change due to plastic pollution, but also climate change and instability of the weather (Stine). Some informants even mentioned that they are afraid of the world being completely destroyed by humanity which would make it impossible to survive (Emilie). The children describe this worry like something that they are concerned about in everyday life and that causes stress (Emilie). Members of all six groups expressed clear feelings of worry and anxiety about the future, either during the interviews or during the creative engagement with the topic.

Stine: "This is destroying our future because we don't know what will happen, what will happen in the future with all the plastic and the planet- I am actually a bit concerned about my future." [int: You are concerned?] "yes because I am afraid that the world will die. No plants anymore and total chaos."

Emilie: "Yes we need to prepare ourselves. And I am really stressed about everything. . . everything that might happen."

Stine: "For example if there are many different kinds of weather, for example a little bit of snow and a little bit of hale, then I think about the climate and about that I am scared of the future and that the planet will be destroyed. And then I think that there is something about it, that the plastic has to be removed."

The second subcategory evolves around the frustration toward past generations and the way they have been treating the environment. One of the informants' mentions that what happens to the world is not his fault but the fault of past generations,



**FIGURE 2** | Example for a mind map created by nVivo 12 software (translated from Norwegian by IR).

**TABLE 2** | Overview over themes synthesized from the semi-structured interviews.

Themes	Sub-categories
Emotions related to plastic pollution	<ul style="list-style-type: none"> <li>• Anxiety</li> <li>• Frustration and helplessness</li> </ul>
Attitudes related to plastic	<ul style="list-style-type: none"> <li>• Negative characteristics of plastic as a material</li> <li>• Positive characteristics of plastic as a material</li> </ul>
Perceptions of plastic pollution	<ul style="list-style-type: none"> <li>• Unnecessary plastic</li> <li>• Plastic in grocery stores</li> </ul>

but that his generation has to fix the problem (Stine). This can be interpreted as frustration about the current situation in which they have to take care of a problem they have not caused, something that is perceived as unfair (Anders). Some other informants explain that the attitude toward nature within past generations has been irresponsible, which they regard as not timely anymore (Helene). Despite the apparent frustration, the children still seem motivated to engage in solutions (Nora).

Stine: “It was our ancestors who have caused this, not us. But we need to clean it up when we are adults.”

Helene: “In the past it was like that that everything was fine and that it was not something stupid that they thought they can just throw their rubbish away and so on, but now this is not good anymore.”

Anders: “They just littered because they did not know what the plastic does so they just threw it everywhere. But now we know a lot. . .”

Nora: “Yes [motivated], we have been down near [location] and tidied up [litter]. The first time we drove to this place and then we came back after half a year and there was almost no rubbish anymore. But the first time we collected nine bags.”

## Attitudes Related to Plastic

The second theme we identified was about the ways in which plastic was perceived, positive and negative. In psychology, these favorable or unfavorable evaluations of something or someone are described as attitudes (Fishbein and Ajzen, 1977). Throughout the process of analysis, we found that the children recognized positive and negative characteristics of plastic as material, which made it difficult for them to formulate a clear statement if plastic is ultimately good or bad.

The negative characteristics of plastic also included the consequences of its use and discard. One of the main statements the children made was therefore the danger discarded plastic poses for animals. Our participants seemed to be particularly concerned about animal welfare, which was reflected in the interviews (Anders, Helle) as well as in the creative engagement (Figure 3). The children describe the animals as innocent beings whilst humans are guilty of endangering them with their behavior (Tim).

Anders: “That we should not litter because then a deer could eat the plastic and then they can die.”

Helle: “That is really stupid because animals think it is food and then they eat it.”

Tim: “It is really bad that plastic harms them who live in the forest because they have been there first and then we come and destroy it.”

Other consequences of plastic pollution that were mentioned were water quality issues (Jenny), plastic in the ocean (Helle) as well as plastic particles in food (Tim).

Jenny: “And plastic ends up in the drinking water and then we drink the water and the food and drink is in danger.”

Helle: “Because if we litter the plastic goes down the hill on a rainy day and then the water brings it to the ocean.”



**FIGURE 3 |** Example for outcome of creative engagement featuring negative consequences for animals.

Tim: “Ehh we found out that we don’t know if there was plastic in the food we eat in some way.”

Characteristics of plastic that were mentioned was that it takes a long time to decompose which makes the consequences mentioned before even worse (Stine, Eline).

Stine: “Plastic takes. . . that it takes very long time to disappear in some way.”

Eline: “It takes a very long time to get rid of it.”

Despite the negative characteristic and consequences of plastic and plastic use dominated the discussions, some positive experiences with plastic have been mentioned, making plastic attractive as a material.

One characteristic that was mentioned as positive was how durable plastic is (Nora) and also how it helps to keep food edible for longer (Tim). Plastic also helped humanity to create new products for communication and travel (Tiril).

Nora: “Because it is a durable material and easy to use.”

Tim: “It makes it [food] keep for longer.”

Tiril: “Hmm it helped us to make a lot of things. . . like display protection of our mobile phones and things like that.”

Articulating positive and negative attitudes toward plastic at the same time turned out to be confusing for our participants. They seemed to struggle with the fact that plastic is difficult to avoid and that the positive characteristics might be used as an excuse for the negative ones.

## Perceptions of Plastic Pollution

The last theme that emerged during the thematic analysis was perception of plastic consumption and pollution, especially in relation to the extent it is used for grocery packaging. Even the groups who did not work with grocery stores as their allocated frame did discuss food packaging and supermarkets. Perceptions are interpretation of sensory experiences which “enable organisms to organize and interpret the stimuli received into meaningful knowledge and to act in a coordinated manner” (APA Dictionary of Psychology, 2020).

The children perceive large parts of food packaging as unnecessary and hard to avoid (Synne, Sophia). Some describe the attempt to cut down on plastic packaging as almost impossible (Marte, Tiril).

Synne: “Because there is. . . everything we buy is packed in plastic.”

Sophia: “Almost everything in the shop is wrapped in plastic.”

Marte: “Because there is plastic in almost everything, in some way there is plastic in everything.”

Tiril: “There is microplastic in everything.”

One child describes that it is hard for her to distinguish plastic from other materials sometimes (Stine).

Stine: “Ehhh Barbie dolls for example! Their hair looks like real hair but it is plastic.”

The children also mention that they think that plastic consumption became a regular component of everyday life (Karoline). Ever since plastic was invented, the production and consumption escalated quickly and humanity became dependent on the material (Emilie). The children point out that changing habits connected to plastic is one of the main challenges (Anders).

Karoline: “We don’t need everything but since plastic is a useful material we began to use it for everything and thereby it became part of our daily life.”

Emilie: “I think there was surely one person who started with for example making a plastic bag and then everyone thought: wow, this person made a plastic bag! And then everyone started to do the same and then they produced even more things and this went on and on all the time.”

Anders: “Because we depend on it. If we for example go to [supermarket name] and buy a lot of food we can. . . instead of a cotton bag. . . we can just take a plastic bag. And if we start doing this all the time we end up with lots of plastic bags.”

## Workshop Outcomes

The workshop consisted of three steps, the eco-visualization, the framing and the twisting. As this was a pilot study, the last step, using, was not fully conducted, due to time- and monetary limitations.

The eco-visualization was composed of three pictures of plastic pollution (**Figure 4**). The children largely reacted with signs of shock and sadness. Especially the photograph of the turtle evoked strong emotional reactions. Similarly strong were the reactions, however, as the participants were informed that the two other pictures were taken in their local area, something they did not expect. When the pictures were shown, the children started having vivid conversations between each other, started asking questions and made comments.

Every group was allocated a certain topic to focus on (framing) and afterward received an identical twisting instruction and similar materials for the creative engagement. All the groups correctly adhered to their frame [classroom, grocery store (**Figure 3**), bedroom, and school playground] and most children understood the instructions for the twisting (“Imagine a world in which all plastic production and consumption is stopped, how would that look like in your frame?”) well.

Each group developed its own creative scenario, featuring distinct solutions and ideas. These between-group-differences demonstrate that the NIYF method evokes creative processes, even under identical frames. As an example, the groups who both worked with school playgrounds as their frames, focused on two different issues: One group presented solutions for cutting out plastic in various sportive activities like soccer and fetch; the other group elaborated on an efficient recycling infrastructure to avoid plastic litter (**Figures 6, 7**).

Some of the groups did collaborate better than others, coming up with more elaborate solutions. This points toward to importance of functioning social interactions for creative engagement and mutual inspiration in which one idea leads to another (Helene, Pia).

Helene: “In the grocery store the tomatoes could just be in a big basket and then you can bring your own basket and take them and place them in your own basket.”

Pia: “Yes! And what you can also do is that when you are in the supermarket usually when you are done you get a bag, but instead I think you can get your own personal shopping cart that you bring every time when you go to the shop.”

The most popular topics that were discussed across groups were exchanging plastic with alternative materials like paper, cardboard, glass, or wood (Stine, Eline) as well as raising awareness for more sustainable behaviors like reducing plastic consumption, recycling or clean-ups (Tilda, Tiril).

Stine: “We can for example instead of a plastic bag for example take all the oranges and fruit and use a paper bag.”

Eline: “Yes, just replace the plastic bag with a paper bag or cotton bag.”

Tilda: “That you can try to not shop more than you need. For example if you already have it from last time you don’t need to buy it again.”

Tiril: “It [clean-ups] took place a couple of times and sometimes with the clean ups you get a few hundred krona per bag.”

(see **Figure 5**).

Some children seemed to have difficulties with the twisting instruction and needed concrete explanations and support. This seemed to impede their creativity as they stayed very close to the given support and consequently did not think out of the box as much. In hindsight, this issue could have been avoided by conducting the interviews after the workshop.

All groups presented their posters in plenum explaining the solutions they came up with and discussing it with their peers in regards to feasibility and attractiveness. This can be understood as a pre-stage to the third step, using, that belongs to the NIYF approach. Some groups were more comfortable with speaking in front of their classmates than others, which had an influence on the quality of the subsequent discussion. Also during this stage, questions posed by the researchers seemed to put a damper on the children’s creativity and made them more focused on answering the questions correctly than on sharing their thoughts. In the NIYF rationale, using represents the step in which policy makers or community leaders take up the suggestions related by the workshop and bring it into action. This last step will be conducted in future NIYF workshops implementing the lessons learned from this pilot study.

## DISCUSSION

### Underlying Psychological Mechanisms

The results of this study point toward three overarching concepts being at the core of how children experience plastic pollution namely (1) Emotions as a reaction to plastic pollution and evoked by the eco-visualization, (2) Attitudes toward plastic as positive and negative material, and (3) Perceptions of the extent of plastic pollution. We would like to discuss the underlying psychological mechanisms these emotions, attitudes





**FIGURE 4 |** The eco-visualizations presented to all children at the beginning of the Nature in your Face Workshop [from left to right: Edvardsen (2018), Löfström and Klöckner (2019), Mayne (2020)].

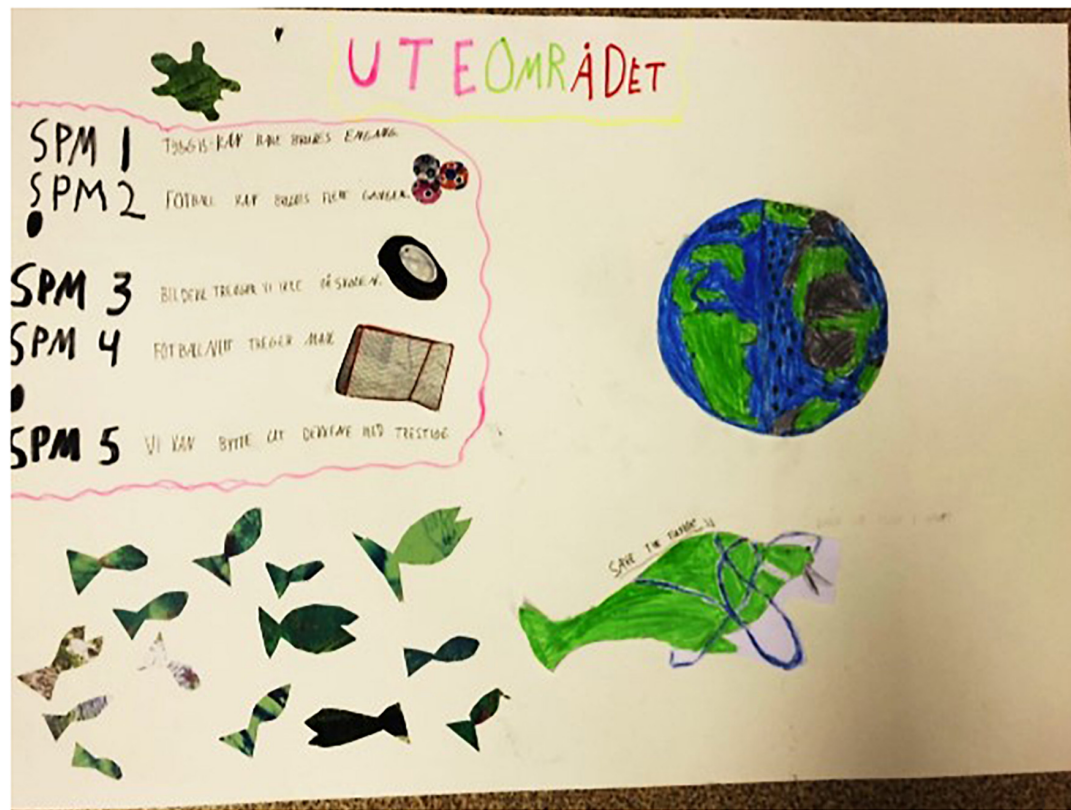


**FIGURE 5 |** Example of creative engagement with the frame “grocery store” (*mat* means food in Norwegian).

and perceptions are pointing at and shed more light on how children experience plastic pollution.

Emotions of worry and frustration have been standing out during the data analysis. These emotions have not only been mentioned in connection to plastic pollution but also related to general environmental problems such as climate change. This type of negative emotions are part of a phenomenon called eco-anxiety (Carville, 2015; Clayton, 2020) which has been on

the rise during the last century (Taylor and Murray, 2020). Lifton (2017) argues that high levels of eco-anxiety makes deterioration and destruction salient and thereby reminds people of their own death (Panu, 2020). Eco-anxiety amongst children has been noticed ever since environmental problems became part of the public discourse (Hutchinson, 1997; Hicks and Holden, 2007). Amongst our participants, many mentioned thoughts about the world coming to end and not being a safe living space anymore.



**FIGURE 6** | Creative engagement within the frame “school playground” illustrating different means of cutting out plastic in sportive activities (top left).

Especially people who experienced natural disasters themselves often have high levels of eco-anxiety (Bourque and Cunsolo Willox, 2014; Clayton et al., 2017). Our participants have not experienced natural disasters but they have most likely been exposed to sensationalist media reporting on catastrophic events. Media reporting often makes use of sensationalist and shocking headlines as well as visual material that attracts attention. Children will potentially remember these headlines and images more clearly than written articles that might involve hopeful content as well (Nicholson-Cole, 2005; Holmes and Mathews, 2010; Weber, 2010). Children are not only more concerned (Burke et al., 2018), but also more affected by climate change as well as by future natural disasters (USGCRP, 2016). Many of our participating groups developed drawings showing how the world will look like in the future. Without exception, all these drawings have been gloomy (for example see **Figure 8**). This shows that even if children wish for their own future to be positive, they expect the world to change into a negative direction (Hicks and Holden, 2007). Negative emotions can function as catalyst for action if appropriate levels of self-efficacy are in place (Nicholson-Cole, 2005; Ojala, 2012). If self-efficacy is low, however, some people tend to use coping mechanisms to deal with overwhelming emotions such as distancing and denial (Tannenbaum et al., 2015). The concept of denial is considered an evolutionary defense mechanism employed from early childhood. Its goal is to aid adaptation by reducing anxiety

and bolstering self-esteem (Cramer, 2006). Denial, or strategic downplaying of the seriousness of environmental problems has been observed in previous studies with children samples (Ojala, 2012). One of our participants described environmental problems as being exaggerated which he found frustrating, which could be interpreted as a form of denial. Stoknes (2015) argues that denial is the most popular strategy when people do not want to deal with environmental problems or need reasons not to adapt their own behavior. In children, denial has been found to be negatively associated with engagement and should be buffered with meaningful coping strategies (Ojala, 2012). We conclude that sufficient levels of self-efficacy are key for negative emotions to be translated into sustainable behavior change (Nabi et al., 2018).

Throughout the analysis, another dominant theme was the almost non-avoidable amount of plastic that is produced, consumed and discarded. Our participants often mentioned feelings of helplessness due to the sheer amount of plastic in the supermarkets, in their community and on the beaches. Plastic consumption, and thereby contributing to the problem, was described as hard to avoid which can, for some people, result in a low level of self-efficacy as well (Geiger et al., 2017). Low levels of self-efficacy related to the amount of plastic consumed can stem from people not having the knowledge and resources to reduce their plastic consumption. They experience that even if they try to cut down on packaging, plastic can be inside the product





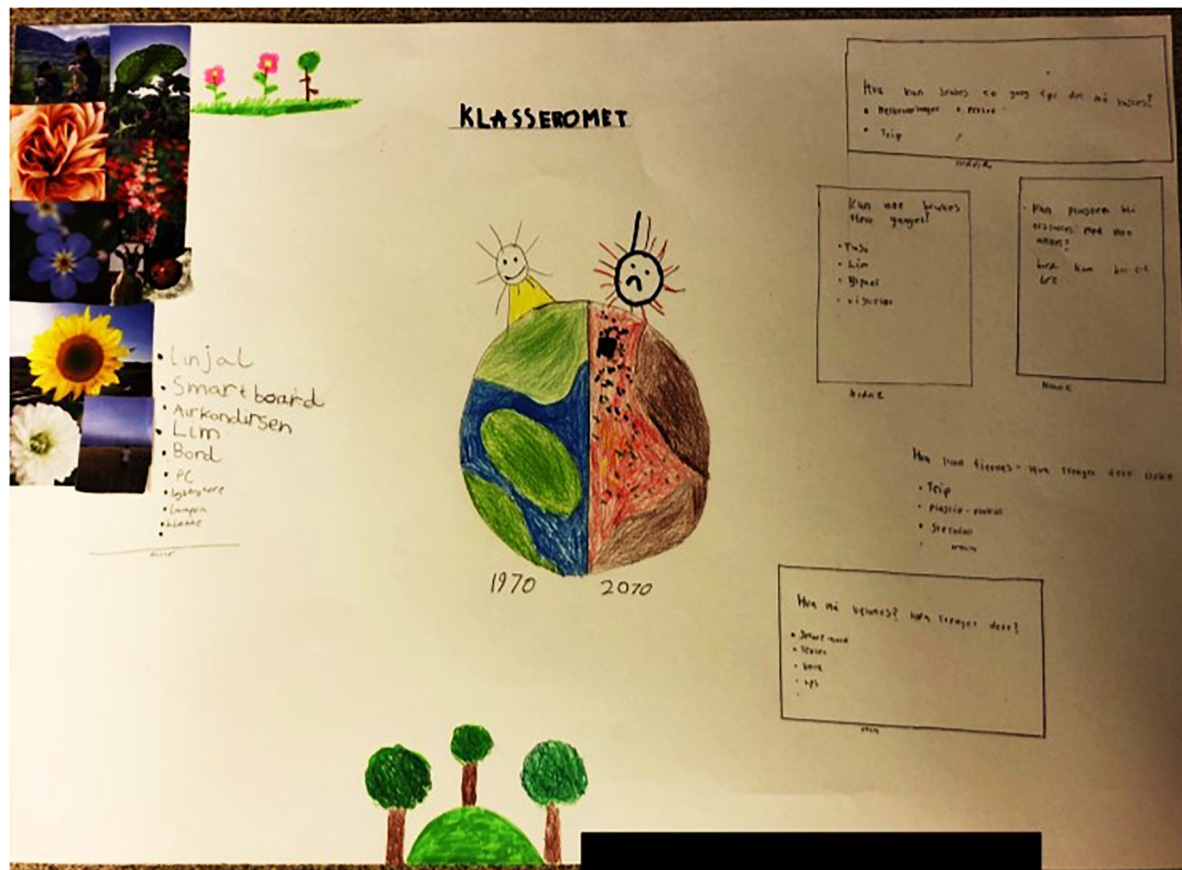
**FIGURE 7 |** Creative engagement within the frame “school playground” illustrating the importance of recycling and different types of bins (bottom half).

(Anderson et al., 2016) and often, they don’t know what to choose as an alternative. Our participants do not explicitly state that they lack the self-efficacy to reduce their plastic consumption. However, the combination of them discussing the large amount of plastic in everyday life, the difficulty to avoid it and the negative emotions points toward low levels of self-efficacy when it comes to avoiding plastic.

Increasing self-efficacy can be achieved through various ways. Social modeling can be a way to increase levels of self-efficacy through observation of others who perform a certain behavior (Bandura, 1977; Bandura and Walters, 1977). Beach cleans, mostly performed in groups could be a way to get social modeling of relevant behaviors that help to cope with the plastic problem. However, social modeling could also have adverse effects in the context of plastic pollution as parents, peers or influencers might function as negative role models consuming large amounts of plastic (Ahuvia, 2015). Consciously choosing positive role models can be a way out of this dilemma. Beach cleans can also serve another function which is giving people a feeling of meaning, agency and social belonging (Wyles et al., 2017). We do not know yet, however, what returning to previously cleaned beaches and finding them littered again might do to the self-efficacy gained through the activity before. Workshop setups like NIYF can also be a way to increase self-efficacy. By collaborating with peers

on finding solutions, workshop participants might feel like they are contributing to positive change (Bandura, 2002). At the same time, individual levels of self-efficacy can influence how participants engage in a workshop setup like NIYF. Low levels of self-efficacy might keep participants from active engagement which is down to their personal judgment of their abilities (Bandura et al., 1999).

The last theme we would like to discuss is the appreciation of plastic as not being exclusively negative. Despite the negative attributes of plastic being the dominant theme of the discussions, our participants also talked about positive aspects such as increased shelf life of products or innovations based on plastic (Zhang et al., 2014). This can potentially lead to a state called cognitive dissonance or, as Ojala (2007) calls it, attitudinal ambivalence. Cognitive dissonance is typically experienced as psychological stress because of mixed emotions because contradictory beliefs and actions are standing against each other (Festinger, 1962). Taking climate change as an example, so do knowledge and attitudes on sustainable lifestyles and mitigation often stand in contrast to people’s actual, unsustainable behavior (Stoknes, 2014, 2015). Striving for consistency, cognitive dissonance can be reduced by either changing relevant cognitions or relevant behavior. For the majority of people, adapting their cognitions is perceived as the easier option (Gifford, 2011; Taddicken and Wolff, 2020). For the young generation, cognitive



**FIGURE 8 |** Creative engagement within the frame “classroom” illustrating, amongst other things, a drawing of a destroyed future planet.

dissonance has been found to be negatively associated with environmental behavior such as recycling (Ojala, 2007). However, as compared to negative attitudes, cognitive dissonance does not lead to ignorance but pushed people to action (as an example see Costarelli and Colloca, 2004), which, when channeled into the NIYF methodology can result in sustainable behavior change. As cognitive dissonance has not explicitly been measured in this study, we can only assume that the children experience it to some extent. Comments arguing that it is impossible to cut out plastic completely or that they recently participated in a beach clean and therefore did their part to help, point toward cognitive and behavioral adaptation strategies. As the NIYF framework is aimed at solution development and thereby building up agency and empowerment, we assume that cognitive dissonance might be reduced within our workshop participants.

### Success of the NIYF Workshop Structure

The results of the workshop indicate that the eco-visualization created active engagement and strong emotional reactions. This became clear during the group interviews, the children's comments, social interactions and their facial expressions. The framing facilitated finding solutions within the children's allocated context and all groups came up with different ideas, pointing toward high levels of creativity. The twisting turned

out to work well for most groups but was perceived as difficult by some, indicating that the task descriptions could have been clearer or better formulated for the target group. The last step, using, has only been partly implemented due to limited time and resources and cannot be evaluated at this point.

Some groups showed highly creative solutions and strong engagement. These groups demonstrated that it is possible to use the NIYF framework to involve children in developing solutions for environmental problems. However, other groups had difficulties interacting with each other and therefore had a hard time with the task. This point toward to importance of functioning social interaction in order to be creative and develop feasible, innovative solutions. Trained facilitators to support constructive interactions, tailor-made instructions for the target group and pre-workshop teambuilding exercises to strengthen group coherence could help overcome this challenge.

In future workshops, the semi-structured interviews will be conducted after, not during the creative engagement. Although the interviews did indeed provide insight in the children's thoughts and understanding of the plastic problem, but they also turned out to be a distraction and as a hindrance for creativity. However, the tight time-frame of this workshop may well have contributed to this problem, and not the questions *per se*. An



alternative could be to have less questions during the engagement, and allocate more time for the tasks.

## Practical Implications

This study has shown how children can be actively involved in the discussion around plastic pollution and environmental conservation using eco-visualizations. In addition, we identified psychological mechanisms determining how children experience plastic pollutions.

For practitioners, this study provides implications regarding the workshop setup. A workshop like NIYF needs to be thoroughly planned and all communicative aspects need to be adapted to the specific target group. In our case, step two of the workshop, twisting, should have been introduced clearer to our participants to avoid confusion. Further, creativity should be least possible be interrupted by other tasks like interview questions. The quality of social interactions needs to be taken into account, especially when group work is part of the setup. As much as good teamwork can inspire creativity and boost productivity, malfunctioning groups can hinder these processes.

Regarding eco-visualizations, we can confirm that they work as tool to evoke emotions and disruption. It is paramount, however, to channel evoked emotions into a process of solution development like described in this study. As Ojala (2007) pointed out in her study including young environmental volunteers: “it is not the ability to get rid of worry that should be sought after but rather the capacity to face worry, to learn from it, and to use it for constructive actions.” Leaving people alone with their emotions as a consequence to eco-visualizations could lead to negative effects such as reduced levels of self-efficacy or maladaptive coping strategies (Moser and Dilling, 2011; Nabi et al., 2018; Nabi and Myrick, 2019).

## LIMITATIONS

This study was part of developing the NIYF methodology further and helped us build a proof-of-concept (PoC) that will be investigated further in future studies. It has successfully shown that the disruptive communication, if used as part of the NIYF structured workshop study can be used to engage children in solving environmental challenges. As an explorative study, aimed at developing the concept further, there are limitations.

The study does give us insight into how children can be included in the plastic pollution issue. It has also given us some initial insights into how children understand—and respond to being exposed to—the problem of plastic pollution as part of a disruptive communication approach. We do not know yet, however, if these results can be generalized over other topics, communities or age groups. We can further not exactly say if the psychological mechanisms we identified throughout the discussions can be verified via quantitative measurements using standardized methods. We have aimed at providing a high degree of transparency in how this workshop was carried out and the conditions around the workshop in order to give the results credibility. Carrying out additional NIYF workshops will allow for generalizability of the workshop results. In further NIYF

studies, carried out in other communities and involving multiple age groups, we will also carry out quantitative evaluation that will accompany the workshops in the project. These future workshops will, using a mixed methods approach, allow for generalizable and reliable results. In future studies we will also measure the impact in form of carbon emission reduction with regards to the transition of the local community to plastic neutrality (the overall aim of the Kristiansund municipality's part of the NIYF main project).

## CONCLUSION

Our aims to evoke emotions and creative engagement using eco-visualizations as form of disruptive communication have been achieved. We therefore conclude that the NIYF framework may indeed be used as a means to engage children in solving environmental challenges. In comparison to gradual change making processes, disruptive communication offers a promising route forward to tackle the environmental challenges we are facing in the world. Implemented on a larger scale, disruptive communication could function as a wakeup call for immediate action.

We conclude that disruptive eco-visualization can create emotional responses and active engagement amongst children. Our results further show that there are to be three concepts reflecting how children perceive plastic pollution: (1) Emotions related to plastic pollution, (2) Attitudes related to plastic, and (3) Perceptions of plastic pollution. Furthermore, these themes could be linked to eco-anxiety, denial, self-efficacy and cognitive dissonance. Active engagement is a key part of the NIYF methodology as it allows people to channel their emotions into action and thereby, potentially, increase their self-efficacy levels. In the future, we aim to validate this novel methodology across further environmental challenges, communities, and age groups. We also aim to measure impact in form of carbon emission levels as a consequence of the workshops. Thereby we will explore how the full potential of NIYF can be realized.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

## AUTHOR CONTRIBUTIONS

EL and IR wrote the manuscript. IN and EL collected all research data. All authors have contributed to the manuscript and approved the submitted version.

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# Organisational Climate and Pro-environmental Behaviours at Work: The Mediating Role of Personal Norms

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Organisations are currently strongly encouraged to adopt more responsible production patterns aligned with sustainable development goals (SDGs). Pro-environmental behaviours (PEBs) in the workplace can strengthen the expected positive impacts of organisations' environmental performance and engender more sustainable transitions to low-carbon production. Research on PEBs at work is relatively recent, so this field still lacks studies of the role of organisational policies and practices in workers' adoption of these behaviours and of psychosocial processes that contribute to more sustainable workplaces. The present research examined how perceptions of organisations' environmental policies and practices (i.e., organisational climate or injunctive norms) and of coworkers' PEBs (i.e., descriptive norms) affect employees' self-reported voluntary PEBs. Thøgersen's norm taxonomy model was also applied to address the role of personal norms. Self-commitment to sustainable goals at work can play a fundamental role in workers' behavioural choices, so this research further investigated whether personal norms mediate the relationship between perceived pro-environmental organisational climate and reported workplace PEBs. To test the proposed model, data were collected on 210 workers from different business sectors, who completed an online questionnaire. The analyses showed that, after controlling for the effects of tenure, education level, and a management position, a pro-environmental organisational climate predicts stronger personal norms and a greater tendency to adopt PEBs at work (adjusted  $R$  squared = 0.36), providing evidence of complete mediation. Coworkers' perceived descriptive norms also contribute directly to self-reported PEBs. The discussion of the results focuses on the importance of organisational level initiatives as a way to promote change in individuals' behaviours, which can have positive consequences for workplaces' transition to sustainability.

**Keywords:** pro-environmental behaviours, organisational climate, personal norms, descriptive norms, workplace

## INTRODUCTION

Organisations are currently strongly encouraged to adopt more responsible production patterns in alignment with the United Nations' Sustainable Development Goals (SDGs). The SDGs to be achieved by 2030 form a framework calling for urgent action at various levels of sustainability (United Nations, 2015), including paying attention to organisational performance's impacts on the environment (i.e., SDG12 – responsible consumption and production). Organisations worldwide are increasingly adopting environmental management systems such as the International Organisation for Standardisation's ISO14000 and the European Union's Eco-Management and Audit Scheme. These systems are a set of processes and practices that enable organisations to reduce their environmental impacts while increasing operational efficiency. In addition, organisations are implementing other initiatives to reduce their ecological footprint and contribute to safeguarding the environment as part of their social responsibility and sustainability policies [Klynveld Peat Marwick Goerdeler (KPMG), 2017; Duarte et al., 2019; Tian and Robertson, 2019]. Climate change has also become an important challenge in organisations' operations (Dahlmann et al., 2019), and successfully dealing with this challenge requires all members – whether they are decision makers or workers – to contribute to implementing the relevant policies. These individuals are ultimately responsible for applying environmental practices in daily routines (Daily et al., 2009; Yuriev et al., 2018).

Pro-environmental behaviours (PEBs) in the workplace can contribute to these practices' positive impacts on organisations' environmental performance (Tsai et al., 2016) and to a sustainable transition to low-carbon production. PEBs in this context may include behaviours such as conserving energy and resources, reducing waste, increasing recycling, or advocating eco-friendly behaviours to coworkers (Cantor et al., 2015; Dumitru et al., 2016; Saeed et al., 2019; Canova and Manganelli, 2020). Some of these behaviours are similar to PEBs at home, but workplace PEBs does not necessarily have the same predictors (Dumitru et al., 2016; Whitmarsh et al., 2018).

More research is needed on how to incentivise workers to engage in these behaviours at work especially since this context is one in which people spend much of their time. More specifically, this field still lacks studies of the role of organisations' policies and practices in workers' adoption of PEBs (Lo et al., 2012; Yuriev et al., 2018) and of the psychosocial processes that contribute to more sustainable workplaces (Ciocirlan et al., 2020). This line of research is important to developing a better understanding of how to encourage PEBs at work (Paillé and Boiral, 2013; Carmeli et al., 2017; Wesselink et al., 2017) and remove potential barriers to their acceptance (Carrico and Riemer, 2011; Yuriev et al., 2018).

## Normative Theories and Workplace PEBs

One of the strongest predictors of behaviours is social norms (McDonald and Crandall, 2015). Social norms are shared expectations about what is appropriate behaviour in specific contexts (McDonald and Crandall, 2015). Within organisations, these norms can be understood as workers' perceptions of

organisational climate (Norton et al., 2014). This climate is traditionally defined as how employees perceive their organisation's formal policies and practices with reference not only to processes and procedures about which workers are aware but also to patterns they usually observe among coworkers (Schneider, 1990; Schneider et al., 2013). Researchers have found that organisational climate is an important driver of employees' attitudes and behaviours and have shown that a pro-environmental organisational climate can contribute to workers' organisational commitment (Tilleman, 2012), work engagement (Hicklenton et al., 2019), organisational identification (Afsar et al., 2018), and job satisfaction (Spanjol et al., 2015). These impacts tend to be stronger for employees who perceive themselves as sharing values and interests with their organisation (Norton et al., 2012; Hicklenton et al., 2019).

A classic distinction made between types of social norms differentiates injunctive norms – what is approved – and descriptive norms – what is observed (Cialdini et al., 1990). Based on this distinction, organisational climate's components can be divided into two categories: injunctive norms that indicate to workers which environmental concerns are important to their organisation and expected of employees and descriptive norms that correspond to how coworkers behave in the workplace. The former norms thus hold up the organisation as a referent for workers. This situation is hereafter referred to as “a pro-environmental organisational climate.” Descriptive norms are, in contrast, perceptions of coworkers' PEBs. This assessment is hereafter termed “a pro-environmental coworker climate.” Both types of climate are expected to be connected to employees' adoption of PEBs, although these climates' effects can follow different paths to these behaviours.

Norton et al. (2014) adopted the above distinction and sought to determine which climate is more closely associated with different PEBs. The cited authors' findings suggest that a pro-environmental organisational climate predicts workers' involvement in task-related PEBs, i.e., behaviours associated with assigned tasks. A pro-environmental coworker climate is, in turn, a better predictor of voluntary PEBs, that is, behaviours that exceed what is officially expected from employees as part of their work (Bissing-Olson et al., 2013). However, these findings imply that formalised systems of environmental procedures and standards have repercussions for task-related PEBs only – a conclusion not fully supported by other studies that have shown that sustainability policies generally promote workplace PEBs (e.g., Paillé and Boiral, 2013; Zientara and Zamojska, 2018; Magill et al., 2020).

The present research sought to address some limitations in a study of Norton et al. (2014). One limitation had to do with the assessment of descriptive norms. The items used focused on what employees value rather than on what behaviours they engaged in as part of their organisation. The current study attempts to clarify the role of descriptive norms by applying an approach similar to that used in social norms research (e.g., Goldstein et al., 2008; Gökeritz et al., 2010; Mouro and Castro, 2016).

Another limitation is related to PEBs' measurement. Although items of Norton et al. (2014) capture the distinction between

task-related and voluntary PEBs, the items' wording is quite abstract, causing difficulties in terms of understanding the types of behaviour respondents have in mind when they formulate their answers. The present research measured more concrete behaviours, which were selected because they are sufficiently common to occur in different types of organisations, business sectors, and work tasks. The rewritten items also focused more specifically on one type of PEB – voluntary behaviours. This study thus sought to determine whether pro-environmental organisational and coworkers climates predict voluntary workplace PEBs such as saving energy and water, separating waste for recycling or actively promoting these behaviours among colleagues.

## Personal Norms

Previous research has showed that both injunctive and descriptive norms affect behaviour (e.g., Goldstein et al., 2008), but they appear to do so *via* different processes (Thøgersen, 2006). According to Thøgersen (2006) norm taxonomy model, injunctive norms have an effect on behaviours indirectly through personal norms. The latter norms are feelings of obligation and a commitment to engage in specific behaviours (Schwartz, 1977). In general, personal norms are positively related to various PEBs related to resource conservation at home (e.g., Thøgersen, 2006; Castro et al., 2009) and in other areas that are legally regulated (cf. Mouro and Castro, 2016). Scherbaum et al. (2008) and Chou (2014) showed that personal norms are also significant predictors of PEBs in work contexts.

Personal norms are considered a strong predictor of PEBs (Niemic et al., 2020), yet their influence can be weakened when strong barriers are put up against these behaviours (Thøgersen, 1996). Recent studies have confirmed that employees may not always feel motivated to commit to acting in pro-environmental ways at work, particularly if these individuals believe that these practices should not be considered their responsibility or if workers feel the necessary conditions to complete these tasks do not exist (Greaves et al., 2013; Ruepert et al., 2015). Some studies have also highlighted how personal norms' role can differ depending on the type of activity involved (Lokhorst et al., 2011). Task-related PEBs may be more closely associated with external instrumental pressures (e.g., salaries and subsidies), while voluntary PEBs can depend more strongly on the internalisation of values that direct individual workers to act in specific ways (Dumitru et al., 2016).

Factors that function as antecedents of personal norms related to being a more environmentally conscious employee thus play an important role in the adoption of PEBs. Previous research has focused on how general environmental values predict personal norms in the workplace (Ruepert et al., 2016). A less frequently explored topic is a pro-environmental organisational climate's impact on personal norms, namely, employees' commitment to lessening their work and organisation's environmental impacts. According to the literature reviewed for the present research, only the study of Zhang et al. (2013) examined the relationship between organisational climate and both personal norms and PEBs at work. However, the cited study focused exclusively on an electricity-saving workplace climate and behaviours, without testing for a mediating effect.

The present research's first hypothesis thus focused on the mediating role of personal norms in the relationship between pro-environmental organisational climate and PEBs. A basic assumption of Thøgersen (2006) is that, if workers perceive their organisation's values and actions as environmentally friendly, this perception generates meaningful reflection about these practices (Afsar and Umrani, 2020). In addition, these individuals are more likely to internalise this commitment to preserving the environment as an important dimension of being a good employee. This sense of obligation to become more pro-environmental can then translate into more workplace PEBs (Scherbaum et al., 2008; Chou, 2014). Therefore, the present study's first hypothesis focuses on a mediating relationship between the above variables, with further details provided by the two subhypotheses:

*H1: Personal norms regarding being a pro-environmental worker mediate the relationship between environmental organisational climate and voluntary PEBs.*

*H1a: Environmental organisational climate is positively associated to personal norms related to being a pro-environmental worker.*

*H1b: Personal norms related to being a pro-environmental worker are positively linked with voluntary PEBs.*

In contrast, descriptive norms, that is, perceptions of what coworkers do in the workplace, have a direct effect on employees' behaviour (Thøgersen, 2006; Niemic et al., 2020) and, more specifically, on voluntary PEBs (Norton et al., 2014). The current research's second hypothesis posited that:

*H2: Pro-environmental coworker climate is positively associated with voluntary PEBs at work.*

## MATERIALS AND METHODS

### Participants and Procedures

The participants comprised 210 employees that voluntarily filled in an online survey. Their ages ranged from 20 to 66 years old (mean = 36.6; *SD* = 10.8). The majority were females (58.6%) with a higher education degree (72.9%). The respondents worked for organisations operating in Portugal, and 63.8% had a permanent employment contract and 19.5% had a management position. Overall, these workers had a mean tenure of 9.2 years (minimum = 0.5; maximum = 40) in their current organisation. The respondents worked mostly in the tertiary sector (89.2%) in various areas including, among others, consultancy services (13.4%), education (10.0%), commercial services (9.6%), health and social services (9.1%), and information and communication technologies (8.1%). Almost three-quarters of the participants worked for for-profit (71.3%) and private organisations (74.6%). About one-third had jobs in extremely large organisations (32.1%), while a fifth of the sample worked for medium-sized organisations (23.0%).

The survey was conducted using the Qualtrics Surveys online platform, and the participants were recruited *via* social media (i.e., a non-probabilistic convenience sampling technique). The study assumed a cross-sectional correlational design, so the

data were collected on the relevant variables at the same time and from the same source. The project followed the ethical standards guidelines of Portugal's Order of Psychologists, and the respondents were informed about how their responses' confidentiality and anonymity would be safeguarded.

## Measures

The survey started with the informed consent and then included the four measures presented below. It ended with questions regarding socio-demographic and professional characteristics of respondents.

### Pro-environmental Organisational Climate

Four items based on research of Turker (2009), Duarte (2011), and Norton et al. (2014) were developed to measure perceptions of organisational climate, namely, organisational policies and practices related to environmental sustainability. The participants rated how much they thought their organisation "makes an effort to reduce its impact on the environment," "makes an effort to reduce the natural resources used during its functions (e.g., water and energy)," "separates materials and waste for recycling," and "upholds the importance of protecting the environment." The responses were given on a scale ranging from 1 ('totally disagree') to 5 ('totally agree'). The four-item scale showed high internal consistency [Cronbach's alpha ( $\alpha$ )=0.80], and a mean score was calculated for use in subsequent analyses.

### Pro-environmental Coworker Climate

Perceived pro-environmental coworker climate was assessed with four items based on studies of Gökeritz et al. (2010) and Carrico and Riemer (2011). The respondents rated how many employees in their organisation "turn off the lights when they leave a room," "use as little water as possible," "shut down equipment after using it," and "separate materials and waste for recycling." The responses were given on a scale ranging from 1 ("no one") to 5 ("all workers"). The four-item scale had good internal consistency ( $\alpha$ =0.76), so a mean score was estimated for use in further analyses.

### Personal Norms Related to Being a Pro-environmental Worker

Personal norms were measured with five items based on research of Chou (2014) and Mouro and Castro (2016) and adapted to address specifically employees' commitment to environmental sustainability at work. The participants rated their agreement with the following items. "I feel personally responsible for this organisation's contribution to environmental issues." "I worry about being an "environmentally friendly" worker." "I feel it's important that the organisation where I work is concerned about the environment." "I worry about my organisation's negative impacts on the environment." "I believe organisations need to commit seriously to protecting nature." The responses were given on a scale ranging from 1 ("totally disagree") to 5 ("totally agree"). The five-item measurement instrument showed good internal consistency ( $\alpha$ =0.77), and a mean score was computed for use in subsequent analyses.

## PEBs at Work

Pro-environmental behaviours were measured using seven items based on studies of Robertson and Barling (2012), Greaves et al. (2013), and Mouro and Castro (2016). Besides reporting the frequency of the four behaviours measured for pro-environmental coworker climate, the respondents also indicated how often they themselves "defend the importance of engaging in environmentally friendly behaviours," "offer to participate in environmental protection initiatives promoted by my organisation," "make suggestions about how my organisation can become more 'environmentally friendly.'" The responses were given on a scale ranging from 1 ("never") to 5 ("very frequently"). The seven-item scale had good internal consistency ( $\alpha$ =0.72), so a mean score was calculated for use in further analyses.

## Common Method Bias

To prevent common method bias, different rating scales were used (Podsakoff et al., 2003). In addition, unrotated principal component analysis was conducted with all the items of the scales used in the present study to check if the adopted measures passed the Harman's single factor test. This test is a diagnostic technique used to evaluate whether common method variance is a problem (Podsakoff et al., 2003). The analysis showed that the first factor explains less than 50% of the variance, more specifically, 28% attributed to the first factor, with a total of 68% of variance explained (Kaiser-Meyer-Olkin=0.81;  $p<0.001$ ). The results thus confirm that common method bias did not significantly weaken the study's validity or distort interpretations of the findings.

## RESULTS

Statistical analyses were conducted using IBM SPSS v26 software, and the mediation test was carried out with the macro PROCESS v3.2 programme (Hayes, 2018). **Table 1** provides the descriptive statistics and intercorrelations between the model's variables and relevant socio-professional characteristics. On average, the participants reported that their organisation is moderately involved in environmentally significant policies and practices (mean=3.62;  $SD$ =0.81) and that some coworkers voluntarily adopt PEBs at work (mean=3.35;  $SD$ =0.73). The respondents also described themselves as having strong personal norms regarding being pro-environmental workers (mean=4.03;  $SD$ =0.57) and a moderately high level of voluntary adoption of workplace PEBs (mean=3.70;  $SD$ =0.65).

Spearman's correlation coefficients were computed because dichotomous variables were present. Both pro-environmental organisational and coworker climate, as well as personal norms, are positively associated with PEBs. Participants' gender, age, and type of employment contract (0=permanent; 1=non-permanent) are not significantly related to the criterion variable. Tenure, level of education, a management or non-management position, and organisation size were significantly related to adopting PEBs in the workplace, so these factors were included as covariates in subsequent analyses. To test the direct and indirect effects proposed in the hypotheses, a mediation analysis was conducted using macro PROCESS's



**TABLE 1 |** Descriptive statistics, correlations, and internal consistency for variables (number = 210).

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8
1. Tenure	9.15	9.34								
2. Education	–	–	–0.24**							
3. Management position	–	–	0.28**	0.03						
4. Organisation size	–	–	0.07	0.01	–0.10					
5. Coworker climate	3.35	0.73	0.12	–0.03	0.07	–0.19**	(0.76)			
6. Organisational climate	3.62	0.81	0.18**	–0.13	0.17*	0.02	0.42**	(0.80)		
7. Personal norms	4.03	0.57	0.19**	0.09	0.18*	–0.02	0.27**	0.34**	(0.77)	
8. PEBs@work	3.70	0.65	0.22**	0.15*	0.21*	–0.19**	0.42**	0.32**	0.49**	(0.72)

*M*, mean. \* $p < 0.05$ ; \*\* $p < 0.01$ .

Management position was scored 0 for “no” and 1 for “yes”; organisation size was scored as 1 for micro (up to nine workers), 2 for small (10–49 workers), 3 for medium-sized (50–249 workers), 4 for large (250–500 workers), and 5 for extremely large (more than 500 workers); Spearman’s rho was used to calculate correlations; Cronbach’s  $\alpha$  in parenthesis.

Model 4 (Hayes, 2018). Tolerance ( $\geq 0.74$ ) and variance inflation factor (VIF) values ( $\leq 1.10$ ) had been previously checked to ensure multicollinearity did not exist between variables. Both values are within the recommended thresholds, exceeding the cut-off point of 0.10 for tolerance (Cohen et al., 2003) and falling below 5.00 for VIF (Montgomery and Peck, 1982).

The first hypothesis focused on the expected positive relationship between employees’ perceptions of a pro-environmental organisational climate and their reported PEBs *via* personal norms. The results confirm that pro-environmental organisational climate significantly predicts employees’ personal norms in favour of PEBs ( $B = 0.16$ ; 95% CI = 0.07; 0.26), and personal norms also significantly predicts reported levels of PEBs ( $B = 0.31$ ; 95% CI = 0.17; 0.46), thus supporting subhypotheses H1a and H1b, respectively (Table 2). In addition, pro-environmental organisational climate’s indirect effect is statistically significant, which provides evidence of a mediation effect ( $B = 0.05$ ; 95% CI = 0.01; 0.06). Hypothesis H1 was thus confirmed.

To determine if the mediation effect was full or partial, the total and direct effects of a pro-environmental organisational climate on PEBs were compared. This climate’s total effect on PEBs is significant ( $B = 0.12$ ; 95% CI = 0.00; 0.22), suggesting that organisations’ investment in environmentally sustainable practices directly contributes to workers’ voluntary PEBs. This climate’s direct effect, however, is not statistically significant ( $B = 0.07$ ; 95% CI = –0.04; 0.17), confirming that this relationship is fully mediated by personal norms. The results, therefore, indicate that a pro-environmental organisational climate reinforces employees’ personal commitment to their organisation’s sustainability. This commitment subsequently generates more voluntary PEBs at work (Table 2).

The second hypothesis posited that a perceived pro-environmental coworker climate would be positively related to reported workplace PEBs. This hypothesis was corroborated by the results ( $B = 0.20$ ; 95% CI = 0.08; 0.31). The model overall explains 36% of the variance in workers’ PEBs at work [ $F(6, 201) = 16.33$ ;  $p < 0.001$ ].

## DISCUSSION

Pro-environmental behaviours in the workplace have received increased attention in the literature in recent years. Organisations are acknowledging their responsibility and central role in the

transition to sustainability, and they have launched multiple initiatives [Klynveld Peat Marwick Goerdeler (KPMG), 2017] – some aimed at reducing their business activities’ environmental impacts. As is true of many other organisational policies, these initiative’s success depends largely upon organisational members’ collaboration (Daily et al., 2009). The latter are responsible for executing daily the processes, procedures, and actions defined by top-level decision makers. More research has thus been conducted to understand more fully how organisations can motivate their employees to behave in pro-environmental ways. Scholars have also increasingly sought to analyse the psychosocial processes that sustain PEBs at work, often based on models and studies of PEBs at home (Whitmarsh et al., 2018).

The present research sought to contribute to this endeavour by investigating whether a pro-environmental organisational climate predicts workers’ involvement in workplace voluntary PEBs *via* a strengthening effect on personal norms. The first hypothesis was supported by a significant mediation effect, indicating that, when organisations invest in pro-environmental policies and practices, these reinforce workers’ personal commitment to becoming pro-environmental. In turn, this personal norm increases the adoption of PEBs at work. These findings corroborate previous studies showing that personal norms – whether general (Zhang et al., 2013; Chou, 2014) or focused on work contexts (Ruepert et al., 2016; Afsar and Umrani, 2020; Ciocirlan et al., 2020) – contribute to workplace PEBs. The current results extend the existing literature by showing that a pro-environmental organisational climate can function as an injunctive norm that incentivises employees’ personal commitment to behaving in sustainable ways, which is in line with a theoretical model of Thøgersen (2006).

More concretely, the present findings extend previous research on the association between a perceived pro-environmental organisational climate and PEBs at work (Norton et al., 2014) by confirming that this injunctive normative influence can also be associated with voluntary PEBs – and not just task-related PEBs – *via* personal norms. As previously highlighted in the literature, personal norms can be particularly important to activating voluntary PEBs at work (Lokhorst et al., 2011; Dumitru et al., 2016). Acting pro-environmentally would be, in this case, rewarded by “doing the right thing” – the internalised sense of obligation that characterises these norms – more than by the external rewards associated with task-related PEBs.

**TABLE 2** | Total, direct, and indirect effects.

	Personal norms			PEBs@work		
	<i>B</i>	LLCI	ULCI	<i>B</i>	LLCI	LCI
<b>Total effect</b>						
Constant				1.56**	0.87	2.25
Organisational climate				0.12*	0.01	0.22
Coworker climate				0.24**	0.12	0.36
Management position				0.14	−0.06	0.33
Tenure				0.02**	0.01	0.03
Education				0.27**	0.14	0.40
Organisation size				−0.07**	−0.13	−0.02
				<i>F</i> (6,202) = 14.65; <i>p</i> < 0.000; <i>R</i> <sup>2</sup> = 0.30		
<b>Direct effect</b>						
Constant	2.21**	1.57	2.85	0.87*	0.14	1.50
Organisational climate	0.16**	0.07	0.26	0.07	−0.04	0.17
Personal norms				0.31**	0.17	0.46
Coworker climate	0.14*	0.03	0.25	0.20**	0.08	0.31
Management position	0.08	−0.11	0.26	0.11	−0.08	0.30
Tenure	0.01**	0.00	0.02	0.01**	0.00	0.02
Education	0.17**	0.05	0.29	0.22**	0.09	0.35
Organisation size	0.01	−0.05	0.06	−0.08**	−0.13	−0.02
			<i>F</i> (6,202) = 9.08; <i>p</i> < 0.000; <i>R</i> <sup>2</sup> = 0.21	<i>F</i> (7,201) = 16.35; <i>p</i> < 0.000; <i>R</i> <sup>2</sup> = 0.36		
		Effect		BootLLCI		BootULCI
Indirect effect		0.05		0.01		0.10

*B*, non-standardised coefficients. \* $p < 0.05$ ; \*\* $p < 0.01$ .

LLCI, lower limit CI; ULCI, upper limit CIs; management position was scored 0 for "no" and 1 for "yes"; organisation size was scored as 1 for micro (up to nine employees), 2 for small (10–49 employees), 3 for medium-sized (50–249 employees), 4 for large (250–500 employees), and 5 for extremely large (more than 500 employees).

The current results, therefore, contribute to clarifying one of the psychosocial processes through which organisational sustainability initiatives can affect employees' pro-environmental organisational citizenship behaviours (Paillé and Boiral, 2013).

The second hypothesis stated that pro-environmental coworker climate (i.e., what workers believe others do) has a positive relationship with voluntary PEBs at work. This hypothesis was also corroborated, a result which is in line with a research of Norton et al. (2014). The present findings also corroborate theoretical frameworks of Cialdini et al. (1990) and Thøgersen (2006), which state that descriptive norms have a direct effect on behaviours (Gökeritz et al., 2010).

## Limitations and Future Research

This study had some limitations that need to be considered when interpreting its results. First, the research relied on self-reported data provided by employees recruited to form a non-probabilistic sample through a convenience sampling approach. Additional studies are required to confirm the findings' robustness by using other sampling methods, surveying workers from specific organisations, or selecting context-specific behaviours. Further research should also focus on gaining a better understanding of the impacts of injunctive and personal norms in different sectors of activity. Previous studies have suggested that personal norms, in particular, can be less closely associated with pro-environmental practices in the primary sector (Niemiec et al., 2020). This pattern could be due to, for instance, farms being a more individualised work setting (Lokhorst et al., 2011; Caffaro et al., 2019) or institutional pressures to engage in PEBs (e.g., environmental laws and subsidies) being resisted or

taking more time to be internalised as personal values (Mouro and Castro, 2016, 2017).

Second, the present study's type of measurement needs to be complemented with other methods for assessing both workplace climate (e.g., using more than one data source and a criteria matrix to analyse and classify organisational policies and practices) and behaviours (e.g., observational data on waste separation). In addition, the present results show that employees' beliefs about coworkers' normative conduct may be affected by the size of the group being evaluated. More specifically, the findings indicate that, in smaller organisations, workers tend to perceive others as acting more often in environmentally friendly ways. This pattern could be related to norm specificity's effect (Mertens and Schultz, 2021). That is, proximal groups in terms of spatial proximity or shared attributes may be more important than distal, more generic groups to individuals assessing a given norm (Goldstein et al., 2008). More research is needed to understand more fully this effect's magnitude, including considering additional referents for larger organisations (e.g., departments) to help clarify norm specificity's role.

Third, another limitation was generated by the correlational research design. Although the mediation analysis (Hayes, 2018) included a directional test of the hypotheses and controlled for systematic errors related to multiple regressions, the model remained recursive, so the variables' causal relationships are still unclear. For instance, organisations that have invested more in environmental policies and in a reduction of production's impacts may also be more likely to recruit workers who value these organisational attributes since recruiters might rely on green human resource management practices (Guerci et al., 2016;

Saeed et al., 2019). In this case, personal norms would be related to a perceived pro-environmental climate *via* the person-organisation fit (Hicklenton et al., 2019).

Last, the interpretation of mediation effects was limited by a cross-sectional design, in which the entire dataset was collected at the same time from the same source. To prevent the occurrence of common source bias, the present study used different rating scales (Podsakoff et al., 2003). The results of Harman's single factor test combined with the weak to moderately strong intercorrelations between the variables under study provide some assurance that common source bias was avoided. However, further studies are needed to address this limitation by adopting a longitudinal design, collecting data at different points in time and/or using multiple sources.

This research examined the role of a pro-environmental climate at the organisational and coworker level in predicting employees' involvement in workplace PEBs. Future studies could also consider the effects of pro-environmental managers' behaviour since previous research has underlined the importance of leading by example (Ramus and Steger, 2000; Robertson and Barling, 2012; Boiral et al., 2015; Wessellink et al., 2017) to PEBs at work. Non-exemplary leaders' role in discouraging PEBs is a significant barrier to these behaviours at work (Yuriev et al., 2018). Another possible avenue of research is related to the inclusion in the present model of variables from the theory of planned behaviour (Ajzen, 1991), which has frequently been used to develop theoretical frameworks for research on PEBs (Wessellink et al., 2017; Canova and Manganelli, 2020; Yuriev et al., 2020; Carrus et al., 2021), especially perceived behavioural control. This factor refers to the extent to which workers feel they are sufficiently in control to be able to perform specific kinds of behaviour in particular contexts. Employees' perceived lack of control can interfere in their ability to adopt PEBs at work (Greaves et al., 2013). Exploring how positive and negative emotions have a role in adopting PEBs at the workplace is another relevant avenue of research, based on recent reviews showing emotions are important predictors of energy saving behaviours (Carrus et al., 2021).

## Practical Contributions

The present study's findings make practical contributions related to how workplace perceptions can have a normative effect that facilitates the adoption of voluntary PEBs on the job. The results highlight how organisations need to not only promote pro-environmental initiatives and policies but also give more visibility to workplace PEBs in which employees voluntarily engage. Large organisations might experience difficulties in translating their commitment to environmental concerns into everyday practices and supporting contexts (Dumitru et al., 2016). Leaders' role can be crucial in implementing good communication strategies for disseminating injunctive norms (Robertson and Barling, 2012) and motivating workers and teams to share their commitment to environmentally friendly performance (i.e., descriptive norms).

As each type of norm or climate dimension has a differential impact on behaviour, organisations can follow both paths to encourage voluntary PEBs more fully at work. For example, conservation behaviours (e.g., reducing energy consumption

and increasing recycling) are considered to be low-intensity behaviours, with low costs for workers and organisations, but these behaviours are also characterised by low visibility (Ciocirlan et al., 2020). Measures that increase the visibility of coworkers' descriptive norms can include developing shared goals and communicating achievements through feedback (e.g., Carrico and Riemer, 2011; Dixon et al., 2014). To activate or strengthen personal norms, expectations about workers' contribution to their organisation's environmental performance can be made more explicit, for instance, through green human resource management practices (Guerci et al., 2016; Saeed et al., 2019).

In conclusion, the present findings help clarify the importance of organisations' investment in environmental policies and initiatives as these appear to contribute to workers' personal commitment to behaving pro-environmentally at work. Employees respond to their environmentally responsible organisation's efforts by engaging in more voluntary PEBs in their workplace. More sustainable production and a faster transition to sustainability rely on organisations' ability to rally their workers around these causes, leading by example, defining goals and making already good green practices more visible.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

CM and AD formulated the study, designed the data collection, performed the analysis, and wrote this article. All authors contributed to the article and approved the submitted version.

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# Social Comparison Information Influences Intentions to Reduce Single-Use Plastic Water Bottle Consumption

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Single-use plastic consumption is at an all-time high and threatens environmental and human health. College campuses in particular serve as a hub for single-use plastics due to their convenience for students on the go. The present research tests whether social comparison information can influence self-perceptions of single-use plastic consumption and motivate behavior change within the college campus environment. In a controlled experiment, we measured college students' existing plastic water bottle usage and gave them false feedback about their behaviors and relative standing to their classmates: participants in comparison conditions learned they were either above or below average in their plastic water bottle sustainability behaviors. Results indicated that (relative to a no-comparison control), being above average at water bottle sustainability led students to be more satisfied with their sustainability efforts. However, either kind of comparison information (i.e., being above or below average) led to greater behavioral intentions to reduce single-use plastic water bottle consumption in the future. This study highlights how comparison information can be used to motivate sustainable behavior change with regards to single-use plastics.

**Keywords:** social comparison, single-use plastic consumption, people-environment studies, sustainable lifestyle choices, environmental identity, self-evaluation

## INTRODUCTION

Every minute, an estimated one million plastic water bottles are purchased globally, and fewer than half of them are recycled (Laville and Taylor, 2017). Americans in particular are responsible for the purchase of 50 billion plastic water bottles per year (Laville and Taylor, 2017). A particular hub for single-use plastics is university campuses (e.g., Smyth et al., 2010). University cafeterias, with multiple food vendors and thousands of students coming to and from class, are a prime site to utilize the convenience of single-use plastics (Fast et al., 2019). Moreover, research suggests that it is in fact university students (not faculty or staff) that are driving the single-use plastic consumption (Diez et al., 2018). Vanderbilt University calculated that students on campus purchase 430,000 plastic bottles per year, and that a university class will consume 1.7 million bottles over 4 years (Kopstain, 1970). In response to the alarming consumption of single-use plastics and its detrimental impact on people and the environment, many universities have made moves towards eliminating single-use plastics and catalyzing change in students' attitudes and behaviors (Kopstain, 1970; Bullock, 2019). One commonly used sustainability intervention is providing consumers with comparison information about others' sustainability habits (e.g., Schultz et al., 2019). The goal of the present

paper is to test how social comparison information can influence university students' attitudes and motivation toward reducing single-use plastic water bottle consumption.

## Motivating Sustainable Behaviors

In recent years, researchers have tested how to motivate sustainable behaviors; one successful strategy for increasing sustainability behaviors is simply making them easier (Thaler and Sunstein, 2008; Benartzi et al., 2017; Varotto and Spagnoli, 2017). For example, one study showed that simply making reusable dinnerware more visible than single-use alternatives in university cafeterias made people more likely to choose the waste-free option (Manuel et al., 2007).

Some researchers argue that even when structural barriers to environmental action are removed, people do not behave sustainably unless they have a strong pro-environmental attitude (e.g., Gifford, 2011) or environmental identity (e.g., Clayton, 2003, 2017). Feeling more connected to the environment (see Nisbet et al., 2008), predicts more pro-environmental behaviors (Hinds and Sparks, 2008; Perrin and Benassi, 2009; Qasim et al., 2019), and even more frequent participation in environmental activism (Schmitt et al., 2019) or volunteer work (Dresner et al., 2015). As such, many researchers argue that the key to promoting sustainable behaviors is to promote a stronger connection to nature or environmental identity within citizens (see Gifford, 2011). Research suggests that it could develop through personal experiences with nature (Prevot et al., 2016), self-efficacy building education (Estrada et al., 2017), and social interaction (Stapleton, 2015).

More generally, a strong influence on self-perceptions and identity is through comparisons with others (e.g., Festinger, 1954; Suls et al., 2002). The present research tests how social comparison information about single-use plastic consumption can influence both self-perceptions of sustainability and motivation for future sustainable behaviors.

## Social Comparison as Motivation

The vast literature on social comparison theory (Festinger, 1954) demonstrates that relative standing with others influences beliefs about the self and can inspire future behaviors (e.g., Kluger and DeNisi, 1996; Lockwood and Kunda, 1997; Mahler et al., 2010; Bruchmann, 2017; Samek et al., 2020). Indeed, in recent years, researchers have turned to social comparison based interventions to encourage more recycling (Schultz, 1999), as well as less water (Schultz et al., 2019), and electricity consumption (Schultz et al., 2015; see Valnoski, 2019 for a review). For example, in one study researchers provided residents of a neighborhood with comparison information about their water usage relative to their community average (i.e., a social norm; Schultz et al., 2019). Residents who were using more water than average reduced their consumption after receiving the comparison information; however, households that were using less water than average continued to consume at a desirable low rate. This study suggests that comparisons with better-off and worse-off others might both lead to desirable outcomes; this may be due to the tendency to use social comparison information to self-enhance (e.g., Bruchmann, 2017). People who learn they are doing better than others might be motivated to maintain their positive sense of self (Wills, 1981).

In contrast, people who learn they are doing worse than others are more likely to be motivated to repair their self-image through committing to improved future behaviors (Mahler et al., 2010; Samek et al., 2020).

## The Present Research

The present research offers a test of social comparison information on university students' self-perceptions of single-use plastic consumption and the motivation and desire to reduce single-use plastic consumption. Participants were given false feedback about their single-use plastic water bottle sustainability behaviors, and in some cases learned that their sustainability behaviors were better or worse than the average student at their university. Participants rated their perceptions of their own sustainability, their motivation to change future behaviors, and their belief in their ability to change future behaviors. Since people generally have more favorable self-impressions when comparing to downward targets, we predicted that participants who learned they were above average would feel better about themselves than those who learned they were below average or a baseline control. However, because comparing with upward targets is more likely to motivate and inspire improved future performance, we predicted that participants who learned they were below average (vs. control) would have more sustainable behavioral intentions for the future.

## METHODS

### Participants and Design

Undergraduates from a mid-sized university ( $N = 181$ ;  $M_{age} = 19.19$ ,  $SD_{age} = 1.03$ ) were recruited to participate in a study about "water bottle sustainability" in exchange for partial course credit. Participants were predominantly female (65.2%) and predominantly white (61.9%). Sample size was determined by making the *a priori* decision to collect data from as many participants as possible across two school terms. Participants were randomly assigned to one of three experimental conditions: above average, below average, or no-comparison control.

### Materials and Procedures

To begin the online study, participants took a bogus Water Bottle Sustainability Quiz created by the researcher team that ostensibly reliably tested a baseline of plastic water bottle sustainability behaviors. Participants read that the quiz was a "validated measure" that was being tested at their university. The quiz included 10 questions with different answer formats, such as yes/no (e.g., "Do you own a reusable water bottle?"), frequencies (e.g., "Across the last 2 months, how many single-use plastic water bottles have you used?"), or response scales (e.g., "how often do you recycle single-use plastic water bottles," 1 = *never*, 7 = *always*). The purpose of these varied scale questions was to ensure that participants did not have a good sense of how they were performing so that the bogus feedback would be believable regardless of their current sustainability behaviors.

### Comparison Feedback

Upon completion of the quiz, all participants saw that their Water Bottle Sustainability Score was a 78 out of 100. This

score was pre-tested with a lab group and a research methods class in order to feel like a middling or “average” score. This numeric feedback was accompanied by the text, “Clearly you have a lot of good sustainable water bottle habits, but there is still room to improve!” For participants in the control condition, this was all the information that was displayed. Participants in the comparison conditions also saw the supposed average scores of students on their campus. Participants in the below average comparison condition learned that the average score was an 85 out of 100 (written in green for emphasis), while participants in the above average comparison condition learned that the average score was a 71 out of 100 (written in red). Note that these two comparison targets were an equal distance away from the participants’ own scores of 78.

### Dependent Measures

Next, participants rated their perceptions of and satisfaction with their Water Bottle Sustainability Score (1 = *very poor/dissatisfied*, 7 = *very good/satisfied*). Participants’ ratings of and satisfaction with their sustainability quiz scores were averaged to create a self-evaluation composite ( $\alpha = 0.71$ ). Then, participants indicated their likelihood of trying to reduce single-use plastic water bottle consumption in the future, and how motivated they were to improve their water bottle sustainability (1 = *extremely unlikely/unmotivated*, 7 = *extremely likely/motivated*). Participants’ reported likelihood of and motivation to decrease single-use plastic water bottle consumption were aggregated to form a behavioral intention composite ( $\alpha = 0.89$ ). In addition, participants also rated if they thought they were able to improve their water bottle sustainability in the future (1 = *definitely no*, 7 = *definitely yes*).

### Environmental Identity

Next, participants indicated how much they identified with nature and the environment. First, participants responded to an 11-item scale measuring Nature Identity (Prevot et al., 2016;  $\alpha = 0.87$  in the current sample). Participants indicated agreement with statements such as “I feel that I am part of nature, not separate from it” (1 = *strongly disagree*, 5 = *strongly agree*). Second, participants completed the three-item Environmental Self-Identity Scale (van der Werff et al., 2013;  $\alpha = 0.89$  in the current sample) by indicating agreement with statements like “Acting environmentally friendly is an important part of who I am” (1 = *strongly disagree*, 7 = *strongly agree*). Finally, participants were asked to recall their own scores and the average scores on the sustainability quiz, were probed for suspicion about the comparison information and the purpose of the study, and were debriefed.

## RESULTS

### Preliminary Analyses

#### Manipulation Check

In order to test whether the social comparison manipulation worked, we examined whether participants were able to recall their own and the average scores. Overall, 98.9% of participants accurately remembered their own score within five points;

there was no difference in accuracy across conditions,  $F < 1$ . Participants in the comparison conditions also overwhelmingly (99.1%) remembered the average comparison information within five points. There was no difference in accuracy between the downward and upward comparison,  $t_{(112)} = 0.90$ ,  $p = 0.371$ ,  $d = 0.09$ .

### Pre-existing Water Bottle Sustainability

Analyzing the answers from our Water Bottle Sustainability Quiz allowed us to examine the existing sustainability behaviors of our sample. Nearly all participants (97.2%) reported owning a reusable water bottle, and over half (56.4%) of the participants indicated that they use reusable water bottles “all the time.” Only 18.3% of our sample reported using more than 2 single-use plastic water bottles in a typical week across the previous 2 months. And, nearly all (81.7%) who use single-use plastic water bottles reported disposing of them in the recycling bin. Overall, from this initial survey, we concluded that our population already showed some sustainable behaviors.

### Environmental Identity

There was not a significant effect of comparison condition on participants’ responses to the Nature Identity Scale,  $F_{(2, 178)} = 2.73$ ,  $p = 0.068$ ,  $\eta_p^2 = 0.030$ , or the Environmental Self-Identity Scale,  $F_{(2, 178)} = 1.54$ ,  $p = 0.217$ ,  $\eta_p^2 = 0.017$ . One-sample  $t$ -tests comparing the mean responses to the midpoint of the scale (4) revealed that participants overall felt a strong nature identity,  $t_{(180)} = 14.28$ ,  $p < 0.001$ ,  $d = 1.02$ , and environmental self-identity,  $t_{(180)} = 10.34$ ,  $p < 0.001$ ,  $d = 1.02$ . See **Table 1** for correlations between nature and environmental identity and our primary dependent measures. Notably, both nature and environmental identity were related to behavioral intentions and ability, and as such, we included them as covariates in our main analyses.

### Primary Analyses

We conducted a series of one-way ANCOVAs with comparison condition as the independent variable and environmental and nature identity as covariates. Note, patterns for all DVs were similar when covariates were not included. See **Figure 1**.

### Self-Evaluations

A significant effect of comparison condition emerged on self-evaluation,  $F_{(2, 176)} = 12.75$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.127$ . As predicted, participants who were told they were above average ( $M = 4.96$ ,  $SD = 0.83$ ) rated themselves more favorably than participants in the baseline control condition ( $M = 4.38$ ,  $SD = 1.14$ ;  $p < 0.001$ ,  $d = 0.58$ ) and participants who were told they were below average ( $M = 3.97$ ,  $SD = 1.02$ ,  $p < 0.001$ ,  $d = 1.06$ ). Additionally, participants who were below average rated themselves less favorably than those in the baseline control condition ( $p = 0.046$ ,  $d = 0.38$ ). Neither of the covariates were related to self-evaluations.

### Behavioral Intentions

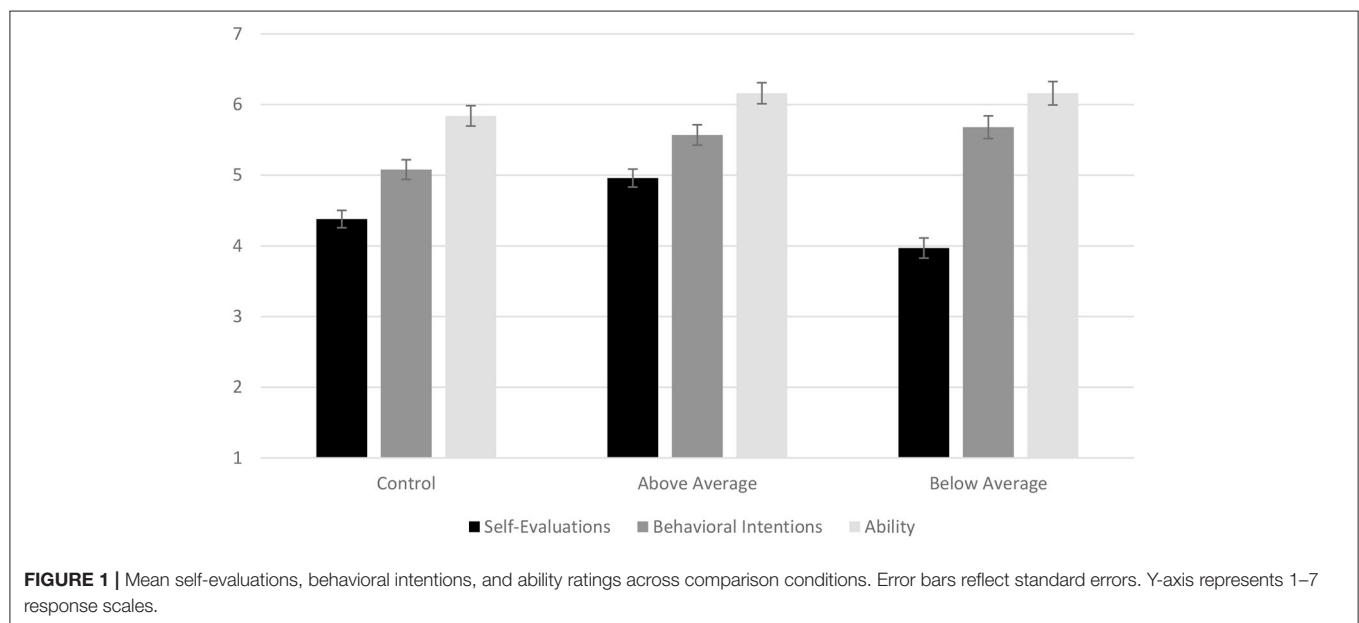
There was a significant effect of comparison condition on behavioral intentions to reduce plastic consumption,  $F_{(2, 176)} = 4.13$ ,  $p = 0.018$ ,  $\eta_p^2 = 0.045$ . Consistent with our predictions,



**TABLE 1** | Means and correlations across dependent measures.

Dependent measure	<i>M</i> ( <i>SD</i> )	1	2	3	4	5
1. Self-evaluation	4.44 (1.07)	1				
2. Behavioral intention	5.42 (1.28)	−0.12	1			
3. Ability	6.04 (1.21)	0.07	0.38***	1		
4. Environmental identity	4.80 (1.04)	−0.15*	0.42***	0.22**	1	
5. Nature identity	5.08 (1.02)	−0.14	0.37***	0.24***	0.61***	1

\*Significance at  $p = 0.05$ , \*\* $p = 0.01$ , and \*\*\* $p = 0.001$ .



participants who were told they were below average ( $M = 5.68$ ,  $SD = 1.25$ ) reported stronger behavioral intentions than the baseline control condition ( $M = 5.09$ ,  $SD = 1.35$ ,  $p = 0.046$ ,  $d = 0.45$ ). Contrary to our predictions, participants who were told they were above average ( $M = 5.57$ ,  $SD = 1.78$ ) also reported greater behavioral intentions of future water bottle sustainability behaviors than those in the baseline control condition ( $p = 0.007$ ,  $d = 0.30$ ). There was no difference between participants who were told they were above or below average ( $p = 0.578$ ,  $d = 0.07$ ). There was a significant effect of both covariates: environmental identity,  $F_{(1, 176)} = 12.13$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.064$ , and nature identity,  $F_{(1, 176)} = 6.06$ ,  $p = 0.015$ ,  $\eta_p^2 = 0.033$ . Consistent with previous research, this suggests that greater feelings of connection to the environment or nature predict motivation to be more sustainable. Notably, our sample overall reported relatively strong ( $M = 5.42$ ,  $SD = 1.28$ ) behavioral intentions to decrease plastic consumption compared to the midpoint of the scale (4),  $t_{(180)} = 14.92$ ,  $p < 0.001$ ,  $d = 1.28$ .

### Perceived Ability

We did not find an effect of comparison condition on participants' perceived ability to decrease single-use plastic water bottle consumption,  $F_{(2, 176)} = 1.76$ ,  $p = 0.190$ ,  $\eta_p^2 = 0.019$ . A one-sample  $t$ -test revealed that in general participants rated their ability to become more sustainable ( $M = 6.04$ ,  $SD = 1.21$ ) above the midpoint of the scale (4),  $t_{(180)} = 22.62$ ,  $p < 0.001$ ,  $d = 1.21$ .

There was also a marginal effect of the covariate nature identity,  $F_{(1, 176)} = 3.80$ ,  $p = 0.053$ ,  $\eta_p^2 = 0.02$ . Consistent with previous research, this suggests that a stronger feeling of connection to nature may be related to self-efficacy surrounding sustainability.

## DISCUSSION

In general, we found evidence that social comparison feedback can be an effective way to motivate the reduction of single-use plastic water bottle consumption. We saw evidence that undergraduates who learned they were above-average in water bottle sustainability behaviors at their university had more favorable self-impressions surrounding their sustainability than a baseline, consistent with research that suggests people use comparison information from worse-off others to self-enhance (Wills, 1981; Bruchmann, 2017).

However, we saw evidence that whether participants learned they were above or below average, they had greater intentions to be more sustainable in the future (relative to baseline). As such, it seems likely that different mechanisms account for a motivation to improve for people with upward vs. downward comparison information. For example, learning that their sustainability efforts are below average may be threatening to self-perceptions and lead people to want to repair their self-image. Indeed, research suggests that after threatening feedback, people try to repair self-esteem by self-enhancing (e.g., Friend and Gilbert,

1973) or by reporting higher expectations of future successes (Aspinwall and Taylor, 1993; see Johnson, 2012 for a review). However, learning their sustainability efforts are above average may lead people to want to *maintain* a positive self-image; the self-evaluation maintenance model (Tesser, 1988) suggests that people are motivated to preserve and protect a positive self-image. Thus, expecting that future behaviors will be even more sustainable may be a way to maintain a favorable and sustainable self-image. Additionally, social comparison research suggests that comparisons with better-off others can under certain circumstances lead to feelings of inspiration (e.g., Lockwood and Kunda, 1997) or motivation to improve in the future (e.g., Suls et al., 2002). Assimilation toward better-off others is particularly likely when the comparison targets are relevant and the successes seem attainable (Lockwood and Kunda, 1997); in the case of our study, students were comparing themselves to peers, and generally reported feeling able to improve sustainability behaviors suggesting that they thought other successes were attainable.

Interestingly, we did not see any effect of social comparison information on people's perceived ability to practice more plastic water bottle sustainability. In fact, participants reported that they were very able to improve. This suggests that social comparison information is influencing a *desire* to be more sustainable, and not necessarily concerning self-efficacy beliefs about being sustainable or action plans to achieve their goals.

## LIMITATIONS

Because our data is cross-sectional, we were only able to measure behavioral intentions to increase plastic water bottle sustainability behaviors, and were not able to measure actual change in behavior. However, other research suggests that social comparison information from better-off others can and does influence actual behaviors surrounding energy consumption (Schultz et al., 2015) or water usage (Schultz et al., 2019). So, it is possible (or even likely) that students who found out they were below average in plastic water bottle sustainability on their university campus could actually show a change. Whether participants who thought they were above average would actually change behaviors is an empirical question; it is possible that reporting greater behavioral intentions than the baseline condition was a means of self-enhancing and that actual behaviors would not change, especially if other situational barriers emerged (e.g., Kaiser and Schultz, 2009). Consistent with this, in a study about social comparison and skin cancer prevention, Mahler et al. (2010) found that comparisons with worse-off others actually negated positive effects of other interventions and did not increase sunscreen usage among participants. As such, it is important for future research to test whether increased motivation to reduce plastic consumption translates to actual behaviors for social comparison conditions.

Additionally, our sample, which is drawn from a university that boasts several sustainability initiatives (Plan, 2019) and regularly finds itself on lists of "most sustainable college campuses" (e.g., Top 50 Green Colleges, 2020) may not be representative of undergraduates more generally, or a broader

population. Because the campus culture overall highly values and emphasizes sustainability, it is likely that students in general feel a stronger environmental identity or more efficacy around sustainability behaviors. This could influence how social comparison information is used; future research should test the effects of social comparison information on single-use plastic water bottle consumption across more diverse populations. Furthermore, future research should recruit higher-powered samples in order to test the generalizability of these preliminary findings.

Finally, our experiment required participants to take a "sustainability quiz" before getting social comparison feedback. In a more naturalistic setting, it is likely that only sustainability inclined participants would be motivated to participate in this type of quiz. Alternately, it is possible that completing the quiz and reflecting on personal single-use plastic consumption before receiving comparison information contributed to the effects. Future research should examine alternative ways to provide social comparison feedback; for example, in campus cafeterias, signs could be displayed near coolers of single-use plastic water bottles that provide comparative information about sustainability-related behaviors across campus.

## CONCLUSION

This research provides evidence that social comparison information can be used as a way to motivate more sustainable single-use plastic behaviors. And, because of the high plastic usage on university campuses, targeting an undergraduate population to become more sustainable can influence the overall campus culture. As single-use plastic consumption continues to threaten our environment and well-being, motivating even the smallest behavioral changes can have an immense positive impact for current and future generations to come.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Santa Clara University Human Subjects Committee. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

All authors contributed equally and are listed in alphabetical order. KB, SC, KD, KN, and CP contributed to the conception and design of the study. KB, SC, and KN performed the statistical analysis and wrote sections of the manuscript. SC, KD, JL, KN, and CP wrote the first draft of the manuscript. All authors contributed to the manuscript revision, all authors read and approved the submitted version.

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# The Physical Learning Environment of Online Distance Learners in Higher Education – A Conceptual Model

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Online distance learning is offered not only in post-secondary distance education institutions but in traditional universities as well. With advances in mobile and wireless technologies, completing academic studies anywhere anytime should become feasible. Research in distance education and online learning has focused on computer-mediated communication, instructional design, learner characteristics, educational technology, and learning outcomes. However, little attention has been given to where exactly learners do their learning and studying and how the physical and social aspects of the physical environment within which the online learner is physically embedded (e.g., the home) supports and constrains learning activities. In this paper, the author proposes a conceptual model for understanding the role that the physical environment plays in online distance learning in higher education, drawing on theories and research in environmental psychology, online learning, telework and mobile work, and higher education. Several gaps in research are identified, and suggestions for future research are proposed.

**Keywords:** physical learning environment, online learner, distance education, higher education, mobile learner

## INTRODUCTION

Distance education has emerged as an important form of education in the last few decades (Lee, 2017; Xiao, 2018). Institutions, such as the British Open University and Canada's Athabasca University, have offered university education online for some years. In recent years, traditional universities have begun offering online courses as well (Lee, 2017; Donovan et al., 2019). A recent national survey indicated that 30 percent of higher education students in the United States had taken at least one online course by distance (Ortagus, 2017). The popular use of portable and mobile devices in our daily lives and accessibility to wireless connectivity at home, workplaces, and many public places should make completing academic studies feasible in multiple settings, seemingly anywhere anytime and while on the move, as some have argued (Traxler, 2009; Hsu and Ching, 2015; Pimmer, 2016).

In the research literature on distance and online education, discussions have historically revolved around interactions between learner and content, other learners, teacher or facilitator (Moore, 1989), and the larger online community (Bozkurt et al., 2015). Until recently, little attention has been paid to one type of interaction: between learner and the physical environment. Regardless of what learning devices students use and what online instructional or learning environments they are in, students are embedded in the physical world (Graetz, 2006) and perhaps surrounded by people as well. The physical (e.g., ambience) and the social (e.g., alone

or with others) contexts may support or hinder online learning activities.

There is a need to understand the complex relationships between learners, their ways of learning and studying, and the environments within which they study, both physical and virtual. The recent incorporation of information and communication technologies (ICT) on university campuses has led to investigations of such relationships within the facilities of traditional universities (e.g., Fisher and Newton, 2014; Beckers et al., 2015), but little research has focused on places beyond these campuses (e.g., students' homes). Other studies have focused on informal learning in field settings (e.g., museum; Wang et al., 2017). With a few exceptions (e.g., Alphonse et al., 2019), research in online learning has not focused on where exactly learners do their learning and studying and how a physical place (e.g., the home) supports and constrains learning activities. Such an understanding would have implications for environmental designers, educators in pedagogical design, and online distance learners.

The purpose of this paper is to propose a conceptual model for addressing the role that the learner's physical environment plays in online learning. The emphasis is on the physical environment though the virtual online environment is always in the background. The model is built upon literature in environmental psychology, online learning, telework and mobile work, and higher education. The focus is on learners pursuing formal university education at a distance in this digital age in developed countries. The paper will begin with an overview of online distance education, several relevant conceptual models, and then the proposed model. It is followed by a description of its components and the interrelationships between the components, and ending with a conclusion, suggestions for future research, and practical implications. My hope is for this paper to stimulate research into how pedagogical design of online distance education needs to consider the physical situated environment as well as its relations to the tools the learner uses. This seems particularly relevant during the current global pandemic (COVID-19) as educators need to teach online to students in diverse dwelling conditions and living arrangements, and access to computer devices and applications and internet connectivity.

## ONLINE DISTANCE EDUCATION

Historically, the goal of distance education was to provide post-secondary education to individuals, primarily adults who could not attend campus-based universities for personal, social, geographical, or other reasons (Lee, 2017). The delivery of distance education has evolved from the use of mail (correspondence courses) to analog audio-based (radio and audio cassette tape) and video-based (television and videotape) technologies, and later, to personal computers and the Internet (Lee and Chan, 2007). By using asynchronous and synchronous features, online learners can have control and flexibility in their learning regarding time and location (Shih et al., 2008). However, learning activities needed to be carried out at a specific physical location with a fixed device (Lee and Chan, 2007).

In recent years, the popular use of portable and mobile devices and accessibility to wireless technologies in our daily lives have stimulated a growing interest in the use of these technologies in higher education and distance education (Park, 2011). Apart from mobility and context, these technologies have the capability to incorporate multiple media (e.g., videos, text, and voice) and to facilitate "spontaneity, interactivity, informality, and ownership in learning" (Traxler, 2009). These capabilities have led to possibilities for developing multi-media, interactive course material, and learning activities to complete in multiple settings and while on-the-go. For example, students can use various functions on their mobile device (e.g., camera to take photos in the field) and share with other online learners, as in a graduate level graphic design course (Hsu and Ching, 2012).

Given these possibilities, Guri-Rosenblit (2009) has cautioned against perceiving online learning as the new generation of distance education; bridging over the digital divide and delivering cost-effective distance education in the digital age remain a challenge. The delivery of distance education in a cost-effective manner depends on economy of scale (Xiao, 2018). In addition, even though students in online distance education have become more diverse since the mid-1990s (Lee, 2017), it is those students who are older (Johnson, 2015) or who cannot afford campus-based education that are more likely to take online courses and programs (Ortagus, 2017).

Current developments in context-aware, situated learning could possibly be incorporated in online distance learning. Context-aware learning involves students accessing or be presented with information that are relevant to the physical location when the student is physically at that location (Hsu and Ching, 2015) and perhaps with augmented reality layers as well (e.g., Chang et al., 2013; Ryokai and Agogino, 2013).

## RELEVANT CONCEPTUAL MODELS

Next, several conceptual models that are relevant to online learners' physical learning environments are described briefly. The Task Model of Mobile Learning and the models of telework and mobile work address how learners and knowledge workers, respectively, carry out cognitive tasks and communicate with others at one or more physical settings *via* the Internet. The Behavior Setting theory focuses on user behaviors and the social rules and norms within a specific physical setting, and the Task Model of Mobile Learning touches upon the physical context of the learner. **Table 1** shows a comparison of these models.

### The Task Model of Mobile Learning

Few existing models for designing mobile learning experiences and environments have focused on, or even mentioned, the physical environment as a component (review by Hsu and Ching, 2015). One of these few is Taylor et al.'s (2006) task model of mobile learning. This model comprises three basic elements of learning (i.e., learner, learning goal, and tools) and three essential components of mobile learning (i.e., context,

**TABLE 1** | A comparison of models relevant to online distance learning in higher education (Authors).

Model (Authors)	People	Activities	Physical settings	Social context	Key ideas
Task model of mobile learning (Taylor et al., 2006)	Learners	Cognitive and communication	One of the contexts (independent, formalized, physical, and socialized)	One of the contexts (independent, formalized, physical, and socialized)	Three components of learning: learner, learning goals, and tools. Three components of mobile learning: context, control, and communication. Mobile technologies allow learners to achieve a learning goal in the most appropriate context via various communication channels and to control the learning process.
Model of telework (Standen et al., 1999)	Knowledge workers	Cognitive and communication	One (home) or two (home and organizational space)	Online and in-person	Variables in family/personal domain interact with variables in work domain to affect outcomes
Model of mobile work (Koroma et al., 2014)	Knowledge workers	Cognitive and communication	Multiple: home, organizational, public spaces	Online and in-person	Work outcomes affected by resources and barriers (physical, social, and virtual)
Behavior setting theory (Barker 1968; Wicker, 2002)	All	All user behaviors	One specific setting at a time	In-person	Physical milieu associated with a standing pattern of behavior. Furniture and equipment afford action possibilities. Social rules and norms support and constrain user behaviors

control, and communication). The use of mobile technologies allows the learner to learn in an environment or context that is most appropriate and to control the learning process as well (Frohberg et al., 2009). For example, the learner's current environment may be independent or having no relationship to the context of learning (i.e., learning from anywhere). On the other hand, the physical context could be relevant to the learning at hand at a particular time (e.g., during a field trip). How tools (e.g., mobile devices) are used would depend on the cognitive rigor. Control can range from tight teacher control to full learner control. Mobile technologies can improve communication and interaction by offering different communication channels. The scale of communication can vary from the isolated learner at one end to collaboration between teams at the other end (Frohberg et al., 2009).

## Models of Telework and Mobile Work

In telework and mobile work, the employee's workspace is embedded within a physical setting or multiple settings. The physical environment is considered an essential component in conceptual models of telework and mobile work. For example, Standen et al.'s (1999) model of teleworking from home emphasizes how variables in the family or personal domain (dwelling size, household size and composition, activity pattern, and social support) and the work domain (social and physical work environment, job characteristics, and organizational characteristics) interact to affect job satisfaction, performance, and wellbeing. Similarly, effective mobile working is influenced by the resources and barriers present in multiple work settings. In Koroma, Hyrkkänen, and Vartiainen's conceptual model (2014), they have identified several physical hindrances when working in multiple settings (e.g., limited working space) as

well as associated challenges presented by the social environment (limited privacy and lacking social support) and the virtual environment (e.g., limited connections and access, and lacking ICT support).

## Ecological Theory

Ecological theories (e.g., ecological model of development; Bronfenbrenner, 1979) take a multi-level, systems approach to understanding how people's behavior and wellbeing are influenced by their everyday surroundings and how people actively change their surroundings. The individual plays a role in the center of each context, and there is a transactional relationship between the individual and the context. The contexts are connected through a system of meso-system links.

Barker (1968) posited the concept of behavior setting as consisting of the physical milieu of a setting together with a naturally occurring, standing pattern of behavior within that setting. The traditional behavior settings include the home, schools, workplaces, coffee shops, and others. Within a behavior setting, affordances (Gibson, 1979), referring to properties in the environment that can provide functional possibilities for an individual as that individual sees it, are present (Heft, 2012). For example, a sofa at a public library affords sitting down to read a book. Each behavior setting has its furniture and equipment, and the participants' behaviors within the behavior setting are regulated by social rules and norms. Participants' choices are constrained, with the range of appropriate behaviors being maintained and inappropriate behaviors being sanctioned by the collective actions of other participants (Wicker, 2002; Heft, 2012). For example, a learner may use the dining table at home to do studying but would need to clear the table when supper time comes. Over time, the behavior setting will

change in response to input from outside or actions by individual participants of the setting (Wicker, 2002).

Stokols (2018) has recently highlighted the influence of virtual features of our surroundings on our behaviors and wellbeing and how the cyberspace has had an important impact on the structure and functions of our built and social environments. The cybersphere has become intertwined with the built, natural, and social-cultural features of our environments, and contextual influences can be identified along spatial, temporal, sociocultural, and virtual dimensions.

From an ecological perspective, the online distance learner is at the center of each context that the learner is in (e.g., home, educational, work, and virtual). As the learner moves between locations, the transactional relationship between the learner and the context changes (Terras and Ramsay, 2012).

(e.g., desktop PC) or carries with him or her (e.g., smart phone) and furniture and equipment provided within that setting (e.g., a desk at home, a small table at a cafe, and wireless connectivity). The learning activities can be supported or hindered by the physical and social aspects of that behavior setting. At the same time, the learner is connected to the learner's institutional virtual learning space, peers, and online community and resources, which can also provide support or present obstacles for the performance of learning activities. Over time, if and when the learner moves from one behavior setting to the next, a new set of activities, and supports and constraints may take over. The learner has the capacity to connect to the virtual environment *via* the Internet.

The following section describes each component of the proposed model, and the next section describes the relationships between these components.

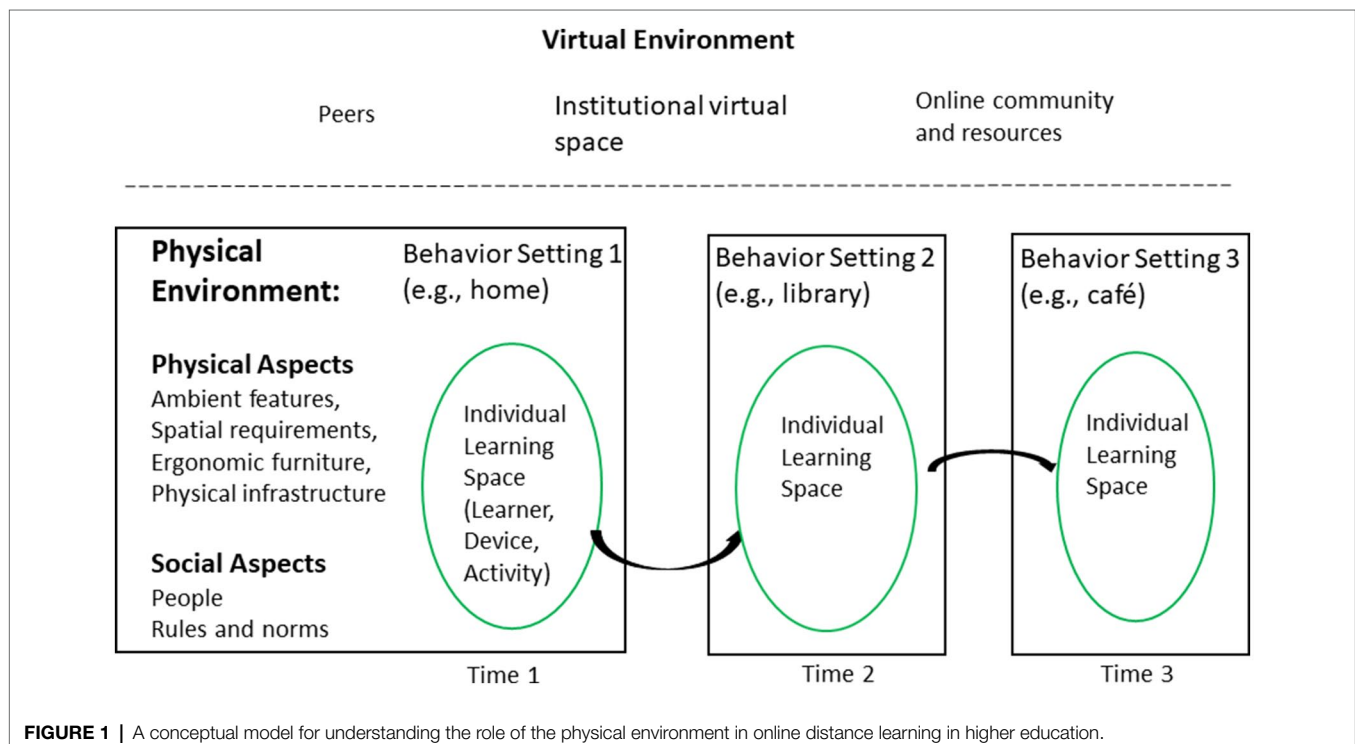
## PROPOSED CONCEPTUAL FRAMEWORK

Building on the models outline above, I proposed a conceptual model that has three components: (1) a learner's individual learning space (consisting of the learner, learning activities, and learning devices), (2) the physical environment (behavior setting) in which the learner is located, and (3) the virtual online environment (see **Figure 1**).

At any one time, an online learner's individual learning space is embedded within one of several traditional behavior settings (e.g., home, library, workplace, café, and public transport). The learner carries out a number of learning activities (e.g., writing an essay, communicating with instructor, and taking photos) using technological devices that the learner has

## Behavior Setting

Unlike campus-based university students, online distance learners perform their learning activities in one or multiple behavior settings that are not necessarily designed as learning spaces (**Figure 1**). In several studies, working adult learners completing courses, programs, or work-based learning online at a distance reported that they studied mostly at home (Willging and Johnson, 2004; Nie et al., 2011; Selwyn, 2011; Alphonse et al., 2019). However, the workplace (Haythornthwaite and Kazmer, 2002; Nie et al., 2011) and public spaces (e.g., libraries, cafes, hotel rooms, airports, and buses) were used as well (Willging and Johnson, 2004; Nie et al., 2011; Bayne et al., 2013; Alphonse et al., 2019). The choice of setting(s) may have been influenced by the learner's age, employment status, and program level,





as most of these studies involved working adults in graduate programs.

In some cases, the behavioral setting itself is crucial for learning. Field trips or field work has been considered essential learning activities in some academic disciplines (e.g., geology and ecology). Depending on the learning goal, online learning activities could be designed to be carried out at local physical settings (e.g., museum) with context-aware mobile devices and applications that can detect the current context of the learner (e.g., location and time) and allow the learner to interact with the surroundings or to receive information pertinent to that particular context and time (Brown and Mbatia, 2015; human geography field course, Jarvis et al., 2016).

Next, how the physical and social aspects of behavior settings can influence the learning activities of online learners are discussed. The physical environment includes the sensory stimuli from the built environment (e.g., lighting, noise, and temperature) and the physical presence of other people. The physical environmental can affect learning and performance through cognitive (attentional distraction and reduced concentration), physiological (temperature changes and comfort level), and affective means (e.g., motivation; refer to revised cognitive load model, Choi et al., 2014), especially when the learner is in a physical setting that is not primarily designed for learning (Terras and Ramsay, 2012). Empirical research has clearly shown that environmental stimuli from the physical learning environment can increase the cognitive load on learners' working memory. As it takes effort for a learner to process irrelevant environmental stimuli, extraneous environmental stimuli should always be removed, or at the least, minimized (Choi et al., 2014).

When learners move from one physical setting to the next, they are exposed to many environmental cues, and changes in environmental stimuli can disrupt the engagement of the learner. Therefore, mobile learners need to develop skills in attention control to inhibit responses to extraneous stimuli (Terras and Ramsay, 2012). On the other hand, mobility from one place to another can be a resource for creativity through the provision of stimulation from different environments, people, and events, as in nomadic freelance creative work (Liegel, 2014) or as a relief from monotony experienced by mobile workers (Hampton and Gupta, 2008).

## Physical Aspects

### *Ambient Features*

The need for a functional and comfortable space (with control of temperature, noise, lighting, air quality, and ergonomic furniture) has been expressed by working adults in online graduate programs (Willging and Johnson, 2004; Alphonse et al., 2019), as with teleworkers (Montreuil and Lippel, 2003) and campus-based university students (Solbert and Rismark, 2012; Beckers et al., 2016) who chose to work or study sometimes from home. Noise, lighting, and movement particularly can affect the learning of online learners.

Noise can impair an individual's concentration and performance of complex tasks (Banbury and Berry, 2005). Meaningful background conversations (van de Poll and Sörqvist, 2016) and intermittent, unpredictable, or uncontrollable noise

(Smith, 1985) are particularly detrimental. As with teleworkers (Gurstein, 1996) and mobile knowledge workers (Hislop, 2012), online graduate students have indicated their need for quietness at home or elsewhere to engage in individual, cognitive work (Alphonse et al., 2019). Some preferred studying with some continuous background sound (Scannell et al., 2016). Others use their iPod and headphones to block out prohibitive ambient noise or listen to their own music while studying. Engaging in any audio-rich online learning activities (e.g., language learning) can be difficult in a noisy environment without the use of headphones.

For reading and other viewing activities, online graduate students studying at home (Alphonse et al., 2019) have reported the need for adequate lighting and a preference for window access to view outside, as with teleworkers (Gurstein, 1996) and mobile knowledge workers (Brown and O'Hara, 2003). The lighting quality for computer work is dependent on several factors, such as illuminance, luminance, direction of light, glare, light source, screen design, and users' visual ability (c.f. review by Osterhaus et al., 2015). Improper lighting, visual display position, and viewing distance contribute to "the computer vision syndrome" (eye strain, dryness, and neck and shoulder pain). The increased use of hand-held devices (e.g., e-readers and smart phones) under varying lighting conditions and closer viewing distances than desktop displays can present additional visual challenges (Gowrisankaran and Sheedy, 2015). Good display quality of computer tablets has been shown to cause less visual fatigue than poor display quality ones during long periods of viewing (Chen et al., 2016).

Studying with mobile devices while on the move is possible but can be challenging. To save time, graduate students completing online, work-based learning programs have reported using e-readers while travelling in public transport (Nie et al., 2011). The ambient conditions can constrain certain work activities when traveling in a vehicle, as reported by mobile knowledge workers (e.g., Hislop, 2012). Learning *via* listening to podcasts is possible while the learner is physically moving (walking or jogging), but learning is less effective than when sitting (Coens et al., 2011). Text input performance was reduced when the mobile device user was walking (Musić and Murray-Smith, 2016). Nevertheless, moving about within a physical setting and exploring with the help of a mobile device is itself part of situated learning (e.g., geography course; Jarvis et al., 2016).

### *Ergonomic Furniture*

The computer workstation should be set up to allow the learner to sit directly in front of the computer screen with the top of the screen near eye level and the keyboard and mouse at elbow level. The chair should be height-adjustable and provides support to the user's back (Honan, 2015). When working with a laptop, the user can make few adjustments to the body position, leading to neck and back pain and stress for the eyes and wrists (Janneck et al., 2018). Therefore, prolonged use of laptop would be better supported by an external monitor, mouse, and keyboard (Honan, 2015). Handheld devices, such as tablets and smartphones, can lead to wrist and neck pain if used for a long period of time. It is even worse working

with a portable or mobile device on non-ergonomic furniture (e.g., at the kitchen table or on a sofa in the living room; Janneck et al., 2018).

### **Spatial Requirement**

Researchers have reported that having a designated place was important for successful course completion online (Osborn, 2001; Holder, 2007; Alphonse et al., 2019) and telework (Hartig et al., 2007). Although some online learners live alone or have a study space set up, other adult distance learners reported having to set spatial boundaries between home and studies. They needed to negotiate a space within their household (Haythornthwaite and Kazmer, 2002; Selwyn, 2011) or with occupants of other spaces, as with teleworkers (Magee, 2000) and mobile workers (Hislop and Axtell, 2009). Men were more likely to have their own office, but women tended to study elsewhere within the home (Selwyn, 2011). With the use of portable and mobile devices, online learners should have the flexibility to move across locations within the home to complete learning activities, if they wanted. However, such mobility may be associated with the age of the learner. The working adult students in the Alphonse et al. (2019) study used only desktop computer and laptops, and wi-fi connections but not newer devices, and those in the Lee and Chan (2007) study preferred to listen to podcasts at a dedicated study location (typically at home) instead of listening to them on portable devices while doing other activities.

### **Physical Infrastructure**

Online learners need to have access to high-speed Internet, wireless connection, power outlets, and a variety of computer devices, as do mobile knowledge workers (Hampton et al., 2010; Mark and Su, 2010) and campus-based students (e.g., Beckers et al., 2016). Today, most people in developed countries have high-speed Internet connections at their work, home, or school (Statistics Canada, 2021; Pew Research Centre, 2021a), and wi-fi has been commonly available in many public places (Doyle, 2011) for some years. However, data security remains a concern when working at coffee shops and other wi-fi hot-spots (Mark and Su, 2010). Cyber security can be a problem as well (Gaines, 2019).

Internet connection can be spotty and slow in those spaces with no wi-fi access (Seneca, 2014), and high-speed Internet services are less accessible to homes in rural areas in the United States (Pew Research Centre, 2021a). Low bandwidth restricts access to resource-rich materials (e.g., video-clips and video streaming) and the downloading of large files (Brown and Mbat, 2015). Cloud computing has now enabled online learners to store and access documents, audio, and video files *via* mobile devices from anywhere (Wang et al., 2014).

Persistent data services range from limited access to continuous access. Learners' access is restricted by locations of wi-fi access points within a community or cellular network tower locations, or their cellular data services plan. Those learners with continuously available persistent network access can use many more functions (Grant, 2019). In contrast, mobile Internet access offers lower levels of functionality and content availability and operates on less open and flexible platforms (Napoli and Obar, 2014).

### **Social Aspects**

How well a learner can engage in various learning activities can be affected by people's activities, and the rules and norms of the behavior setting. Adult distance learners reported having difficulty not interacting socially with their family members, especially children, when at home (Haythornthwaite and Kazmer, 2002; Selwyn, 2011). Similarly, home teleworkers and mobile workers reported the need to negotiate rules regarding interruptions by people within and outside their home (Johnson et al., 2007) and in public places or transport (Hislop, 2012). Putting on the headphone to evade social interactions with those physically present and to communicate the need for privacy seems to have become a new social norm (Enriquez, 2013).

On the other hand, the presence of other people in the behavior setting could facilitate learning and studying in some situations, as social facilitation theory suggests (Zajonc, 1965). At the least, students reported high satisfaction when they watched videos for an online course together at the same location (Li et al., 2014).

Like teleworkers and mobile knowledge workers (Perry et al., 2001; Cooper and Kurland, 2002), students in distance education have reported feeling isolated (Wheeler, 2002). Building interpersonal relationships with others at home or in other behavior settings is important for learners pursuing academic studies completely online at a distance. The social support online learners received from family, friends, and colleagues have been reported to be an important predictor of student persistence (Holder, 2007; Ivankova and Stick, 2007; Lee and Choi, 2011).

### **Individual Learning Space**

Next, the second component of the proposed model, the individual learning space, comprising learning devices, the learner, and learning activities will be described. These are the three basic, inter-related elements of learning stipulated in the task model of mobile learning (Taylor et al., 2006). Likewise, the characteristics of the learner, learning task and its associated use of learning tools, and the interaction between learner and task characteristics are identified as the main factors affecting cognitive load and learning (Choi et al., 2014).

### **Learning Devices**

Online learners must have access to appropriate learning devices and applications to be able to learn and study effectively at home and in multiple settings (Alphonse et al., 2019). To be effective, the applications need to be adapted to the tasks and the learner's skill level, and technical assistance needs to be easily available to those students. Lack of technology preparation and technical support was identified as a reason for online learners to drop out of their programs (Willging and Johnson, 2004).

Learning devices may include desktop PC, portable devices (e.g., laptop), and mobile device (e.g., smartphones) for completing various learning activities in various physical settings. In a usability study, the users reported tablet PC to be less desirable than laptop PC, although the users could perform

such tasks as reading well and were impressed by the general computing capabilities and portability of tablet PCs (Ozok et al., 2008). In another study, students found the iPad had enhanced their learning experience but not necessarily learning outcomes (Nguyen et al., 2015).

Ownership of mobile devices, such as smart phones, has increased rapidly in developed countries (Pew Research Centre, 2021b). In 2021, 85 percent of all adults in the United States owned a smart phone; of the 18–29-year-olds, 96 percent said they owned a smartphone (Pew Research Centre, 2021b). Mobile devices offer the benefits of portability, connectivity, convenience, expediency, immediacy, accessibility, individuality, and interactivity (Song, 2011, as cited in Terras and Ramsay, 2012). Mobile devices can support learning through enhancing users' cognitive functions, such as performing calculations, note-taking, and accessing information *via* mobile internet (Terras and Ramsay, 2012). At the same time, these devices can also “solicit” demand for attention, as some proponents of the enactivism approach to cognition argue (Aagaard, 2018).

Usability for mobile phones is dependent on their features and physical limitations, technology, usage goals and environment, and user characteristics (e.g., compatibility between different platforms and devices, amount of human-device interaction, ergonomics, and readability and layout; Salazar et al., 2013). The small screen size of mobile devices can be problematic for users (Coursaris and Kim, 2011). A smartphone with larger screen (5.3 inches) was perceived more positively and easier to use than was a smartphone with smaller screen (3.7 inches; Kim and Sundar, 2014). Likewise, usability of mobile phone applications needs to be evaluated using standardized measurement scales (von Wangenheim et al., 2016) and for different devices and genres (Ahmed et al., 2018). Surprisingly, applications on phone platforms were perceived by users to be more usable than applications on the tablet platforms, partly due to ineffective mimicking of the large-screen functionality of desktop PC on tablet apps but effective focus of phone platforms on the core functionality needed by the users (Kortum and Sorber, 2015). The key is to use the right tool for the right job (e.g., smartphone for checking email and sending text updates, but larger-screen devices for extensive writing and other content creation activities; Honan, 2015).

Podcasts represent a low-threshold technology to deliver regular recordings of difficult, content-heavy material to learners who have little resources and a fear of technology (Gachago et al., 2016). Although some studies have reported students using mobile devices to listen to podcasts only infrequently when on the move (Lee and Chan, 2007; Evans, 2008; Pearce and Scutter, 2010), other studies have reported that students used e-readers or downloaded apps to read in short stretches of time while traveling or in public places, or when outdoors even with no access to an Internet connection (Nie et al., 2011; Seneca, 2014).

No doubt any technical limitations are temporary as advances in research in human-computer interactions are made to accommodate users' physiological and psychological needs in response to ambient conditions and locations (e.g., home and train; Chen et al., 2008) and individual needs and preferences through various platforms, devices, and tools (e.g., Hsieh and

Chen, 2016). For effective learning, mobile device should follow mobile design principles that are based on mobile user context, learning theory, and user interface design (Seneca, 2014), and learning applications design must consider the pedagogical effectiveness and technical functionalities and usability (Yau and Joy, 2010).

## Learner Characteristics

Online learners today use technologies to different extents, and their skills and comfort levels vary (Gallardo-Echenique et al., 2015). Age could be a factor, as suggested in Alphonse et al.'s (2019) study of older, online graduate students. Whether or not “digital natives” have high digital literacy regarding the use of technologies for academic purposes is still being debated (cf. review by Gallardo-Echenique et al., 2015).

Social economic background continues to contribute to the digital divide (Guri-Rosenblit, 2009; van Deursen and van Dijk, 2018). Even within developed countries, such as the United States and Canada, those with lower income are less able to afford high-speed Internet services at home (Statistics Canada, 2021; Pew Research Centre, 2021a). In 2021, 15 percent of US adults were smartphone dependent (Pew Research Centre, 2021b), and the cost associated with cellular data plan is a legitimate concern (Grant, 2019). In the Netherlands, income level was associated with access to a diversity of devices and peripherals and the ability to afford maintenance costs for hardware, software, and subscription; such material access affected Internet skills, uses, and outcomes (van Deursen and van Dijk, 2018). Besides access, digital divide exists in psychological skills for appropriate use as well. Students' usage of different technologies and their motivation may have different effects on academic performance. It is therefore important to provide training in information and digital literacy skills to support learners in their educational use of technology and to develop skills in screening out redundant or irrelevant input to their learning (Terras and Ramsay, 2012). More research is needed to examine other variables that are associated with students' use of digital technologies in online learning.

## Learning Activities

As with campus-based university students, online learners in higher education engage in various learning activities with their learning devices, broadly to include individual study of a cognitive nature and collaborative work with others that involve synchronous and asynchronous communication (Alphonse et al., 2019). Exploring (context-aware situated learning) and content creating (e.g., *via* wikis and microblogging) can be important activities as well (Terras and Ramsay, 2012).

### Individual, Cognitive Work

When learning or studying at home, learners may be distracted or tempted to engage in other activities at the same time (campus-based students; Solvbert and Rismark, 2012). Such demands on attention may lead to a switching of attention from one task to another, or a sharing of attentional resources. When attention is divided between two tasks, performance is impaired, particularly



when the two tasks are presented in the same sensory modality. When two tasks are performed close in time, performance of the primary activity can be affected negatively because of interference (cf. review by Levine et al., 2012).

To concentrate fully on individual cognitive work, online learners need to be free from interruptions and distractions when in a behavior setting. Interruptions can increase perceived workload and impair a learner's performance of cognitive tasks (e.g., slowing the task down immediately after the interruption, van de Poll and Sörqvist, 2016; forgetting to carry out a task, Terras and Ramsay, 2012). It is harder for people to resume their original task when the interruption is long or there is little opportunity to rehearse the task goal during the interruption (Monk et al., 2008; review by Couffe and Michael, 2017).

Some physical learning environments have more distractions than do others. Several studies have shown that having a designated studying place that is relatively free from interruptions was a strong predictor of course completion for online learners (Osborn, 2001; Holder, 2007). Such designated space may be at home (Willing and Johnson, 2004). But for some online graduate students, it was difficult to have to manage family responsibilities while studying at home (Selwyn, 2011; Alphonse et al., 2019). Similarly, teleworkers and mobile workers have reported distractions from conflicting activities within and outside the home and in public places to be a challenge in maintaining focus (Johnson et al., 2007; Hislop, 2012).

### **Collaboration Through Oral Communication**

To carry out collaborative learning activities orally online (e.g., on the phone, *via* Skype and Zoom), online learners need a quiet place to listen (if they do not want to wear headphones or ear buds) and talk. When talking in public spaces, they may have concerns about privacy for others physically present, as do mobile workers (Hislop, 2012). However, the social norm seems to be changing that it is becoming acceptable to talk to someone online in public while ignoring those physically present (Enriquez, 2013). Nevertheless, online learners can choose the communication channel that is most appropriate for a certain behavior setting. When there are barriers to communicating orally, the learner could communicate in text form even though this alternative form of communication may not be as effective.

## **Virtual Environment**

The third component of the proposed model is the virtual environment (**Figure 1**), consisting of the institutional virtual space (e.g., learning management system, institutional administration, course materials and resources, and instructors or facilitators), peers (i.e., fellow learners in the course or program), and other online communities and resources (e.g., community of practice and open educational resources).

## **Relationship Between Individual Learning Space and Behavior Setting**

As discussed earlier, the physical and social aspects of a behavior setting can support or hinder learning and studying. Further, the physical environment can interact with the task (including the

learning device), the learner, or both to affect cognitive load and learning. For example, the effectiveness of instructional design and type of task is dependent on the characteristics of the physical environment, such as noise level. A learner's skills level interacts with the ambient conditions of the physical environment to affect cognitive load and learning outcome (Choi et al., 2014).

For effective learning, learners need to be able to choose or control their physical learning environment. "Studying environment" has been shown to be significantly associated with academic performance, satisfaction, or course completion among online learners ranging from community college to graduate program level (Osborn, 2001; Holder, 2007). Managing physical environment has been identified as an important self-regulation skill for online distance learners (Kocdar et al., 2018). They need to develop skills to withstand the environmental interruptions while moving from location to location and to self-monitor and manage demands on their limited attentional resources (Terras and Ramsay, 2012).

The behavior setting itself affords learning. In situated learning, the physical context is relevant to the learning at hand at a certain time (Frohberg et al., 2009). Learning activities can be designed to be accomplished on site (e.g., a museum) and perhaps with the use of context-aware mobile devices and applications (Brown and Mbatia, 2015; Jarvis et al., 2016). This can be particularly useful for skills training when the context in which learning takes place is similar as the context in which skills are tested (i.e., the context-dependent effect; Smith and Vela, 2001). Mobility between contexts may disrupt this supportive effect of context dependency because it is unlikely that memory encoding and recall will take place in the same context (Terras and Ramsay, 2012). If the goal is to facilitate transfer of learning, then learning should take place in various contexts (Choi et al., 2014).

## **Virtual Environment and Its Relationship With Individual Learning Space**

Learners with different characteristics use various portable and mobile devices and applications to carry out individual, cognitive learning activities, access resources, communicate with instructors, and interact and collaborate with peers *via* the Internet. In computer-supported collaborative learning, a variety of technical and digital tools and pedagogical strategies (e.g., discussion boards, simulations, and wikis) have been used to support learning and instruction that foster the social nature of learning (Sung et al., 2017; Jeong et al., 2019). Learners need to develop and maintain social networks and support with their peers online (Ivankova and Stick, 2007; Shackelford and Maxwell, 2012), and the online learning environment needs to be well-designed for fostering and enabling these social connections. There is a whole area of scholarship and research devoted to various components of the virtual environment and their relationships with learning, such as computer-mediated communication, learning community development, instructional design, and educational technologies that facilitate such activities and among learners with different characteristics (cf. reviews of distance education research by Bozkurt et al., 2015; mobile learning research by Krull and Duarte, 2017).



An emerging area of research concerns distraction and interruptions that result from using media to multitask while studying. So far, research has shown that using media devices to multitask during lectures (e.g., text messaging or checking Facebook) is common among college students (Moreno et al., 2012) and that multitasking has negative effects on academic performance (Rosen et al., 2013; Conard and Marsh, 2014; review by Levine et al., 2012). The extent of impairment depends on how similar (in modality in particular) and difficult the tasks are (cf. review by Chen and Yan, 2016). On the other hand, earlier studies have reported that most students did not engage in other activities while listening to podcasts (Lee and Chan, 2007; Evans, 2008; Pearce and Scutter, 2010), as the cognitive load of multi-tasking can be too much (Pearce and Scutter, 2010).

### Interrelationship Between Individual Learning Space, Physical Environment, and Virtual Environment

As in mobile working, online learning involves the learner using technologies to interface two environments – the immediate environment in which the learner is physically present and the virtual space of the learner's institution or other learners – at the same time (Frohberg et al., 2009). Learners and instructors can choose, or are required, to access the virtual environments synchronously or asynchronously and perhaps from multiple physical locations. As with mobile knowledge workers (Mark and Su, 2010; Hislop, 2012), the mobile learner needs to be aware of what the distant instructor or the other learner is doing, where that person is, and what time it is to decide what types of access and interaction is possible or appropriate. For example, the teacher or student may be engaging in a separate activity or be interrupted by unrelated matters at his or her physical location while participating online (Jamieson et al., 2000). The learner can also consult with the online community and other online resources at the same time from where the learner is physically present. Learners can use social media to find out who is in close physical proximity and arrange to meet in person. At the same time, online messages and social intrusions can come from the virtual environment at any time, which may support or hinder learning activities.

Considering that learners can switch their psychological “presence” between the physical environment and the virtual environment, researchers could examine how learning effectiveness may be associated with congruence between the physical learning environment and the online environment (e.g., studying online in the library *versus* at home) in the future. When using mobile devices to learn in media-rich physical environments, information from the virtual environment may complement or compete with information from the physical space. For example, the combination of information sources may result in split-attention and redundancy effects, thus affecting students' learning negatively (Liu et al., 2012). Mobile augmented reality, involving overlaying dynamic, location-based digital information on learners' mobile devices (e.g., through videos), can allow learners to interact with and learn about the physical environment surrounding them. Although mobile augmented reality can keep learners more engaged, it can also direct attention away from the very environment they are learning

about. In the end, how learners look at the environment is dependent on how information is presented to them by the instructor (Ryokai and Agogino, 2013). Such active engagement in learners is consistent with enactivist approaches to cognition, which emphasize the dynamic relations between brain, body, and environment (Gallagher, 2018).

### Time

Conceptually, the individual learning space can be considered a mobile space that moves from one behavior setting to the next over time (see **Figure 1**). The ability to manage time has been shown to be significantly associated with academic performance, satisfaction with the course, or course completion among online learners at various program levels (Osborn, 2001; Holder, 2007). As suggested in research in mobile work (Vartiainen, 2006), how long online learners stay in one setting and how frequently they move from one setting to the next could influence the effectiveness of learning. The optimal frequency and duration may depend on the extent to which course materials and learning activities are designed for fragmented learning.

One significant benefit of the Internet is to transcend geographical boundaries and time. Mitchell (2003), as cited in Fisher and Newton (2014), proposed a synchronous/asynchronous and virtual/physical matrix of learning opportunities: synchronous and local (face-to-face meeting); synchronous and remote (telephone, video conference, and text messages); asynchronous and local (site-specific signage and white board); and asynchronous and remote (internet web virtual studio; google). For synchronous activities, learners physically located in different parts of the world are to a great extent bound by time, which regulates their daily activities and the behavior settings they are in. Therefore, online social norm may dictate what kinds of communication and behaviors are appropriate and what are not (e.g., attending a skype meeting during nighttime).

### Flexibility and Control

Online students value flexibility and control in deciding what, where, and when to study (Nie et al., 2011). As with many teleworkers (Lundberg and Lindfors, 2002) and mobile knowledge workers (Hislop, 2012), online learners could move at various times between different settings that have different ambient features, interact with people, carrying out different tasks using the appropriate technology necessary for performing those learning activities (Solvbert and Rismark, 2012; Bayne et al., 2013). In practice, online learners have reported less flexibility in when and where studying can take place. Instead, many online learners established fixed routines of studying that were much influenced by their gender, life stage, and employment status; for example, some working adult learners made use of time during their commute to and from work and lunch breaks at work to study (Selwyn, 2011).

## CONCLUSION AND DISCUSSION

The physical environment plays an important role in online distance learning in higher education in this digital age. The physical environment that includes the physical infrastructure and space,

and ambient features together with its social environment can support or hinder the performance of learning activities carried out by the learner with various computer and mobile devices. At the same time, the virtual learning environment is all encompassing, interacting with the learner's individual learning space within a physical setting. As the learner moves from one physical setting to the next, the learner would encounter a new set of supports and barriers. The use of mobile technologies and devices facilitates such mobility, interactivity, and connectivity.

The proposed conceptual model provides a roadmap for future research that focuses either on elements of one of the three components: individual learning space, physical environment (behavior setting), and virtual environment, or on the interrelationships between the components.

For example, researchers may focus on the behavior setting component of the model in examining how physical learning spaces can be designed to support online learning. Empirical research that examines environmental opportunities for and constraints to learning and studying, and how learning takes place in typical behavior settings (even the home) is quite limited. Further research could examine how noise, lighting, other ambient features, ergonomics, and other variables in various behavior settings may affect the effectiveness and satisfaction of studying audio, visual, and multi-media online content. Also, how online learners set and negotiate spatial and social boundaries in various settings can be explored. As these behavior settings are dynamic in nature (Wicker, 2002), future research may explore how traditional behavior settings (e.g., café) are or will be transformed, replaced, or merged by actions taken by online learners. Other researchers may study how learners with different characteristics (e.g., personality and ability) prefer the use of different learning devices (currently available or yet to be developed) to achieve different learning goals (e.g., individual self-reflection or collaboration with others).

And yet other researchers may go beyond one component (e.g., individual learning space) to focus on its relationship with another component (e.g., behavior setting). As the population of online students becomes more diverse (Lee, 2017), future research could examine where younger students, who may have a higher need for peer-interaction and less control over their residence than working adult graduate students, carry out their online learning activities. Whether the learner is taking one course, or an entire online program may also influence what behavior setting or settings they study in, how long they stay in each, and how frequently they change settings.

Overall, the model has additional implications for pedagogical design and for students. The constant accessibility to computer and mobile devices has led to information overload, increasing demand on our attention, and facilitated multi-tasking both within the virtual environment and between the virtual and the physical environment (Terras and Ramsay, 2012; Stokols, 2018; Gaines, 2019). Research has begun to examine the effects of multitasking and associated division of attention on learning and learners' coping strategies (cf. Levine et al., 2012; review by Chen and Yan, 2016). It seems likely that such factors as learner characteristics, learner motivation, task characteristics, and perception of relative importance of the tasks are important

in influencing a learner's ability to multi-task while learning (Coens et al., 2011; Gaines, 2019).

Concerns have been raised about how advances in information technology have encouraged browsing with shorter attention spans rather than in-depth reflection (Gaines, 2019). Future research may explore the temporal dimension of online learning, for example, how fragmentation of learning activities affects learning satisfaction and outcomes. For example, Seneca (2014) suggests designing apps downloadable in short bursts for quick access on mobile devices. However, there is some evidence that adult distance students preferred to set aside dedicated time for their academic studies (Lee and Chan, 2007). Thus, learning designers should consider whether online learning tasks should be designed for focused attention and active engagement in learners, or divided across several tasks to accommodate lifestyle integration (Lee and Chan, 2007). Designing for absorption and engagement will need to consider the management of interruptions (Terras and Ramsay, 2012).

Educators may consider how learning goals can be accomplished in different physical environments by incorporating various communication channels, synchronicities, and sensory modalities. For example, course materials presented in visual format and activities performed by hand can be learned in a relatively noisy physical environment. Audio content may be suitable when in poor lighting environments. Future research might explore how multimedia learning (Mayer, 2005) might be influenced by the physical environment in which the learner is located.

On the social side, educators need to design an online learning environment that fosters and enables social connections and social support. Providing institutional support for students (e.g., technical training and support) is crucial, considering that students may be using different devices and across different physical settings. Krull and Duarte (2017) suggest further studies are required to examine what devices students use and how they access content and university services, perhaps with the use of learning analytics.

For students, they need to be aware of the effects that the physical and the virtual environment have on their learning and studying and be able to choose, set up, or control their physical environments for optimal learning effectiveness. Universities could provide information to help students achieve this objective. Research is needed to study strategies that would help learners with different learner characteristics succeed in online learning across multiple settings, such as learner autonomy, self-direction, and self-regulation (Grant, 2019).

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# Physical Connectivity as Enabler of Unexpected Encounters With Information in Campus Development: A Case Study of South China University of Technology

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This paper is an attempt to advance research on spatial potential for interdisciplinary innovation of university campuses by proposing a spatial quantitative method. The aim is to develop the campus to adapt to the new pedagogical structure of encouraging interdisciplinary innovation in the era of knowledge society. For this purpose, literature from management, psychology, and architecture are reviewed to provide insight into the relationship between innovation and physical environment. The existing research mainly focused on the characteristics of physical environment that supported individual innovative thinking or innovative interaction between people in building scale, which is relatively limited in this study for the campus scale since people are less likely to exchange academic information with strangers because of a lack of knowledge about their professional background. In this context, this research enriches the understanding of spatial potential for innovation by proposing a more effective way of increasing unexpected encounters with information, which are probably occurred while people passing by laboratories, seminars, or exhibitions of other disciplines. In this process, the unexpected encounters with information act as the medium or promotion factor for face-to-face interaction. This kind of innovative potential requires fewer conditions like acquaintance or face-to-face interaction but depends more on the space organization. Physical connectivity acts as enabler and the effects vary. This article reports on a preliminary study of how Space Syntax as a quantitative approach is applied to evaluate the effects in the case of South China University of Technology. The proposed method aims to sustain a sustainable transition toward a more adaptable relation between people and the campus environment. However, to improve understanding of spatial effects on innovation, more empirical studies must be carried out.

**Keywords:** interdisciplinary innovation, space syntax, university campuses, physical connectivity, unexpected encounters with information

## INTRODUCTION

In the era of knowledge society, universities are expected to evolve from performing conventional research and education functions to adapting to the new pedagogical structure of encouraging interdisciplinary innovation. Since there is a near-universal agreement within the social and architectural literature on the importance that physical environment plays in the innovation process (Allen, 1977; Hillier and Penn, 1991; Penn and Hillier, 1992; Van den Bulte and Moenaert, 1998; Clements-Croome, 2006; Wineman et al., 2009; Stryker et al., 2011; Oksanen and Ståhle, 2013), restructuring the existing campus to achieve the goal of promoting interdisciplinary innovation is a sustainable transition toward a more adaptable relation between people and the campus environment. Existing research on the correlation of organizational innovation and physical environment concentrates on management, psychology, architecture, and so on. Research in psychology and management has mainly focused on how the physical environment supports individual innovative thinking and innovative interaction between people in building scale (Allen, 1977; Amabile, 1996; Allen and Henn, 2007; Oksanen and Ståhle, 2013). As to architecture, studies are based on the findings that interaction can trigger innovation and further explore how spatial organization can promote interaction (Hillier and Penn, 1991, 1992; Wineman et al., 2009; Kabo et al., 2014; Sailer and Thomas, 2019). Space syntax, as a quantitative approach to investigate relationships between spatial layout and social phenomena, is the main method for innovation studies in architecture. Research using space syntax theory has shown how movement patterns are powerfully shaped by spatial layout and how buildings can create more interactive organizational cultures.

In this paper, we are concerned with university campuses and a global perspective on innovation promotion. Since existing studies focused on building scale, the previous approach of promoting face-to-face interaction is relatively limited in this study for the campus scale. Due to the fact that people are less likely to interact with strangers that they meet in the campus, academic information exchange hardly occurs. In this context, this research enriches the understanding of spatial potential for innovation by proposing a more effective way of increasing unexpected encounters with information from other disciplines, which is probably occurred while people passing by laboratories, seminars, or exhibitions of other disciplines. Related research in human information behavior argued that information horizons and information resources are factors that influencing innovation processes (Sonnenwald, 1999; Toker and Gray, 2008). The proposed way of promoting innovation by the unexpected encounters with information is to increase information resources. Encounter with information during one's movement is passive input of the latest information from different disciplines, which are more likely to trigger interdisciplinary innovation. In this process, the unexpected encounters with information act as the medium or promotion factor for face-to-face interaction. Thus, promoting the unexpected encounters with information complements the

existing research that focused on face-to-face interaction, especially in the context of university campuses.

This research is an attempt to explore a spatial quantitative method for evaluating the innovative potential brought by the campus development. This development aims at breaking down the knowledge boundaries of different disciplines and increasing the through-movement to pass by space with information of different disciplines. Inspired by MIT's "physical connectivity" principle, the goal of creating unexpected encounters with information can be achieved by the spatial strategy of connecting isolated research buildings and integrating them into the network of the whole campus. The key of the method is to evaluate the innovation potential by calculating the effective large-scale through-movement. This article reports on a preliminary study of how Space Syntax as a quantitative approach is applied to the innovation-driven renovation in the case of South China University of Technology. Data collection included the syntactical properties calculated by Depthmap (Turner, 2006) and the practical data by gate counts (Al-Sayed, 2014) from cameras. Different schemes are compared quantitatively and the effects of physical connectivity are discussed. The results of the study approve the adaption of Space Syntax and provide effective spatial strategies for the campus development. Overall, the greatest contributions of this research are to enrich the understanding of the spatial potential for interdisciplinary innovation in campus context and provide a quantitative method for evaluating the innovative potential brought by the campus development.

## Existing Research on the Effects of Physical Environment on Innovation

The effects of physical environment on organizational innovation are explored in many different disciplines such as management, psychology, and architecture. As early as in the late 1970s, Allen had proved the effect of architectural layout on information dissemination through a decade of empirical study into communication behavior among technologists. Allen revealed the exponential drop in frequency of communication between engineers as the distance between them increases, which was graphically presented as "Allen Curve" (Allen, 1977). This discovery bridges the gap between physical environment and work performance by the effect of proximity on communication frequency. Later in 2007, Allen and Henn further explored how organizational structure and physical environment affect communication among people for inspiration that was central to the innovation process (Allen and Henn, 2007). The study illustrated that inter-group communication was more likely to bring innovative problem solving and proximity could be a factor that triggers collaboration. Based on Allen's pioneering work that proved the importance of communication networks in the Research and Development (R&D) environment for successful innovation, the attention was then turned to the role of communication, cooperation, and integration of R&D with marketing (Griffin and Hauser, 1996). Souder and Moenaert (1992) argued that effective innovation requires various types of knowledge to be mobilized and integrated. Through empirical

research, Van den Bulte and Moenaert (1998) demonstrated that communication among R&D teams was enhanced after co-locating these teams. However, the increased physical distance did not affect the frequency of communication between R&D and marketing department. They concluded that the effect of co-location may depend on the content, medium, and strength of the communication flows. Except for physical proximity, the visibility of the work environment and the formal and informal space available for meetings and collaboration are proved to be related to face-to-face communication by a field study conducted at two R&D sites in a large Midwestern United States pharmaceutical company (Stryker et al., 2011). Since new ideas for innovation need to be disseminated rapidly, electronically mediated interactions are growing to replace traditional face-to-face communications. There existed studies comparing the benefits of computer-mediated communication (CMC) and co-location of R&D staff, as well as the mutual interaction between them. Through empirical data collected from 402 high-technology firms in the United States and Netherlands, the results support the effects of the two communication channels on knowledge dissemination, as well as the mutual strengthening role. The research concluded that effective knowledge dissemination required a balance between co-location and information technologies (Song et al., 2007). The space layout typology for collaboration in workplace was further research and the distractions from others' interactive behavior were considered as well (Hua et al., 2011). Generally, research in the area of management mainly focused on the supporting effect of physical environment on interactive innovation between people. A large number of empirical studies have proved the positive effect of physical environment on innovation through promoting face-to-face communication (Allen, 1977; Van den Bulte and Moenaert, 1998; Hua et al., 2011). However, not all communication can lead to innovation. Innovative interaction requires various knowledge exchange. According to the existing research, the factors of physical environment for supporting innovative interaction include physical distance, visibility, space layout, space type, etc. These factors affect the opportunities of interaction like communication or collaboration thus affects the input of new ideas for innovation.

In the area of psychology, researchers focused more on how physical environment supports individual innovative thinking. The quality of physical environment greatly affects people's working experience and thus being the most significant factor for innovation. Oksanen and Ståhle (2013) state that physical environment can foster innovation by improving the well-being and happiness of people. "Attractiveness" is one of the five attributes of innovative space presented in her research. She explained attractive space as comforting which affected people's job performance and satisfaction. Temperatures and noise are revealed to be environmental factors that affect innovative thinking (Clements-Croome, 2006). An attractive physical environment for work is perceived as inspirational and motivational and can trigger innovation (Haner, 2005). Consistent with these findings, Csikszentmihalyi's study on creativity from the perspective of psychology states that *'prepared minds in beautiful settings are more likely to find new connections*

*among ideas and new perspectives on issues dealing with'* (Csikszentmihalyi, 1997, p. 136). He also discovered that an environment where freedom, security, and control are experienced was beneficial for innovative thinking. Despite comforting environment, stimulating environment can enhance creativity as well. Amabile (1996, p. 249) stated that "physical environments that are engineered to be cognitively and perceptually stimulating can enhance creativity." Apart from the quality of physical environment, the places and the context affect innovative thinking as well. According to the research of Haynes and Martens (2011) by interviews with creative professionals, places for innovative thinking are diverse. Most people have innovative thinking on moments of relaxation, such as on the way home, while running, under the shower, etc. A similar viewpoint was proposed by Csikszentmihalyi (1997) as well. He stated that *"Just sitting and watching seem fine, but taking a walk is even better"* (1997, p. 137). In general, physical environment can support innovative thinking by providing comforting or stimulating experience. And, many kinds of places are possible to foster innovation, especially on moments of relaxation.

As a specialized discipline studying physical environment, architecture research on the effect of physical environment on innovation is based on the research results of other disciplines, aiming in exploring how to achieve the spatial potential for innovation by design. Since a comforting and attractive environment is the common goal in architectural design, organizing the spatial layout to induce movement that can trigger innovative interaction is the main issue in architecture research. For instance, "generative building" is conceived as being able to increase innovation and creativity since it allows and encourages plurality, contradictions, and dissensus through its spatial organization (Kornberger and Clegg, 2003). Physical proximity is measured with metric distance, topological distance, or geometric distance. Not only the location of staff but also the daily path between different destinations is measured to analyze the degree of overlap (Kabo et al., 2014). Methods applied in these researches include Space Syntax, ArcGIS, flow simulation, and so on, among which Space Syntax is the main force. The purpose of this paper is to explore the spatial possibility for interdisciplinary innovation in the context of university campuses and apply space syntax to construct a spatial quantitative method for innovation-driven renovation.

## Quantitative Research on Organizational Innovation by Space Syntax

Space syntax is an approach built on quantitative analysis and geospatial computer technology to investigate relationships between spatial layout and social phenomena. It is originally proposed by Hillier and Hanson in the 1970s. The approach has developed a set of theories and methods for the analysis of spatial configurations of all kinds and at all scales. Research using the space syntax approach has shown how movement patterns are powerfully shaped by spatial layout and how buildings can create more interactive organizational cultures. Thus, innovation in organizational context is an area to which space syntax theory has contributed.



In “visible colleges,” Hillier and Penn (1991) argued that randomness played a crucial role in the advance of science. They proposed that buildings as organizers of space could act either a conservative or a generative mode. Space with conservative mode leads to the reproduction of existing knowledge, while space with generative mode leads to production of new knowledge. A generative building is depending on relating its spatial structure to randomness. By maximizing randomness of encounters through spatial proximity and movement, new relational patterns like new ideas or new relationships are more likely to emerge. Citing the research of Allen (1977) on the relationship between innovation and communication, as well as Granovetter’s work on social networks in broader community, the paper pointed to the need for a more global view of networks. It is proposed that good urban networks are not self-contained groups but distributions of probabilities within a larger, continuous system (Hillier and Penn, 1991, p. 38). In general, this paper demonstrates how the patterns of space work in the generation of innovation as a social function of buildings, which accounts for the application of space syntax.

In the later paper of Penn and Hillier (1992) “the social potential of buildings,” they focus more directly on the innovative milieu in scientific research laboratories. Based on the findings of Allen (1977) linking innovation to inter-group communications, they bridged the gap between innovative potential of a building and its configuration, which is instrumental in the process of random encounters. Integration was used as a measure of spatial layout to quantify building plans. Through 24 building floors’ studies by means of spatial analysis, observation and questionnaire survey, the paper proved the correlation between spatial integration and the level of useful work-related inter-group communication. The paper further emphasized the significance of movement and recruitment by citing Backhouse and Drew (1992). Hence, they put forward the proposition that innovation requires large-scale movement structure to generate probabilistic interaction between people in different fields and thus break down the boundaries of scientific knowledge.

Similar research on space of innovation has been done in work environment (Penn et al., 1999) as well. A case study of an energy utility was carried out both before and after the company moved to new premises, where spatial analysis assisted the design process. The study found that spatial configuration had an impact on the innovative potential in office-based organizations by affecting the frequency of contact, which was the basis of useful work-related communications.

Despite research focusing on the spatial dimensions involved in the innovation process, there are studies taking social networks into consideration as well. In “spatial and social networks in organizational innovation,” Wineman et al. (2009) examined the effects of spatial layout on social network structure and the support of innovation in a professional school at the University of Michigan, which allocating office space across departments to promote cross-disciplinary collaboration. In this context, the study used co-authored academic publications as the indicator of successful collaboration that reflected the effect of the innovative space. The social network was inferred from

the patterns of co-authorship. The study concluded that social (departmental affiliation) and spatial (step-depth) variables do have a significant effect on co-authorship (Wineman et al., 2009, p. 437), and integration could be a spatial measure of innovative potential. Wineman’s study enriched the understanding of innovative potential of space in social dimension by proposing the collaborative interface generated by spatial layout. Collaboration as a social pattern can be directly related to the innovative output by co-authored works, which is more objective than the useful communication by questionnaire surveys in previous research.

In the recent study of Sailer and Thomas (2019), an organization’s innovative potential was quantified according to the “correspondence or non-correspondence” theory, which is an essential description of social-spatial relations by Hillier and Hanson (1984). “Correspondence” describes the high degrees of overlap between spatial and social closeness. This means similar people occupy proximate spaces due to the spatial and social boundaries. In contrast, “non-correspondence” describes an open system that can generate randomness (Hillier and Penn, 1991) and bring different people together across scales. Hence, the paper proposed a way to calculate the degree of correspondence or non-correspondence for the purpose of judging innovative potential. The calculation methodology analyzed the spatial network in depth. Instead of measuring the distance of work locations to establish proximity, this paper defined spatial closeness according to the visible areas of each worker’s daily routine. Those that could be seen in one’s daily routine were potentially encounters and therefore calculated as spatially close. The method was applied to study two work organizations and the results confirmed that non-correspondence system performed better in the spatial promotion of innovation. This means that passing by areas of other fields in daily path makes sense in the process of innovation.

Numerous analytic studies of the structure and functioning of space suggest that the spatial configuration as a property of space on global scale is critical, whether to the structuring of co-presence through movement, or the development of social networks. Space as a physical arrangement acquires its social logic through the encounter probabilities in terms of the frequency and the type of encounters. As innovative problem solving requires importing new information from other fields, large-scale movement that is more likely to pass by work locations of other fields can break down the spatially enforced boundaries between people in different fields. This is the general logic of research on innovation by space syntax.

## The Inspiration of “Physical Connectivity” by MIT

Massachusetts Institute of Technology (MIT) was founded in 1861 and is widely known for its innovation and academic strength. The MIT community aims in making a better world through education, research, and innovation. Its pursuit of innovation is reflected in its campus development as well. Before moving to Cambridge, the MIT campus consisted of

dispersed faculties in different city blocks due to the hectic expansion, which was time-consuming and inconvenient for students and faculty. The dispersal of campus layout resulted in the sense of diffusion. Demands for a cohesive collegiate atmosphere become imperative for its preeminent innovative institutional identity. Therefore, the design of the new campus in Cambridge situated the Institute inside a single, massive structure closely resembling the arrangement of the modern factories which pursue efficiency (Jarzombek, 2017; Deng et al., 2019). The emphasis of “physical connectivity” between buildings of different faculty was born. The unified central structure has become the most significant design innovation on campus, which created the inspiring space in the MIT campus: the infinite corridor. It is MIT’s spinal cord that connects most buildings of different disciplines at MIT, including various departments, classrooms, and labs. Since it is the most direct route to disparate parts of the school, it is unsurprisingly the busiest within the campus. It enables conversation and interchange among students, faculty, and staff, which is important for the cross-fertilization of interdisciplinary studies. Besides, the role of the infinite corridor in promoting interdisciplinary innovation was enhanced by renovation projects that created public-facing laboratories, such as the Nano Lab, the Under Graduate Teaching Laboratory, and the Laboratory for Advanced Materials, etc. These Laboratories are equipped with floor-to-ceiling glass walls through which casual passersby could see researchers and students at work. This is how physical connectivity acts as enabler of unexpected encounters with information that promotes innovation. The characteristics of physical connectivity in MIT can be concluded as interconnected, visible and accessible. “Interconnected” requires links between buildings of different disciplines, which promote interdisciplinary communication. “Visible” requires open or transparent segregation along the corridor, which enables the unexpected encounters of information; “Accessible” is the requirement of flow, which will be effective in accordance with students and teachers’ daily routine. Today, the MIT building stands largely unchanged, testifying to the farsighted planning more than 100 years ago. Although the Institute’s needs and ideas shifted over the years, the Planning Office of MIT strove to make MIT the great institution “*where an array of ideas are readily available and opinions vigorously articulated*” (Simha, 2001, p. 4). Physical connectivity is considered as the fundamental qualities that nurtured the intellectual and social life of students and faculty in various ways (Simha, 2001). It is also a vital principle in future planning. “MIT 2030” is a living framework that guides the planning activities of MIT campus. “Innovation and collaboration” is one of the themes, which require future planning activities to create the possibility of unexpected connections between people or knowledge in different fields. The proposed physical developments on campus address issues of proximity, potential collaboration, knowledge transfer, and interdisciplinary cross-fertilization. The success of MIT has proved the significance of “physical connectivity” for innovation, which is worthy of reference by other campus planning.

## Interdisciplinary Innovation by Unexpected Encounters With Information in Campus Context

This paper is an attempt to advance research on the spatial potential for innovation in the context of university campuses. The research scope does not cover the whole innovation process but mainly focuses on the introduction of new ideas, which has much to do with space. The adoption and implementation of new ideas remain outside the scope. Literature from management, psychology, and architecture is reviewed. The existing research mainly focused on the characteristics of physical environment that supported individual innovative thinking or innovative interaction between people in building scale. Interaction as a prerequisite of innovation is relatively limited in the context of campus since people are less likely to exchange academic information with strangers because of a lack of knowledge about their professional background. Hence, inspired by the physical connectivity principle in MIT and based on the findings of human information behavior, this paper proposes that unexpected encounters with information from other disciplines can be an effective way to promote interdisciplinary innovation in campus context. It probably occurs while people passing by laboratories, seminars, or exhibitions of other disciplines, where advanced information is visible or displayed on purpose. This kind of innovative potential requires fewer conditions like acquaintance or communication but depends more on the spatial structure and function allocation, in which aspects architecture can intervene. Besides, the unexpected encounters with information may act as the medium or promotion factor for face-to-face interaction. Thus, promoting unexpected encounters with information complements the existing research that focused on face-to-face interaction, especially in the context of university campuses.

Related theories in human information behavior and social psychology account for this proposition. On one hand, it is argued that innovation process is influenced by one’s information horizons, which are formed by the available information resources (Toker and Gray, 2008). Information resources are various, such as social networks, documents, information retrieval tools, and experimentation and observation in the world (Sonnenwald, 1999). The proposed way of promoting unexpected encounters with information from other disciplines is to increase information resources. There are active and passive inputs of information. Except for interacting with people, active information seeking is limited within one’s scope. Encounter with information during one’s movement is passive input of information from different disciplines, which is more likely to bring innovative ideas. The findings of information behavior also indicate that such unexpected encounters with information have more chances to promote innovation in terms of one’s daily routes. This is because the absorption of information follows the principle of minimum effort. And people are more likely to have innovative thinking on moments of relaxation, such as on the way home. On the other hand, the visible stimulation like the display of research results or working status can create an atmosphere of competition, which is a kind of creative context (Amabile, 1996).

Accordingly, the spatial strategy that we adopt in the innovation-driven development of university campuses is to construct physical connectivity between isolated research buildings and integrate the indoor traffic flow into the network of the whole campus. How to maximize the daily movement passing through spaces with information is the key to spatial organization. The innovation-driven development aims at breaking down the knowledge boundaries of different disciplines and increasing the through-movement to pass by the space like labs, exhibitions, or seminars. This spatial strategy of connecting various disciplinary buildings is to improve the environmental heterogeneity, which enables people to gain new perspectives of thinking (Qiao, 2010). This paper attempts to explore a spatial quantitative method for the innovation-driven development of university campuses. Based on the enhancing understanding of spatial potential for interdisciplinary innovation, the application of space syntax is discussed and developed. The key of the method is to evaluate the innovation potential by calculating the effective large-scale movement through spaces with information. Compared to the existing studies, in this context the overlap degree of movement and information is calculated instead of that of different movements. The next chapter will detail how we apply space syntax for this endeavor.

## PRELIMINARY APPLICATION STUDY IN SOUTH CHINA UNIVERSITY OF TECHNOLOGY

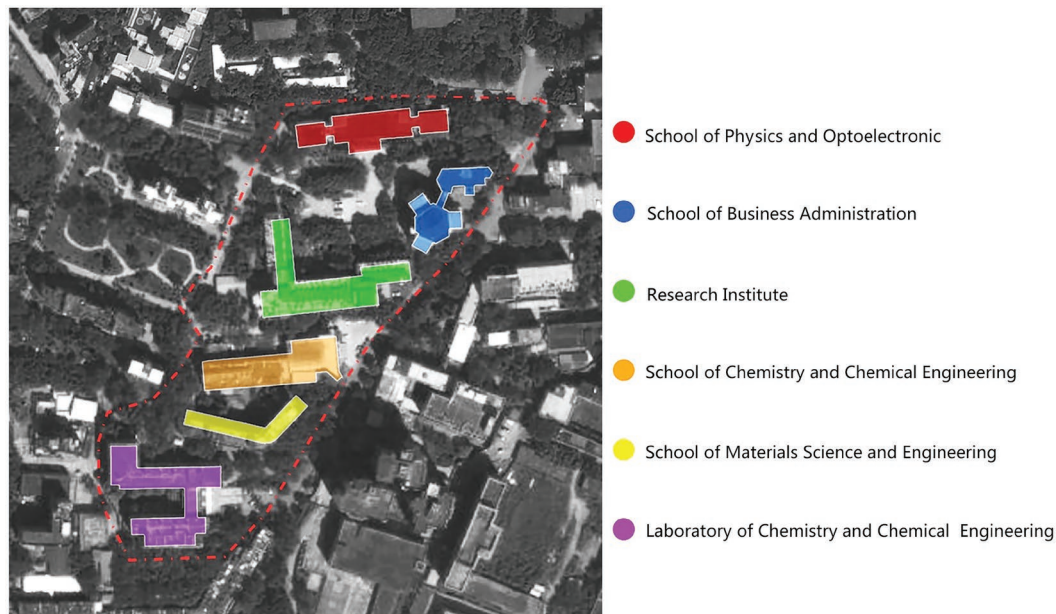
This article reports on a preliminary study of applying space syntax to the innovation-driven development of a research district in the campus of South China University of Technology. There are six isolated buildings of different departments inside the district, which mainly afford offices, classrooms and laboratories for different disciplines (Figure 1). In the previous chapter, we have already reviewed the relevant research by space syntax to highlight its potential for understanding innovation of space. However, most studies focused on one organization within a building. As to campus, it is more like part of the urban network and the social pattern is more complicated. This requires constructing a larger urban network model to estimate and visualize movement performance. Our application study includes two parts. The first part is to construct the network performance model of the whole campus through the correlation analysis of syntactic measures and observation data from cameras. The strongest predictor of the syntactic measures is figured out and lays the foundation for the further analysis of renovation schemes. Other movement attractions like transport and land use are also discussed in the formation of the actual movement performance within the campus. In the second part, according to the aim of integrating the isolated buildings into the network of the campus for promoting innovation by encounters of people and information, we develop different schemes with physical connectivity for the selected research district. We compare the schemes based on quantitative analysis and propose relatively effective spatial strategies for innovation-driven development of the campus.

## Constructing the Network Performance Model of the Campus

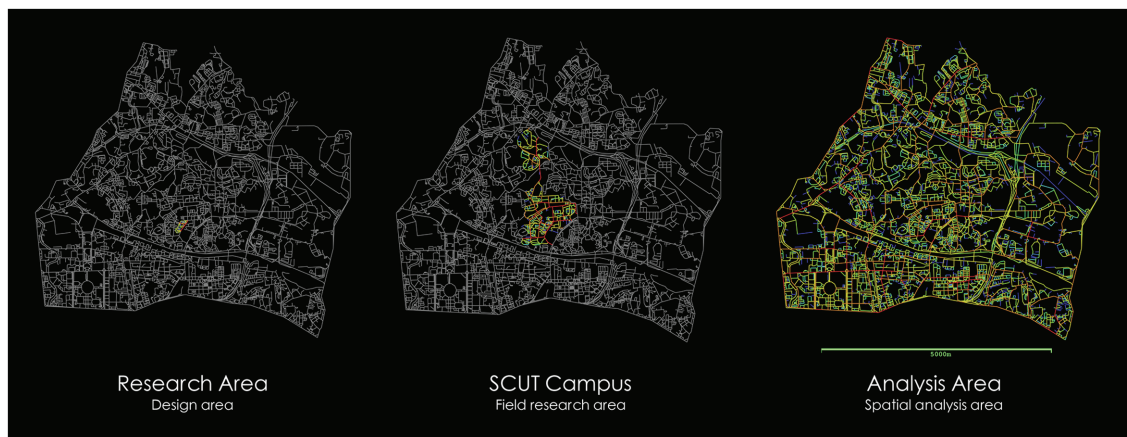
The construction of network performance model is particularly relying on angular segment analysis with metric radius, which is a powerful tool for measuring accessibility in street networks and thus predicting social activities (Al-Sayed, 2014). This analysis is on the level of street segments, considering their topological, metric and angular connections. Using this type of segment graph, spatial measures will be calculated to measure accessibility and compare configurational properties of space with observed urban activity. According to the space syntax methodology of requiring a larger area for analysis, we define the boundary of the study area roughly 2,000 m from the site (Figure 2) and create the segment map for spatial configuration analysis. The analysis is conducted in Depthmap. Several global and local spatial measures are calculated, including integration and choice at different radius. Both integration and choice are the most powerful syntactic properties in both analysis and movement prediction (Hillier et al., 2012). Integration represents the to-movement potential of a space and choice represents the through-movement potential. In our study, we calculate the integration and choice at radius 400 m, 800 m, 1,200 m, 2,000 m, and  $n$  as global radius (Figure 3). All the measures are normalized to permit comparison of different models. Figure 3 shows the graph results of the analysis. Each segment has its calculated value that can be export for further statistical analysis. “NACH” is short for normalized angular choice. “NAIN” is short for normalized angular integration. The 10 graphs represent the calculated value of “NACH” and “NAIN” at different radius. The colorful segments represent the streets within the campus. Different color represents different degree of the value. The warmer the color the higher of the value. In other words, the red segments are the most accessible streets and predicting the largest flow. The results of the 10 graphs will then be compared with the observed data to define the best predictor.

In order to measure real movement and test spatial predictors, field observation was conducted. Observation techniques are field research methods of space syntax to construct a quantitative description of the movement behavior in the public realm. In this study, we applied gate counts as the method, which was usually directed to observe the density of pedestrian or vehicular movement flows in an urban layout (Al-Sayed, 2014). Our sample consisted of 35 gates being observed for 5 min every 2 h from 8 AM to 5 PM (8:30–8:35, 10:30–10:35, 12:30–12:35, 14:30–14:35, and 16:30–16:35) during both working days and weekends. The observation covered the peak flow period of just before or after class and lunchtime, as well as the trough period of during class. We focused on the non-vehicle movement since both walking and biking were main transportations in campus (Sun, 2019). As most space syntax research, we transformed the movement data by logarithm. Then, we performed correlation and linear regression analysis on the spatial results of the segment analysis above of each radius with the real movement data (Tables 1 and 2). As a result, the normalized choice at radius 1,200 m showed the highest correlation and adjusted  $R^2$  value, which indicates the segment





**FIGURE 1** | The research district in SCUT campus.



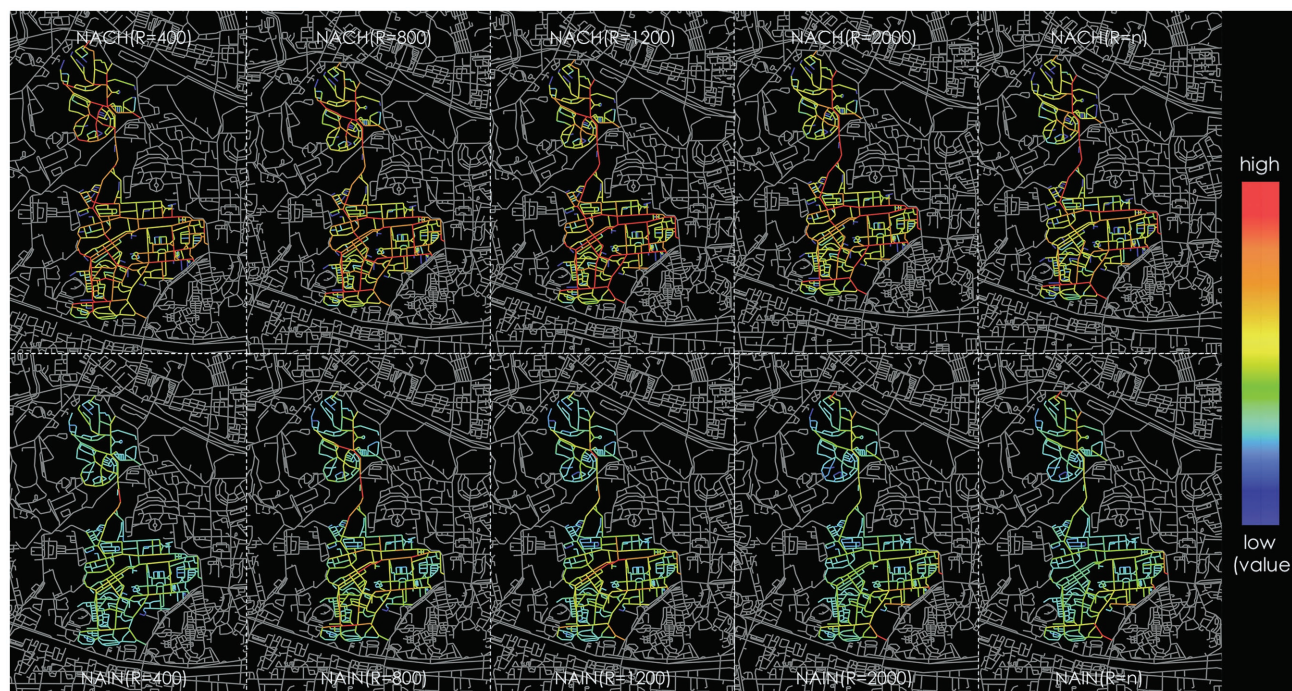
**FIGURE 2** | The study area.

angular choice at 1200m as the best predictor that can predict 57.6% of the real movement.

The segment analysis quantified the accessibility of each street according to the configuration of the whole network, which reflects the movement distribution to some extent. Besides, transport station and some land use can affect the movement as well. For instance, once there is a bus station or an attractive shop on the street segment, it will attract much flow even in a relatively segregated position. Transport station and some land use act as movement attractor to some extent. Therefore, we further processed the transport and land use attraction measures to narrow the gap between the segment map and the real movement. We conducted the survey of the distribution of bus stops and land use on the campus. The

land use attraction we tested in this study included teaching (include labs, offices, classrooms, and seminars), students' dormitories, and canteens. We used the metric step depth function in Depthmap to quantify the attraction of both transport and land use. Metric step depth analysis measures the walking distances from each origin to all segments in the network. Origins are the bus stops and the land use attraction that we surveyed before. **Figure 4** shows the graph results of the metric step depth analysis of different attractors. The color of the segments represents the calculated distance from attractors. The warmer the color the longer the distance. The distance of each segment calculated in Depthmap was transformed into the attractive ability of movement according to the distance decay. It means that the effect of movement attraction on





**FIGURE 3 |** The normalized integration and choice at radius 400m, 800m, 1,200m, 2,000m, and  $n$ .

segments is decreased with the increase of distance from the origins. Having prepared the data of transport and land use attraction for each segment, we performed multiple variable regression analysis with the data of normalized choice at radius 1,200m and real movement in JMP (statistical software). The statistical analysis demonstrated that teaching, students' dormitories, and canteen are the most effective land use attractions. Combined with these three factors, the  $R^2$  value of the regression analysis increases from 0.576 to 0.67, which means the explanatory power of the spatial accessibility is improved (Figure 5). However, due to the limitation of small sample size, the values of  $p$  of the attractions do not reach the threshold for significance. Even though, there are conclusions that we can draw from this analysis. On one hand, it demonstrates that spatial configuration (represented by normalized choice at radius 1,200m) plays a significant role in the real movement performance of campus, just like most urban network. On the other hand, unlike urban environment where transport and commerce are always effective attractions, the movement in campus is more likely to be affected by the distribution of teaching and living areas.

### Comparison of Different Schemes for Innovation-Driven Development

In this study, we attempt to link research outcomes with design interventions and introduce an evidence-based process into design. The innovation-driven development of campus from the perspective of space syntax aims in improving the innovative potentiality of space through increasing random encounters of people and information in different fields. The

design interventions are thus required to connect buildings of multiple disciplines and integrate the indoor circulation into the public transport network of the campus. Alternative solutions are simultaneously tested by quantitative analysis as the evidence-based process to propose effective design interventions.

In Scheme A, the basic concept is to well connect the isolated buildings within the district to form an integrated group, which is achieved by the connection on both ends of each building. The shared entrances are placed in the newly connective part to organize the circulation routes, which not only integrates the group into the public network, but also maximize the overlap of movement to different disciplinary buildings (Figure 6). As to Scheme B, it focuses on global movement performance and the design interventions aim in organizing the indoor circulation routes to enhance the existing network. Therefore, the newly built part concentrates on the east connection of all buildings, which is parallel to one of the busiest and mixed roads in the campus. Such an indoor corridor can efficiently separate pedestrian flow from the existing road and attract through-movement into the research buildings. The entrances are located on the end of each building so that the existing corridors are transformed into direct east–west links across the site and well connected with the existing intersections on the west (Figure 7). With a different starting point, two schemes are generated into different spatial structures. How they perform is further analyzed quantitatively on different scales and effective spatial strategies for innovation-driven renovation are proposed.

**TABLE 1** | Results of the correlation analysis of spatial analysis results and real movement data by SPSS.

		Normalized angular choice (NACH; $R = 400$ )					Normalized angular integration (NAIN; $R = 400$ )					NAIN ( $R = 800$ )	NAIN ( $R = 1,200$ )	NAIN ( $R = 2,000$ )	NAIN ( $R = n$ )
		NACH ( $R = 800$ )	NACH ( $R = 1,200$ )	NACH ( $R = 2,000$ )	NACH ( $R = n$ )										
Log movement average	Pearson Correlation	0.404*	0.654**	0.767**	0.753**	0.667**	0.398*	0.470**	0.439**	0.236	0.172				
	Sig. (2-tailed)	0.016	0.000	0.000	0.000	0.000	0.018	0.004	0.008	0.172	0.324				
	N	35	35	35	35	35	35	35	35	35	35				

\*Correlation is significant at the 0.05 level (2-tailed).

\*\*Correlation is significant at the 0.01 level (2-tailed).

On global scale, angular segment analysis is conducted to compare the effect of design interventions on the introduction of through-movement into the research buildings. The analysis is conducted with the model constructed in the previous part and the value of normalized choice at radius 1,200 m as the strongest predictor of real movement is used to evaluate the schemes. **Table 3** presents the calculated results of the segments within the site for the current situation and two design schemes from Depthmap. The value of normalized choice at radius 1,200 m (NACH,  $R = 1,200$ ) represent the amount of movement, which indicates the spatial potential for unexpected encounters with information that will probably trigger interdisciplinary innovation. The table shows that both the average value of scheme A and scheme B are increased, indicating that both design interventions succeed in introducing through-movement to the buildings. Compared to the value of the current situation, the average value of scheme A increases by 9.4%, while that of scheme B increases by 20.41%. This means that scheme B performs much better than scheme A in attracting through-movement to the research buildings on global scale, which may generate more random encounters that will trigger innovation. As to the max value and standard deviation, scheme A and scheme B shows a similar trend. The max value of two design schemes are decreased lightly since through-movement is no longer concentrated in two or three routes due to the enhancement of network by design interventions. Thanks to the connection of isolated buildings and the integration of indoor circulation into the public network, both schemes greatly decrease the standard deviation, which is rather high because of so many segregate segments before. The distribution of calculated results is further analyzed (**Figure 8**; **Table 4**). Compared to the current situation, scheme B performs better than scheme A in both increasing the percentage of segments with high value and decreasing the percentage of segments with low value. Although scheme A decreases the percentage of segregate segments as scheme B, it does not increase the percentage of segments in the range of relatively high value. To summarize, both the design interventions of scheme A and scheme B have positive effect on the promotion of encounters of people and information by the introduction of through-movement on global scale of the campus. According to the contrastive analysis of calculated results of normalized choice at radius 1,200 m, both the average value and frequency distribution reveal that scheme B performs better than scheme A on global scale of the campus, indicating that organizing direct routes across the site to enhance the existing network based on the real movement performance is a relatively effective spatial strategy for innovation-driven development on global scale of the campus. **Figure 9** explains how scheme B organizing the physical connectivity to enhance the through-movement network based on the existing busy road on campus. According to the observation data, the road on the west of the site is one of the busiest and mixed roads on the campus. On one hand, scheme B organized a corridor parallel to it that can attract pedestrian from the existing busy and mixed road. On the other hand, entrances are located on the end of each building so that the existing corridors are transformed into

**TABLE 2** | The linear regression analysis of NACH ( $R = 1,200$ ) and real movement data by SPSS.

Model	Unstandardized coefficients		Standardized coefficients		t	Sig.	R square	Adjusted R square	F
	B	Std. error	Beta						
1	(Constant)	0.877	0.276		3.172	0.003*	0.589	0.576	47.264 (0.000**)
	NACH(R= 1,200)	1.584	0.230	0.767	6.875	0.000**			

\*Correlation is significant at the 0.05 level (2-tailed).

\*\*Correlation is significant at the 0.01 level (2-tailed).

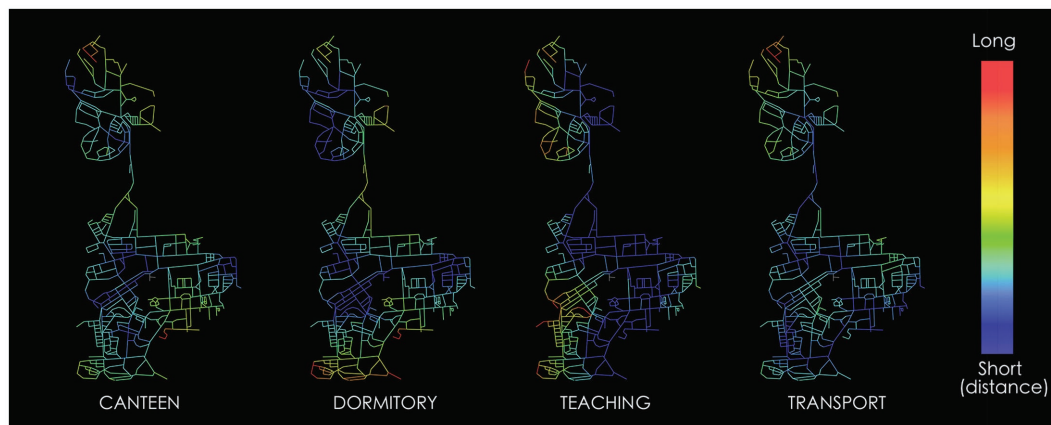
Dependent variable: log movement average.

Predictors: (constant), NACH( $R = 1,200$ ).

direct east–west links across the site and well connected with the existing intersections on the west. The corridors are becoming part of the campus public network that significantly increase the through- movement, which promote unexpected encounters with information that may trigger interdisciplinary -innovation.

On local scale, the visibility graph analysis is conducted within the group of buildings. Visibility graph analysis is another type of representation of spatial configuration based on visual relationship of space. It helps to understand the visual perception of the built environment and contribute to forecasting how accessible spaces afford movement (Al-Sayed, 2014). Compared to the segment analysis, visibility graph analysis explains a high resolution picture of the spatial configurations of a layout, which is more detailed and suitable for indoor space analysis. In visibility graph, the space is divided into grids, each of which is a unit for analysis. As Penn argued in a study with a sample of 24 building floors (1991), the degree of spatial integration predicted the strength of the network significantly and related to the level of useful work that contributed to inter-group communication. Therefore, integration is used as the syntactic property to evaluate the innovative potential within the building floors at local scale. In general, loop layout with little end space will have higher integration than tree layout. However, the results (**Figure 10, Table 5**; the warmer the color, the high the integration value/ the better accessibility) reveal that although buildings of different disciplines are well connected by loop circulations in scheme A, its performance of integration does not show a distinct advantage over scheme B, in which buildings are connected on one end. Despite the small advantage in average value, the minimum, maximum and standard deviation value of scheme A are worse than that of scheme B. The difference of minimum and maximum value between two schemes is relatively distinct, which means that both the most integrated and segregated spaces in scheme B perform much better than scheme A. This analysis of local scale shows that the number of connections between isolated buildings is admittedly meaningful, but the effect on innovative promotion by increasing through-movement also has much to do with how the connections are organized. According to the results, on local scale scheme B performs better than scheme A for two reasons. On one hand, the physical connectivity across buildings of multiple disciplines is straighter that act as a spinal cord of the whole district, while in scheme A physical connectivity are relatively limited between every two buildings. The heterogeneity of physical connectivity affects the chance of unexpected encounters with information from other disciplines thus affecting interdisciplinary innovation possibility. On the other hand, in scheme B the expansion space concentrates in the main physical connectivity that are much visible and accessible for passersby all over the district, while in scheme A the expansion space allocates to physical connectivity between every two buildings like accessory space of different disciplinary. Accordingly, the characteristics of physical connectivity that affect the to-movement potential include not only the amount (in scheme A isolated buildings are





**FIGURE 4 |** Quantify different attractions by metric step depth analysis.

### Least Squares Fit

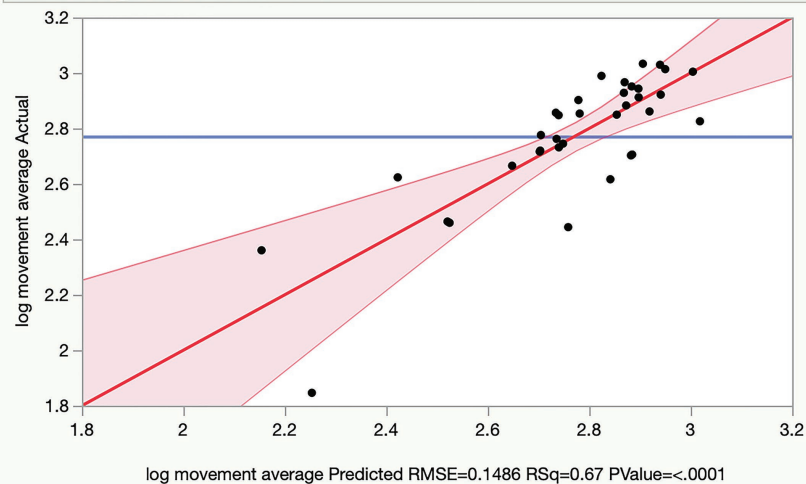
#### Effect Summary

Source	LogWorth	PValue
scut NACH(R=1200)	6.869	0.00000
distance decay(teaching/office)	1.138	0.07274
distance decay(dormitory)	1.052	0.08875
distance decay(canteen)	0.822	0.15062
distance decay(transport)	0.130	0.74122

#### Response log scut ped av

#### Whole Model

#### Actual by Predicted Plot



**FIGURE 5 |** Multiple variable regression analysis in JMP.

connected on both ends, in scheme B isolated buildings are connected on one end), but also the form and the alongside space organization. Constructing spaces along the connective corridors to enhance the connection leads to better performance than merely connective corridors between different buildings.

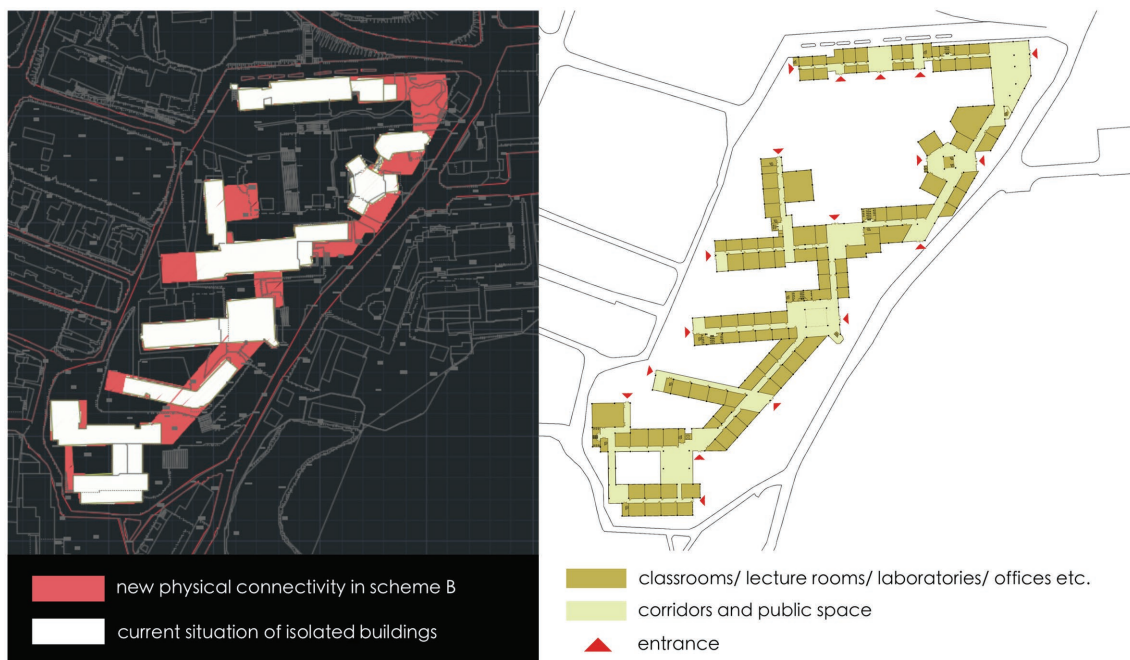
## DISCUSSION AND CONCLUSION

This work advances the research on spatial potential for interdisciplinary innovation and provides a spatial quantitative method for guiding innovation-driven development in the





**FIGURE 6** | The plan of scheme A which connects isolated buildings on both ends.



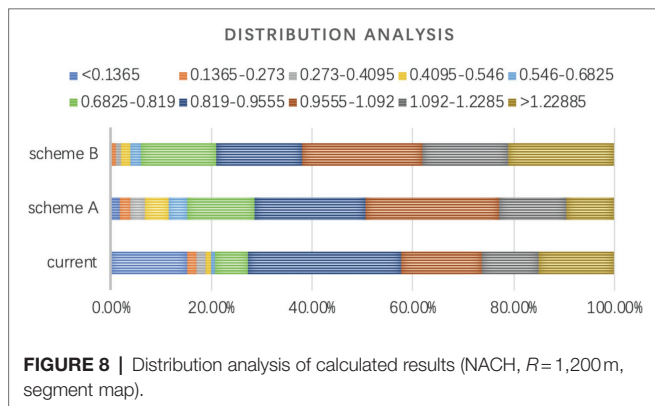
**FIGURE 7** | The plan of scheme B which connects isolated buildings on one end.

context of university campuses. Previous studies in various areas have proved the effect of physical environment on innovation. However, they mainly focused on how physical environment can support innovative interaction within a building, which is relatively limited in this work due to the low possibility

of interaction with strangers on the campus scale. Based on the inspiration of the “physical connectivity” in MIT and the related theories in human information behavior and social psychology, the paper enriches the understanding of spatial potential for interdisciplinary innovation by proposing that

**TABLE 3** | General comparison of the segment analysis (NACH,  $R=1,200$  m).

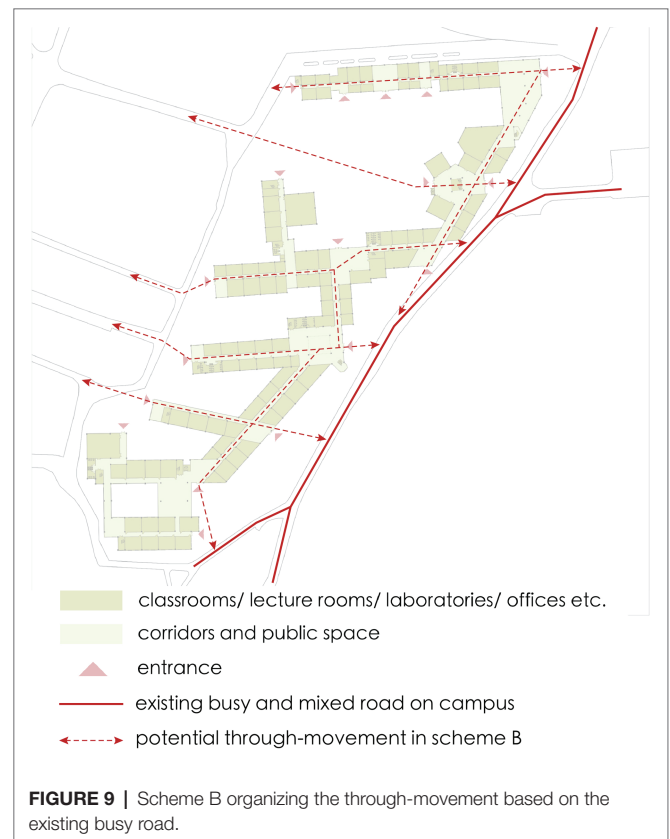
	NACH ( $R=1,200$ m) of the current situation	NACH ( $R=1,200$ m) of the scheme A	The increase percentage of scheme A compared to the current situation (%)	NACH ( $R=1,200$ m) of the scheme B	The increase percentage of scheme B compared to the current situation (%)
Average	0.832521	0.910811	9.40	1.00245	20.41
Max.	1.36536	1.36238	-0.22	1.33625	-2.13
Std. dev.	0.417651	0.272837	-34.67	0.223965	-46.38

**FIGURE 8** | Distribution analysis of calculated results (NACH,  $R=1,200$  m, segment map).**TABLE 4** | Distribution comparison of the calculated results.

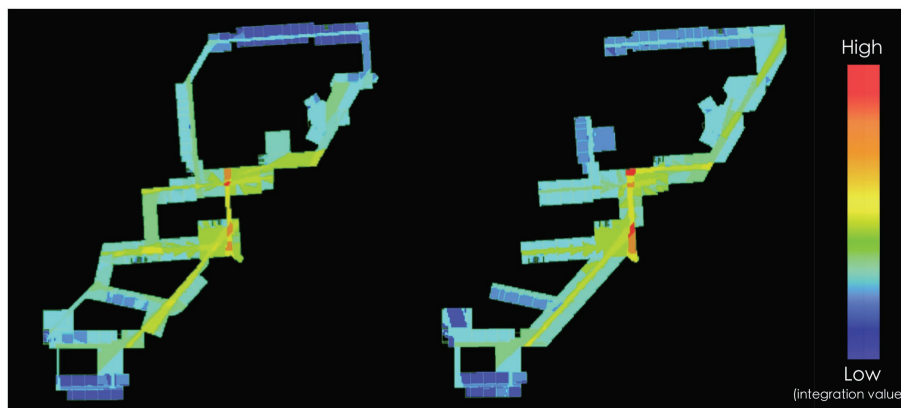
Value of NACH ( $R=1,200$ m)	Percentage of segments amount of the current situation (%)	Percentage of segments amount of scheme A (%)	Percentage of segments amount of scheme B (%)
<0.1365	15.09	1.90	0.00
0.1365-0.273	1.89	1.90	1.00
0.273-0.4095	1.89	2.86	1.00
0.4095-0.546	0.94	4.76	2.00
0.546-0.6825	0.94	3.81	2.00
0.6825-0.819	6.60	13.33	15.00
0.819-0.9555	30.19	21.90	17.00
0.9555-1.092	16.04	26.67	24.00
1.092-1.2285	11.32	13.33	17.00
>1.22885	15.09	9.52	21.00

unexpected encounters with information can trigger innovative problem-solving as well. In order to explore a spatial quantitative method to apply this proposition to the innovation-driven development of university campuses, this paper reviews and develops the application of Space Syntax. In this work, the key of the method is to evaluate the innovation potential by calculating the effective large-scale movement through spaces with information. Compared to the existing studies, in this context the overlap degree of movement and information is calculated instead of that of different movements.

In the preliminary application study, we have presented evidence for the dominance of spatial configuration in the movement performance within the campus of South China University of Technology, which proves the application of space syntax to the study. We also discussed movement attractions

**FIGURE 9** | Scheme B organizing the through-movement based on the existing busy road.

and found that unlike urban environment where transport and commerce were always effective attractions, the movement in campus was more likely to be affected by the distribution of teaching and living areas. Alternative solutions for innovation-driven development were simultaneously tested by quantitative analysis as the evidence-based process to propose effective design interventions. Scheme A and scheme B presented a rich comparison of the design process and its outcome of different innovative potential by spatial configuration. Starting with quite similar briefs, their spatial translations were different. Through the quantitative analysis on global and local scale, the study showed that the design briefs of connecting buildings of different disciplines and integrating the group into the campus public network had the spatial affordances to induce random encounters that would trigger and accommodate innovation, but the effect differed from different interventions. It was demonstrated that organizing direct routes across the site to enhance the existing network based on the real movement



**FIGURE 10 |** Comparison of visibility graph analysis on local scale (integration,  $r=n$ ).

**TABLE 5 |** Comparison of the visibility graph analysis on local scale (integration,  $R=n$ ).

	The integration ( $R=n$ ) value of Scheme A calculated by visibility graph analysis	The integration ( $R=n$ ) value of Scheme B calculated by visibility graph analysis
Average	3.00933	2.95318
Minimum	1.59817	1.82412
Maximum	4.99472	5.30263
Standard deviation	0.650529	0.638936

performance was more effective than concentrating in the connection of isolated buildings to construct an integrated group within the site. For instance, providing parallel routes to the existing busy and mixed roads around the site can effectively separate pedestrian flow and attract through-movement into the research buildings. Besides, extending existing streets that block by the site and transforming existing indoor corridors into direct link across the site is also effective solutions to enhance existing network as innovation-driven spatial strategies. Moreover, the visibility graph analysis within the group of buildings indicated that connections between isolated buildings contributed to the innovative potential by increasing through-movement in terms of connectivity amount, space form and alongside space organization.

To summarize, this research explores potential opportunities to guide the campus development to create more innovative work processes. In previous studies, innovations are predicted by connecting disconnected individuals and enhancing coordination between connected individuals (Hillier and Penn, 1991; Wineman et al., 2009; Sailer and Thomas, 2019). This paper enhances the possibility of innovation by promoting unexpected encounters with information. Physical connectivity as enabler is discussed in terms of its effect on organizing the global through-movement and transforming the spatial configuration of the local indoor space. This area of exploration has broader impacts to campus administrators, research space designers and architects in producing innovative work

environment. Spatial layout is often considered a powerful tool for shaping organizational culture and achievement. And physical connectivity in the campus context can be a useful strategy to adjust the spatial layout to respond to the new pedagogical structure of encouraging interdisciplinary innovation.

Limitations of this application study are mainly derived from the small sample of field research data. Due to the Covid-19 pandemic, we could not obtain more data of the real movement in campus. Moreover, it is crucial to support this study with investigations of the actual performance of the buildings, which might differ according to the daily operation of the building, the management and many other factors. Therefore, further research may continue to study the academic and social life inside the buildings as well as activity patterns, and relate this to the innovative potentiality afforded by configuration.

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding authors.

## AUTHOR CONTRIBUTIONS

YL and QD contributed to the conception and framework of the study. MJ wrote the first draft of the manuscript. KH was actively involved in the application study. All authors contributed to the article and approved the submitted version.

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# Co-created Future Scenarios as a Tool to Communicate Sustainable Development in Coastal Communities in Palawan, Philippines

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Scenarios can be used to communicate potential future changes and engage and connect different audiences in exploring sustainable solutions. Communicating scenarios using creative visualisation, co-creation and a focus on local contexts are especially promising. This research is conducted on the island of Palawan in the Philippines as part of the GCRF Blue Communities project. With a quasi-experimental design, we investigate the psychological and emotional effects of the engagement with future scenarios as a tool for communicating sustainability. Together with local stakeholders and community members, three distinct, locally relevant scenario narratives (Business as Usual, Best Case, and Worst Case) have been co-created. Subsequently, a sample of  $N = 109$  local high school students was asked to creatively engage with these scenario narratives. Intentions to engage in sustainable behaviour, perceived behavioural control, ascription of responsibility, consideration of future consequences, six basic emotions and connectedness to place were assessed before and after the activity via paper-pencil administered questionnaires. A mixed-model analysis showed significant increases in intentions to engage in sustainable behaviour, however, this increase disappeared when consideration of future consequences was added as a covariate, suggesting a mediating effect. The level of consideration of future consequences also increased significantly after engaging with any of the future scenarios, which questions the common interpretation of consideration of future consequences as a trait variable. Perceived behavioural control significantly increased following the engagement with each of the scenarios whereas ascription of responsibility and connectedness to place did not show any changes. Overall, the two most emotion-evoking scenarios, Best Case Scenario and Worst Case Scenario, turn out as superior over the Business as Usual Scenario, which points to the relevance of emotional framing for effective messaging in our sample. This is the first systematic, quantitative assessment of the effects of future scenarios as a communication tool.

**Keywords:** future scenarios, intentions, consideration of future consequences, coastal communities, co-creation

## INTRODUCTION

The importance of achieving the 2030 Agenda of Sustainable Development is globally recognised and 17 goals (SEGs) have been formulated, representing 17 areas of importance. What has been discussed less so far is how these 17 global goals are to be translated and communicated on a local scale; ideally by developing and evaluating tailor-made strategies for different locations and challenges.

Facing social and economic struggles, many communities around the world are balancing the conflict between their everyday needs and the needs of future generations, possibly compromising environmental sustainability. This is because making sustainable choices might result in immediate economic disadvantages, which can have particularly severe consequences in the Global South. Most subsistence communities are forced to prioritise day-to-day adaptation to an ever-changing environment, which they closely depend on for food, health and livelihood over long term strategies for sustainable development (Kroll et al., 2019; Scharlemann et al., 2020). Research on human perceptions and behaviour systematically over-represents university samples from industrialised Western countries, leading to an information deficit around decisions, behaviour and communication strategies of people who live in developing regions and are directly affected by the conflict between everyday subsistence and sustainable development.

Future scenarios are a popular means to communicate the potential prospects of climate change (for example see IPCC, 2021) and might be a means to engage communities and policy makers around the world in sustainable development. The psychological and emotional effects of scenarios as communication tool, especially on lay audiences, are still under researched and direct links between future scenario communication and sustainable action are questionable (Dieckmann et al., 2017; Guilbeault et al., 2018; Xexakis and Trutnevyte, 2021). Very complex graphs or tables can even lead to confusion and reactance (McMahon et al., 2015). It is therefore recommended to customise formats of future scenarios to the audience (Corner et al., 2018; Xexakis and Trutnevyte, 2021), for example with the use of non-technical solutions such as narratives or visuals. These formats, however, still lack thorough evaluation for their effects. In this work, we aim to evaluate the psychological and emotional effects of engaging with future scenario narratives and the co-creation of future scenario visuals. To increase the significance of this technique beyond the Western context, this study has been conducted in Palawan, the Philippines, an area that does not only represent a region of particular ecological vulnerability, but also provides insights into understudied communities (Henrich et al., 2010a,b). This research is part of the GCRF Blue Communities project<sup>1</sup> which aims to support sustainable co-management of marine resources whilst protecting marine ecosystems and enabling alternative livelihoods via capacity building as a collaborative

approach between the United Kingdom and South-East Asian countries.

This is the first systematic assessment of the psychological and emotional effects of differently framed scenarios.

## FUTURE SCENARIOS: FORMS AND APPLICATION

Developing alternative scenarios to depict different variations of how the future might look like is not new (Fontela and Hingel, 1993) and is used in scientific-, socio- political-, business-, and communication contexts. As Schoemaker (1995) points out in his book, scenarios can be both an outcome of traditional, numeric data simulation or of “soft” data, like cultural frameworks, community structures, political regulations, values and human behaviour, integrating quantitative and qualitative methodologies. The scenarios themselves can take different forms: They can be presented traditionally in the form of graphs or tables, but also as narratives (Steenberg et al., 2019), drawings (Löfström and Klöckner, 2019), infographics, (augmented) photographs (see Tress and Tress, 2003; Sheppard, 2012), GIS-maps (Dockerty et al., 2005) or in virtual reality (Lovett et al., 2002).

Natural scientists develop precise prospects on a variety of dimensions such as levels of carbon emissions, nitrogen in the atmosphere, or fish stocks (Fernandes et al., 2015; Queirós et al., 2016). Another form of future scenario is developed by the International Panel for Climate Change (IPCC). The IPCC's end-of-century emission scenarios depict what the world would look like under different, almost antithetic regimes (globalisation vs. regionalisation; conservation vs. economy) (IPCC, 2021). These scientific scenarios are used within scientific frameworks but also consulting socio-political decision making (Sala et al., 2000; Merrie et al., 2018). Businesses including large commercial companies have a history to develop future scenarios to gain economic advantages and enhance their resilience (Schoemaker, 1991, 1995). In participatory workshops around the world, scenarios have been co- developed and used as a communication tool to enrich dialogues or inform local policy making (for examples see Berkhout et al., 2002; Kok et al., 2007, 2015; Kok and van Vliet, 2011; Varela-Ortega et al., 2013; Intergovernmental Panel on Climate Change, 2014). According to anecdotal remarks during these workshops, alternative scenarios might have the potential to engage people with the relationship between the current situation and potential futures (Amer et al., 2013), evoke higher levels of problem awareness and encourage community members and policymakers in solution development (Johnson et al., 2012; Sheppard, 2012) and support the identification of obstacles for change processes, such as finances, governance structures (Kok et al., 2011) or a lack of trust (Tress and Tress, 2003). Scenarios might even contribute to larger scale system change (Moss et al., 2010; Darbas et al., 2011). Systematic, empirical evaluation of potential psychological and emotional effects as well as whether any subsequent behavioural changes are attributable to the scenario work are so far lacking (O’Riordan et al., 2008; Measham et al., 2012).

<sup>1</sup> www.bluecommunities.org

## PSYCHOLOGICAL PRINCIPLES AND BIASES DRIVING SUSTAINABLE BEHAVIOUR CHANGE

There are numerous barriers for climate action (for an overview see Gifford, 2011). The ones that can potentially be addressed with the help of co-created future scenarios include non-accessible, specialist information, ignorance and numbness, psychological distance, and temporal discounting.

### Tailored Communication

Lack of environmental action on individual and communal level is commonly interpreted as the result of an information deficit (Lorenzoni et al., 2007); however, increasing the availability of natural science evidence *per se* (e.g., evidence on climate change effects) has not been found to be a strong, direct trigger of sustainable behaviour change (Whitmarsh, 2011). A range of principles have been discussed to improve the accessibility of communication about sustainability which are based on knowledge about fundamental abilities and constraints of the human brain to perceive time and the future (for an overview see Klöckner, 2015). One of the key recommendations is audience-tailored communication which has the potential to spark environmental action (Moser, 2010, 2014; Mycoo, 2015; Harold et al., 2020). Further, messages are processed more successfully when they are made easy to understand for lay people and experts alike (Behavioural Insights Team, 2010; Center for Research on Environmental Decisions, 2014), emphasise a social dimension (Zlatev et al., 2010; Bain et al., 2012) tell a story or refer to a well-known narrative (Garb et al., 2008; Pahl and Bauer, 2013; Nabi and Green, 2015) and consider the human preference of visual information processing (Nicholson-Cole, 2005; Sheppard, 2012; Corner et al., 2015). As an example, Sheppard (2005, 2008) and Sheppard et al. (2011) created realistic imagery depicting the future of local landscapes as a means of engaging community members with climate change to support sustainable regional development. The researchers report that community members responded with increased engagement, understanding and joint environmental decision making, however, they point out that systematic evidence on psychological and emotional effects is needed to understand these processes better.

### Emotional Engagement

Ignorance and numbness are common barriers of climate action. Communication is considered impactful, persuasive and lead to action if it evokes emotions (Pooley and O'Connor, 2000; Slovic et al., 2002). This holds for both positive and negative emotions (O'Keefe and Jensen, 2009; Nabi and Myrick, 2019), discrete emotions and transforming emotions [emotional flow, Nabi and Green (2015) and Nabi et al. (2018)]. Positive emotions such as hope have been found to encourage pro-environmental behaviour (Ojala, 2012), but only if specific actions are included in the message (Hornsey and Fielding, 2016). Negative emotions such as fear or anger as reactions to a story or visual usually evoke strong responses which could be used as catalyst (Pestridge, 2017; Hornsey and Fielding, 2020).

In both cases, it is vital to combine the (positive or negative) message with action information to facilitate the feeling of self-efficacy (Tannenbaum et al., 2015) and thereby prevent unwanted responses such as ignorance or rejection. Previous studies provide contradicting evidence regarding emotional framing and behaviour change. Feinberg and Willer (2011) found reactance effects caused by (negative) emotional scenario framing whereas Nabi et al. (2018) claims that positive and negative framing of climate change messages leads to attitude and behaviour change, mediated by emotions like hope and fear. According to the Extended Dual Process Model, individuals only take emotionally motivated action if they feel able to undertake the necessary action that can avoid the threat (Witte, 1992). For scenarios, this implies that positively or negatively framed future visions such as Best- or Worst-Case Scenarios might have stronger effects on motivation and behaviour compared to an emotionally neutral prospect if combined with specific action advice.

### Consideration of Future Consequences

One core psychological mechanism impeding sustainable engagement is that the impacts of many pressing environmental problems, such as climate change and sea-level rise, have been found to be perceived as “psychologically distant.” This means that these threats are seen as geographically distant (Lorenzoni et al., 2006, 2007), happening at a point in time that is too far away to relate to Pahl et al. (2014), and happening to others rather than to ourselves (Spence et al., 2012; Myers et al., 2013). Researchers are exploring ways to overcome this psychological distance to encourage sustainable behaviour change, for example, through proximation of climate change by presenting people with information about local climate change effects (Spence and Pidgeon, 2010; Brügger et al., 2015), by using tangible time horizons (Tonn et al., 2006) and by communicating via common narratives or experiential visualisation, such as the Future Delta 2 video game (Dulic et al., 2016; Breves and Schramm, 2021) or the ecosystem simulation game ECO (Fjællingsdal and Klöckner, 2019). These recommendations could be combined in co-created future scenarios. As one core characteristic of future scenarios is the temporal dimension, they might have the potential to help people overcome the temporal discounting bias (assuming that environmental problems will only take place in the far future) and to start taking more responsibility for their current actions. In a meta-analysis, Milfont et al. (2012) show that people considering the future outcomes of their actions more, behave more environmentally friendly. Stable interindividual as well as intercultural differences in the level of how much people consider the future consequences can explain variance in actual environmental engagement (Bain et al., 2015). This concept has been conceptualised as a trait measure, called consideration of future consequences (CFC; Strathman et al., 1994; Joireman et al., 2012; Arnocky et al., 2014). It represents the level of how much people think in long- or short time horizons and consequently adapt their actions. So far, no research is available demonstrating if or how CFC could be strengthened to benefit sustainable development.

## CURRENT STUDY

In the current research, we sought to explore the effects of co-created future scenarios as a communication tool. More precisely, we assess changes in a selection of psychological and emotional variables as a consequence of engaging creatively with a future scenario that was either emotionally framed (Best Case Scenario and Worst Case Scenario) or neutrally framed (Business as Usual Scenario).

The study sample falls into the category of non-WEIRD societies, which have been found to differ from WEIRD samples in several characteristics like risk perception, decision making or moral reasoning (Henrich et al., 2010a,b; Arnett, 2016), requiring suitable measures and methods. The study design as well as the survey questionnaire were co-created by resident and international researchers and adapted to local circumstances, resulting in a unique set of variables. The commitment of the Blue Communities project to deliver capacity-building points toward a special interest in variables that represent agency and means to drive and manage sustainable development on the community level.

## Selected Constructs and Measures

The variables we identified during stakeholder consultations ahead of this study as well as borrowed from popular theories from environmental psychology such as the Theory of Planned Behaviour and the Norm Activation Model (Schwartz, 1977; Ajzen, 1991). Intentions to engage in sustainable behaviour (Int\_sust), consideration of future consequences (CFC), perceived behavioural control (PBC), ascription of responsibility (ASC), connectedness to place and emotions (worry, hope, fear, anger, curiosity, and empowerment) have been included.

As a key determinant of pro-environmental behaviour, an adapted measure for behavioural intentions has been included with one item (*In the near future, I want to engage in more work that helps my community to be sustainable*) (Ajzen, 1991). As behaviour change for sustainable development in our study site encompasses a large variety of actions (e.g., selective fishing methods or uptake of alternative livelihoods), we opted for a more general term. It is to note that this stands in contrast with the recommendation by Kaiser and Gutscher (2003) to adapt the specific level of the behavioural intention measure with the behaviour in question. In our case, we decided to opt for the general measure to allow individual interpretation of the item and keep the survey short.

Judgements of how easy behavioural performance is perceived are reflected in *perceived behavioural control* (PBC). We included one item for this construct (*I think it is difficult to do something for my community as an individual*, reversed) adapted from Ajzen (1991). Especially in the context of sustainable practices, behaviours might seem complicated or unfamiliar, leaving people with low confidence to engage in them (Armitage and Conner, 2001; Lorenzoni et al., 2007; Simmons and Fielding, 2019). According to our consultations, local stakeholders and communities often struggle with a

sense of disempowerment and helplessness, making PBC a key construct to include.

The feeling of being responsible for negative consequences if not acting pro-socially is represented by the psychological construct *ascription of responsibility* (ASC) (De Groot and Steg, 2009). Traditionally part of the Norm Activation Model (Schwartz, 1977), ASC is known as an indirect predictor of intentions for pro-environmental behaviour (Bamberg and Möser, 2007; Klöckner, 2013; Han, 2014). Feeling responsible for the sustainable development of the community has turned out to be a key theme that can spark sustainable behaviour change (Kaiser and Shimoda, 1999), especially in small communities in low-income countries (Simmons and Fielding, 2019). We included one item (*I don't feel responsible for the problems of my community*) adapted from Doran and Larsen (2016).

When it comes to sustainable change-making, considering the future consequences of our actions today is of key relevance. The trait measure "*Consideration of Future Consequences*" (CFC) can explain inter-individual differences in future-oriented behaviour and reflects the extent to which people consider the distant and imminent consequences of their behaviour (Arnocky et al., 2014; Murphy and Dockray, 2018). This concept is related to the expression of pro-environmental, -social and -health related intentions and involvement (Joireman et al., 2001, 2012). We included a shortened, five-item CFC scale suggested by Joireman et al. (2012) measuring the Future dimension of CFC (example item: *In the near future, I want to engage in more work that helps my community*).

*Feeling connected* to a particular place or region has been found to drive pro-environmental behaviours such as sustainable land management, clean-ups, recycling or water conservation (Vaske and Kobrin, 2001; Scannell and Gifford, 2010). The nature and size of this place can vary, which means that for some people it might be the own property (Stedman, 2002), for some it is a national park (Halpenny, 2006), for some it is their country (Laczko, 2005; Bonaiuto et al., 2006; Gustafson, 2009) and for some an even wider area such as the planet as a whole, which is reflected in our measurement levels. To assess on what level of abstraction our participants experience place connectedness, we asked them how connected they feel to their city, region, country and the world as a whole (adapted from Williams and Vaske, 2003).

All above-mentioned constructs were measured on a 1 (*Strongly disagree*) – 5 (*Strongly agree*) Likert scale.

People's decision making is also influenced by their *emotions*, which is known as affect heuristic (Slovic et al., 2002). According to Sheppard (2005), being exposed to scenarios leads to affective responses and the urge to adapt and prepare for the future, however, the author is not specific on the type of emotions. As we expect a range of different emotions to be evoked, also depending on the type of scenario developed, we included six basic emotions, worry, hope, fear, anger, curiosity and empowerment, measured via the Positive and Negative Affect Schedule (PANAS, *Thinking about the future makes me feel...*) (Watson et al., 1988). The selection of emotions was based on literature documenting the effects of climate change



scenario communication (Nicholson-Cole, 2005; Sheppard, 2005; Healey and Hodgkinson, 2008).

## RESEARCH QUESTIONS

RQ1: How does engaging with future scenarios affect Int\_sust, CFC, PBC, ASC, Con\_place, and emotions?

RQ2: Does engaging with emotionally framed scenarios affect Int\_sust, CFC, PBC, ASC, Con\_place, and emotions differently as compared to the non-emotionally framed scenario?

RQ3: Does the initial level of CFC influence the effect that future scenarios have on Int\_sust, PBC, and ASC?

## MATERIALS AND METHODS

### Scenario Development

The Blue Communities project engages with communities from three regions across Palawan (Puerto Princesa, Aborlan, and Taytay) of which one (Taytay) was selected as a focus area for this study. In collaboration with 23 local stakeholders from various sectors such as the local government, NGOs, representatives of fisheries, aquaculture and tourism, three scenarios were developed (see Table 1 in **Supplementary Document 4** for list of attendees; see **Supplementary Document 4** for more details on this process). The first scenario, Business as Usual (BAU), represents the continuation of the current situation and its developments into the future (see **Supplementary Document 1**). Under this scenario, the current local problems of the local community such as illegal fishing, mangrove cutting and commercial fishing vessel intrusion were narrated and the most likely future outcomes in the next 15 years were depicted. The second scenario, termed here as Worst Case Scenario (WCS), represents the communities' least desirable future (see **Supplementary Document 2**). In this scenario, current developments have been driven toward a negative extreme through the narrative: steeply declining fish stocks and dead coral reefs, malnourished children, epidemic diseases and ubiquitous pollution. The third scenario is a depiction of the communities' most desirable future, the Best Case Scenario (BCS) (see **Supplementary Document 3**). This scenario narrates how through management interventions, a sustainable future was achieved including for example well performing officials, successful mangrove restoration, coral reef protection and sustainable fishing practices. All three scenarios depicted a version of the future in 15 years' time, following the recommendations to use a human time horizon (Pahl, 2010; Pahl et al., 2014). The development of the scenarios followed the principle of participatory research by Green et al. (2003), according to which the research process is gradually co-shaped by researchers and participants, and scenarios were elicited with group work manuals adapted from Mansfield (2018) (exact task instructions in the Appendix).

The rich volume of information provided by the stakeholders was collaboratively synthesised by the research team and turned into three coherent narratives (see **Supplementary Documents 1–3**). As a common element, all three narratives revolved around one protagonist, representing a stereotypical local family.

### Design and Procedure

The study design was a 2 (time: pre, post)  $\times$  3 (scenarios: BC, BAU, WC) mixed-design (see **Figure 1**). The study took place in September 2019 over the course of 1 day, starting in the morning with the general registration as well as explanations on the general nature and ethics of the study given by the local head researcher (AA). Subsequently, the first part of the survey (please see **Supplementary Document 5**, Part 1) was administered in form of a paper and pencil survey, which they had to fill out quietly and seated separately from each other. In case of difficulties with filling out the survey, trained local facilitators supported the participants without influencing their answers. Subsequently, the students were divided into three groups and instructed to move to the designated separate classroom. Each group was accompanied by two researchers, one of which was responsible for reading out and discussing one of the scenario narratives, while the second researcher had a supervisory role. After the three scenario narratives were read out to the respective groups, the students were provided with drawing equipment and instructed to use the following 2 h to discuss and illustrate the narrative they just heard in small groups of 3–5. Examples of the scenario drawings are shown in **Figures 2–4**. After 2 h spent drawing within their groups the second part of the survey was administered (please refer to **Supplementary Document 5**, Part 2).

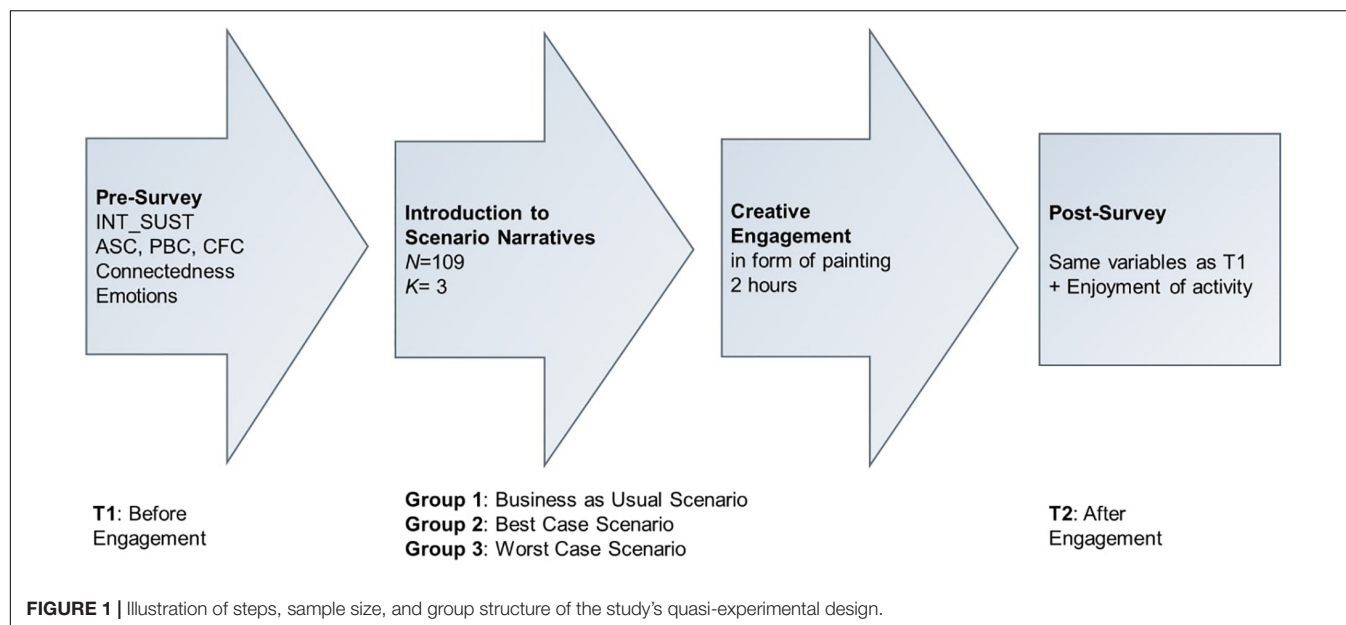
### Sample

The participants ( $N_1 = 109$ ) were recruited via their teachers from Central Taytay National High School in the municipality of Taytay and the study took place during normal school hours. Slightly more girls (52.3%) than boys (44.7%) participated and all of them came from the Philippines (of which 98% grew up in the study area) originally. Their age ranged between 12 and 18 ( $M = 16.37$ ) and they visited 7th to 12th grade.

### Data Analysis

For the data analysis, initial checks were carried out for all analyses in terms of outlier analysis, checks for normality, homogeneity of variance, multicollinearity and independent observations. Cronbach's Alpha across the five CFC items has been calculated and can be regarded as questionable with  $\alpha = 0.64$ . However, Nunnally (1978) states that Alphas slightly lower than  $\alpha = 0.70$  can be accepted when a small number of items is used or if the research is using under-researched samples or measurements, which is the case here. Therefore, we proceeded to calculate one mean score across the five CFC items for each participant. We also report effect sizes, using (Cohen, 2013) conventions of  $\eta^2 = 0.01$  as small,  $\eta^2 = 0.06$  as medium and  $\eta^2 = 0.14$  as large.

A Mixed Model analysis was conducted for behavioural Int\_sust, CFC, PBC, ASC as well as aggregated emotions with the different scenarios as between-group variable and controlling



**FIGURE 2 |** Example of the Business as Usual Scenario drawing, converted into a mural painting in Taytay town after the study was conducted.

for the level of enjoyment of activity<sup>2</sup>, gender and age. To investigate the initial level of CFC or emotions affects the

<sup>2</sup>The pattern of results and significance levels remain the same if the variables enjoyment of activity, gender and age are added or removed. This rules out that our effects are based on the participants' enjoying of the group work rather than on the engagement with the scenario content.

reaction to the scenario intervention, CFC was added as a covariate into the Mixed Model investigating Int\_sust, PBC, and ASC. To receive a more detailed picture on emotional reactions, single mixed model analyses were performed on each emotion (hope, curiosity, empowerment, anger, worry, and fear) separately.





**FIGURE 3 |** Example of the Worst Case Scenario drawing, converted into a mural painting in Taytay town after the study was conducted.

## RESULTS

### Intentions to Engage in Sustainable Behaviour

There was a significant main effect of Int\_sust across the two time points,  $F(1,97) = 21.79$ ,  $p < 0.001$ ,  $\eta^2 = 0.18$  ( $M_{before} = 4.21$ ;  $SE_{before} = 0.06$ ; to  $M_{after} = 4.53$ ,  $SE_{after} = 0.06$ ). In addition, we also found a significant interaction between time and scenarios  $F(2,97) = 10.98$ ,  $p < 0.001$ ;  $\eta^2 = 0.19$ . Following up this interaction, there was no significant change in the Business as Usual Scenario group from time 1 to time 2. However, the mean scores for both, the Worst Case Scenario group and the Best Case Scenarios group increased significantly over time. Visual inspection of the estimated marginal means revealed that the biggest changes could be recorded for the Best Case Scenario group, however, the increase was not significantly larger than the increase for the Worst Case Scenario group (see Figure 5).

### Consideration of Future Consequences

We observed a slightly different pattern for CFC as there was a significant main effect across the two time points,  $F(1,93) = 30.04$ ,  $p < 0.001$ ,  $\eta^2 = 0.24$ , ( $M_{before} = 3.72$ ;  $SE_{before} = 0.45$ ;  $M_{after} = 3.95$ ,  $SE_{after} = 0.47$ ) but no significant interaction between time points and activity (see Figure 6).

This indicates that all types of scenarios lead to a greater level of CFC with the Worst Case Scenario recording the strongest change upon visual inspection, however, not significantly stronger than the other two scenarios (see Figure 6).

### Consideration of Future Consequences as Covariate

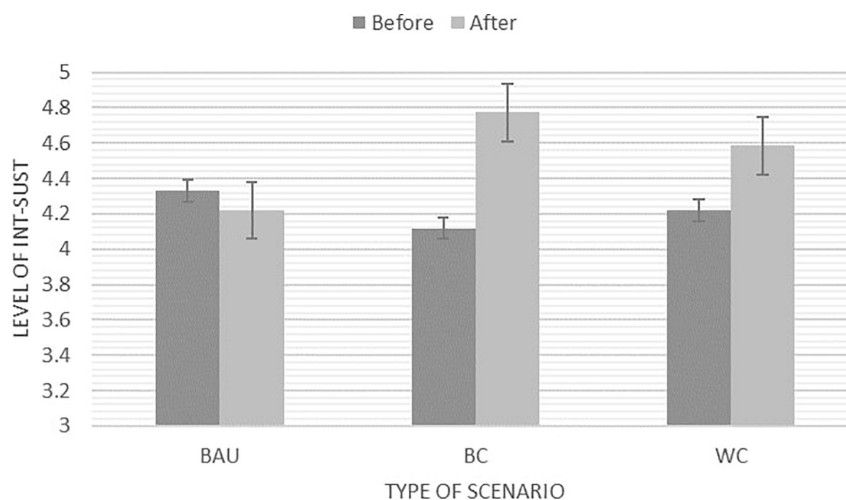
If we control for the initial level of CFC, the significant main effect of Int\_sust disappears, indicating that the change that we observed before and after engaging with the scenarios depends more on the initial level of CFC than the type of scenario. The crossover interaction between time and activity remains significant  $F(2,92) = 9.51$ ,  $p < 0.001$ ;  $\eta^2 = 0.17$ , indicating that Int\_sust is increasing in the Best- and Worst Case Scenario whereas it remains relatively stable in the Business as Usual Scenario as visualised in Figure 7.

### Perceived Behavioural Control

Perceived behavioural control increased over time  $F(1,98) = 3.96$ ,  $p < 0.05$ ,  $\eta^2 = 0.04$ , ( $M_{before} = 3.04$ ;  $SE_{before} = 1.19$ ;  $M_{after} = 3.30$ ,  $SE_{after} = 1.27$ ), but similar to CFC, no interaction between the type of scenario and the increase of PBC was observed. Due to the non-normality of the perceived behavioural control variable, we



**FIGURE 4 |** Example of the Best Case Scenario drawing, converted into a mural painting in Taytay town after the study was conducted.



**FIGURE 5 |** Estimated marginal means for Int\_sust before and after the creative engagement with three different types of scenarios: BAU, Business as Usual; BC, Best Case Scenario; and WC, Worst Case Scenario. NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).

suggest applying a more conservative  $p$ -value of  $p = 0.01$  which indicates treating this effect with caution.

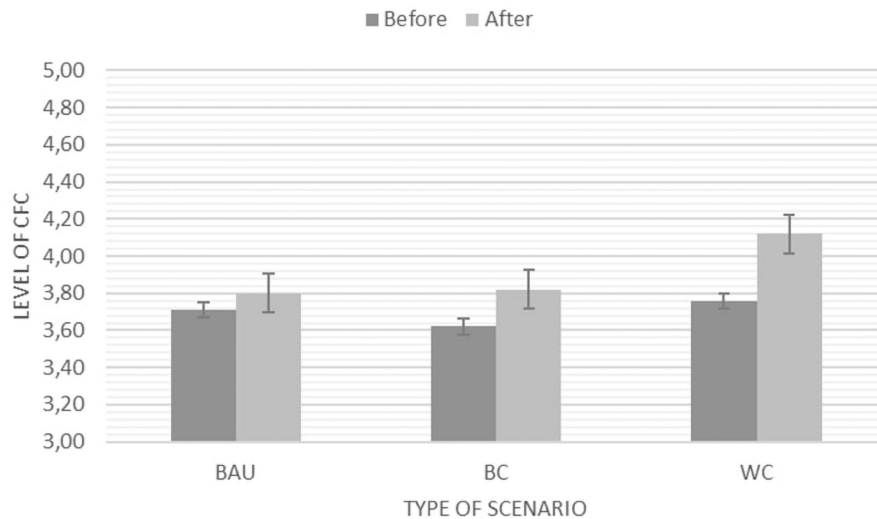
## Emotions

### Aggregated Positive Emotions

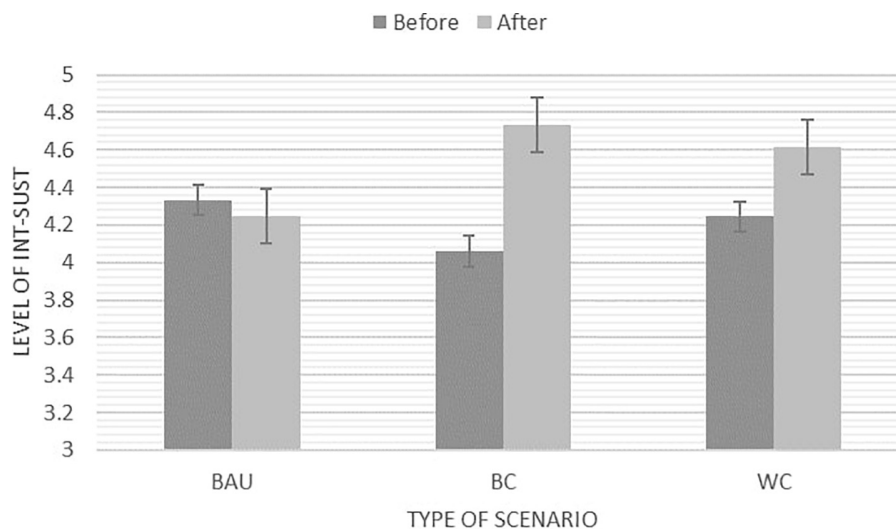
There was a significant main effect of positive emotions across the two time points,  $F(1,96) = 12.43$ ,  $p = 0.001$ ,  $\eta^2 = 0.15$  indicating stronger positive emotions (on aggregated level) after

the scenario engagement  $M_{before} = 3.02$ ;  $SE_{before} = 0.04$ ; to  $M_{after} = 3.17$ ,  $SE_{after} = 0.04$ . In addition, we also found a significant interaction between time and scenarios  $F(2,96) = 4.03$ ,  $p = 0.021$ ;  $\eta^2 = 0.08$ . Following up this interaction indicated that there was no significant change in the Business as Usual Scenario group from time 1 to time 2, whereas the Best Case Scenario and the Worst Case Scenario lead to significant increases in positive emotions with the Best





**FIGURE 6 |** Estimated marginal means for CFC before and after the creative engagement with three different types of scenarios: BAU, Business as Usual; BC, Best Case Scenario; and WC, Worst Case Scenario. NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).



**FIGURE 7 |** Significant interaction between scenarios after adding CFC as covariate. NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).

Case Scenario showing the strongest effects as visualised in **Figure 8**.

### Aggregated Negative Emotions

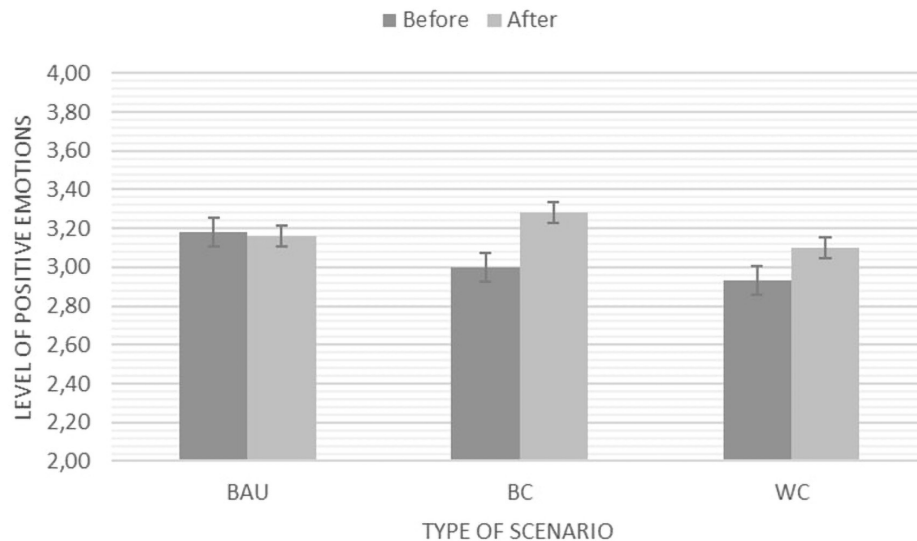
Aggregated negative emotions did not show any significant changes over the course of the engagement with the future scenarios  $F(1,97) = 0.05$ ,  $p = 0.953$ ,  $\eta^2 = 0.001$ ;  $M_{\text{before}} = 2.24$ ;  $SE_{\text{before}} = 0.06$ ; to  $M_{\text{after}} = 2.29$ ,  $SE_{\text{after}} = 0.06$ .

### Individual Emotions

The General Linear Model across each of the six measured emotions individually shows that we can identify significant changes in three emotions: hope, empowerment, and anger.

Hope showed a significant main effect  $F(1,98) = 12.86$ ,  $p = 0.001$ ,  $\eta^2 = 0.12$  with higher average values of hope after the engagement of the scenario than before ( $M_{\text{before}} = 3.95$ ;  $SE_{\text{before}} = 0.08$ ; to  $M_{\text{after}} = 4.27$ ,  $SE_{\text{after}} = 0.07$ ). Visual inspection points toward the Best Case Scenario inducing the strongest increase, albeit not significantly different from the Worst Case Scenario and Business as Usual.

Both a significant main effect  $F(1,96) = 15.89$ ,  $p < 0.001$ ,  $\eta^2 = 0.14$  ( $M_{\text{before}} = 3.85$ ;  $SE_{\text{before}} = 0.07$ ; to  $M_{\text{after}} = 4.19$ ,  $SE_{\text{after}} = 0.07$ ) and a significant interaction  $F(1,98) = 3.25$ ,  $p = 0.04$ ,  $\eta^2 = 0.06$  were found for the feeling of empowerment after the engagement with our three scenarios. We need to be cautious with interpreting this particular interaction, as the



**FIGURE 8 |** Significant main effect and interaction for positive emotions before and after engaging with one of the three scenarios (BAU, Business as Usual; BC, Best Case Scenario; and WC, Worst Case Scenario). NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).

before-level in the Business as Usual group deviates from the before-level of the other two scenarios as can be seen in **Figure 9**, albeit not significantly.

We found a significant main effect for the feeling of anger after the engagement with the future scenarios. Individual inspection of the values shows that the Worst Case Scenario increased the most, however, not significantly more than the Best case and the Business as Usual Scenario (see **Figure 10**). Overall, we can note that the levels of anger were relatively low compared to other emotions. Curiosity, worry and fear did not significantly change throughout the activity.

## Additional Analyses

ASC did not significantly change across time  $F(1,98) = 2.73$ ,  $p = 0.102$ ,  $\eta^2 = 0.03$ ;  $M_{\text{before}} = 3.79$ ;  $SE_{\text{before}} = 0.09$ ; to  $M_{\text{after}} = 3.97$ ,  $SE_{\text{after}} = 0.10$  and no meaningful differences could be observed between before and after our intervention for connectedness to place, i.e., connectedness to the city  $F(1,98) = 2.55$ ,  $p = 0.11$ ,  $\eta^2 = 0.03$ ;  $M_{\text{before}} = 3.96$ ;  $SE_{\text{before}} = 0.09$ ; to  $M_{\text{after}} = 4.08$ ,  $SE_{\text{after}} = 0.09$ , the region  $F(1,98) = 0.108$ ,  $p = 0.30$ ,  $\eta^2 = 0.01$ ;  $M_{\text{before}} = 3.83$ ;  $SE_{\text{before}} = 0.09$ ; to  $M_{\text{after}} = 3.90$ ,  $SE_{\text{after}} = 0.09$ , the country  $F(1,98) = 0.58$ ,  $p = 0.45$ ,  $\eta^2 = 0.006$ ;  $M_{\text{before}} = 4.11$ ,  $SE_{\text{before}} = 0.09$ ; to  $M_{\text{after}} = 4.06$ ,  $SE_{\text{after}} = 0.09$  or the world  $F(1,98) = 0.10$ ,  $p = 0.75$ ,  $\eta^2 = 0.001$ ;  $M_{\text{before}} = 3.69$ ;  $SE_{\text{before}} = 0.09$ ; to  $M_{\text{after}} = 3.71$ ,  $SE_{\text{after}} = 0.10$ .

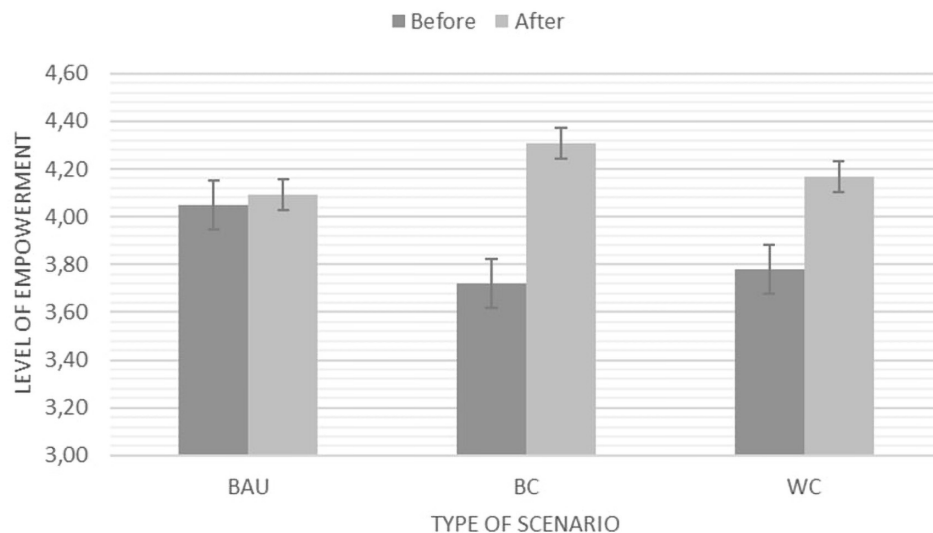
## DISCUSSION

We sought to investigate whether engaging with different types of future scenarios affects people's behavioural intentions to engage in sustainable behaviour, consideration of future consequences, perceived behavioural control, ascription of responsibility, connectedness to place and emotions.

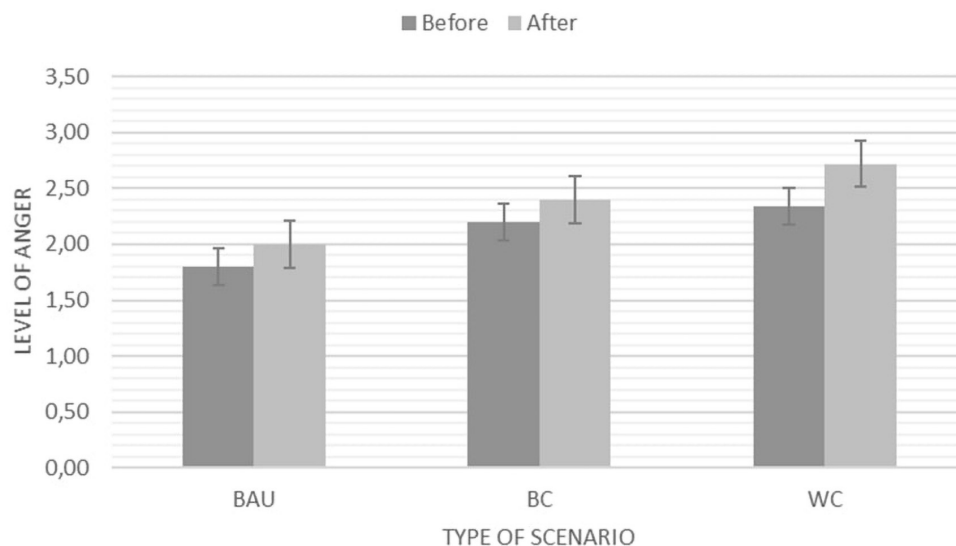
Overall, we can summarise that engaging with scenarios, especially the emotionally framed ones (Best Case and Worst Case Scenario), led to significant changes most variables we measured and that the construct consideration of future consequences deserves some special attention.

Responding to RQ1 and RQ2, we find increased levels of intentions to engage in sustainable behaviour after our intervention. However, it appears that the Best- and Worst Case Scenario were mainly responsible for this effect. A similar pattern was found for perceived behavioural control and positive emotions. In all these cases we found significant changes in the Worst- and the Best Case Scenarios but no or significantly lesser changes for the Business as Usual scenario. The Business as Usual Scenario was by definition created surprise-free and as close as possible to the realistic vision the community members of Taytay hold about their future. The instruction for the Best- and Worst Case Scenario, however, was to think out of the box and create future visions that drive the current positive (for the Best Case Scenario) or negative (for the Worst Case Scenario) developments of Taytay to the extreme. A possible explanation for the effects we found is that emotionally stimulating scenario narratives (Best- and Worst Case Scenario) are more impactful than narratives that focus on the most probable future which is in line with evidence showing that emotions are a key ingredient of impactful narratives (Pooley and O'Connor, 2000; Loewenstein et al., 2001; Lecheler et al., 2013; Nabi et al., 2018). This is supported by the theory of affect heuristics in decision making (Finucane et al., 2000; Slovic et al., 2002).

Looking closer at the effects the scenarios had on our participants' emotions, we found that especially positive emotions, hope and empowerment, were affected, but also the feeling of anger increased significantly. Aggregated positive emotions and also the individual measures of hope and empowerment increased after engaging with the Best Case



**FIGURE 9 |** Significant main effect and interaction for the feeling of empowerment before and after engaging with one of the three scenarios (BAU, Business as Usual; BC, Best Case Scenario; and WC, Worst Case Scenario). NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).



**FIGURE 10 |** Significant main effect for the feeling of anger before and after engaging with one of the three scenarios (BAU, Business as Usual; BC, Best Case Scenario; and WC, Worst Case Scenario). NB: Y-axis adapted for illustration purposes. The Likert scale ranges from 1 (*Strongly disagree*) – 5 (*Strongly agree*).

Scenario, a narrative that very positively depicted the future of Taytay, expanding on existing sustainable developments in the region including feasible solutions such as pro-environmental programs and investments. Overall, the Best Case Scenario induces the strongest emotional effects compared to the other two scenarios. This underlines how important it is to use positive language, present realistic solutions and thereby spark people's optimism.

The participant's positive emotions also increased after engaging with the Worst Case Scenario, but not with the Business

as Usual Scenario, which seems counterintuitive at first but mirror the findings by Nabi and Prestin (2016). Their study on emotionally consistent narratives shows that stories framed positively and including solutions (hope/high efficacy) equally boosted intentions to engage in protective actions as did stories that were framed negatively and without solutions (fear/low efficacy) as compared to emotionally inconsistent narratives. Our scenario narratives mimicked the same structure. In our case, the positive emotions evoked by the apocalyptic scenario might be related to wishes for rehabilitation and reconstruction and the

possibility of a new start for the community. As the Worst Case Scenario has been depicted overly negative, the positive emotions could also stem from the assumption that reality will most likely be better than the Worst Case Scenario and that there is still time to change course. Further, sustainability is a topic that is now taught in schools in Palawan, potentially leading to a sense of optimism amongst the children.

The rise of anger as a consequence of engaging with all three of the scenarios might be due to negative future prospects on which children in particular do not have a lot of influence as many problems are caused by the generation before them. This is in line with the finding that ascription of responsibility did not change across the activity indicating that the children did not feel more responsible for the state of their local area. A current lack of environmental law enforcement coupled with the limited allocation of resources to sustainable development projects in Palawan may leave children feeling angry. Adding open questions to elaborate more on the reason for and direction of the anger might have provided more insights. Overall, these findings confirm the assumption that emotionally framed scenarios evoke emotions which might work as a catalyst for intentions to engage in sustainable behaviour (Nabi et al., 2018, 2019).

Particular attention should be paid to RQ3, looking at the effects in the consideration of future consequences which is traditionally interpreted as a stable personality trait. One main hurdle for sustainable behaviour change is the lack of an apparent connection between current behaviour and future consequences (Gifford, 2011; Fauré, 2016; Wittmann and Sircova, 2018). We found that engaging with any of the three future scenarios led to a significant increase in consideration of future consequences. Compared to the other effects in which the emotional scenarios were superior, consideration of future consequences significantly increased across all three scenarios. This might indicate that it is the engagement with scenarios of any kind that helps people to establish a closer connection to the future and therefore consider the consequences of their behaviours more. The significant increase of consideration of future consequences across all conditions also indicates that the interpretation of consideration of future consequences as a stable trait might have to be reinterpreted as it can be manipulated by immersing people with future scenarios. Toepoel (2010) argues that consideration of future consequences is subject to slow changes over the course of life, driven by education or significant life events. However, we identified significant changes after only a few hours. We have reason to assume that creative engagement with future scenarios can have similar effects as significant life events. In contrast to significant life events, engagement with future scenarios can be induced in a single experimental setting. This is relevant evidence on the possibility to increase people's level of consideration of future consequences by co-creating future scenarios. This effect has not been discovered before and might, together with the increased level of perceived behavioural control after engaging with all types of scenarios provide some leverage for the development of effective communication strategies and eventually for sustainable behaviour change.

The finding that engaging with the future did not change our participants' connectedness scores shows that this factor remains stable over time and does not interfere with our results or is affected by our intervention. We also found the effects of our scenarios were independent of the demographic characteristics such as gender, age or education of our participants as well as of how much they enjoyed the activity. Especially as our study design was quasi-experimental, it is important to reaffirm in prospective studies that engagement with the scenarios is the reason for the effects we found. Within the GCRF Blue communities project, this experimental setting has been replicated in locally adapted designs in several other study sites. The data collected is currently being analysed and will complement the present study.

## LIMITATIONS

From potentially confounding extraneous factors like noises, temperature and weather changes which can affect the participant performance, to variance in interpersonal interactions in the sub-groups the children were working in, there were some factors we could not fully control. This is due to the nature of the study being a field experiment taking place in the ordinary environmental of our participants, on a remote island with limited facilities to conduct controlled research experiments. To limit the impact of interpersonal interactions and conflicts that might have arisen, we controlled for the level of enjoyment of the activity in an additional survey question, which was added as a covariate to the analysis. This variable did not significantly affect any of our analyses, indicating that the activity was perceived as equally enjoyable by all our participants across conditions.

Another limitation is that we did not test several different scenarios of each type (BAU/WC/BC) against each other. Therefore, we cannot clearly say if it was the type of the scenario or the specific narrative leading to our effects. The quasi-experimental design further did not include a control group in which participants did not engage with any future scenario. The question if our effects are merely caused by a creative, social activity can be ruled out by the inter-scenario differences.

Another key limitation is the sample consisting of junior and senior students of the local High School located at the study site, in the city of Taytay. The age cluster between 12 and 18 coincides with puberty and is therefore an emotionally intense and challenging time for most teenagers. Despite the argument that emotion regulation develops across the whole lifespan (Cole, 2014), we are aware of this age cluster being particularly susceptible for emotional triggers (Burnett et al., 2011). Due to this particular age profile of our sample, we advise against generalising this conclusion across all age groups before additional studies have been conducted. Within our sample, we did not find that age differences affected the result patterns. This indicates that at least within the age range covered by our participants, no differences of scenario effects can be observed depending on how old the participants are.

The last limitation concerns the validity of our measurements and responses. To simplify and shorten the survey as much as



possible, we only included one item per psychological construct. Ideally, we would have used multi-scale instruments to average out potential measurement errors (Nunnally, 1978). Weighing up the reliability that can be gained by including more items against a possible response error, especially in a children sample, we decided to stick with one item per measurement. The responses could have been influenced by the wish of the children to reply in a socially desirable manner which we attempted to control as much as possible. To encourage the children to provide authentic answers, the facilitators did not interact with the children while they responded to the survey questions because direct interaction could increase social desirability effects (Miller et al., 2015). Furthermore, all participants were notified that the survey will remain anonymous and individual number codes were allocated to each child instead of their names.

## CONCLUSION

Our study shows that scenarios, that were carefully designed according to the criteria of environmental communication, are powerful tools to communicate about sustainable development. Engaging with co-created, and locally relevant future scenarios significantly increased people's intentions to engage in sustainable behaviour, their consideration of future consequences, their perceived behavioural control and their positive and negative emotions. Especially emotionally framed scenarios seemed to have a strong effect on people's motivation to engage in sustainable behaviour change. This underlines the importance to communicate to people not only with factual information but on an emotional level when we want to see change.

Engaging with scenarios also seems to bridge the psychological distance between now and the future and change the individual levels of consideration of future consequences, which is a novel finding that is worth exploring further.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article can be made available on request.

## ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Faculty Research Ethics and Integrity

Committee University of Plymouth. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

## AUTHOR CONTRIBUTIONS

IR, JS, AA, and SP developed the study design. IR, SP, and EG-T developed the survey questionnaires. JS and AA were responsible for recruitment and correspondence with stakeholders and schools as well as planning of data collection, location, and infrastructure. IR, JS, AA, and LC collected the data and held the stakeholder meetings. IR coded and analysed the data, and wrote the manuscript. JS, AA, LC, and SP gave feedback to the manuscript. SP and LC supervised the project. All authors contributed to the article and approved the submitted version.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2021.627972/full#supplementary-material>

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# Living Place Matters: The Duplicity of Shared Housing in the Young Adults of South Korea

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This study focus on the phenomenon of the preference for co-living among young adults that has manifested in South Korea. The study examines life in a shared house as a living place, which is the representative form of co-living that the younger adults in South Korea have been choosing. The objective of the study is to examine shared housing as living place matters and their possibility of being a home and house for the young generation. The study procedures included reviewing place attachment theory, analyzing the operational structure of shared houses, and interviewing residents to discuss the place attachment of the residential environment in shared houses. The young adult generation who chose to share a house display indecision on the issue of residential choices and behavior in terms of spatial possession. The results are as follows. Although co-living is a realistic residential choice for the reduction of residential costs, the majority of young adults experientially highlight the values of co-living rather than acknowledge the real reasons behind their choices. Such results signify that they recognize such limited residential choices as a means of temporary residence, not rooted to a living place, rather than an ordinal difference between the best and the second best, and ultimately the need to further consider the issues of continuous life and lifestyle on the foundation of the perspective of the universal life cycle of the young adult generation.

**Keywords:** shared house, co-living, living place, lifestyle, young generation, place-attachment

## INTRODUCTION

### Background and Objective

Choosing a house in accordance with the stages of one's life cycle is the physical foundation for quality of life. A house is a living place through which residents are rooted to their everyday life. Although young adults, in the early stages of their life cycles, are in a process of fully settling in as members of society, they are at a stage of economic vulnerability with limited housing choices (Doling, 1976; Kendig, 1984; Andersen, 2011). After young adults begin to live independently from the home that they lived in with their parents, it is widely accepted by society that they seek a temporary living place instead of owning a home, which many wait until marriage to do (Maalsen, 2018). In addition, the economically and residentially disadvantaged have found shared houses to be alternative living places. However, the meaning of shared houses is changing in the twenty-first century (Hemmens and Hoch, 1996; Xu et al., 2015; Holton, 2016; Maalsen, 2018). There are many shared house arrangements around the world, such as WeLive in the United States, where start-up entrepreneurs co-work and shared living quarters, and Old Oak in the UK where various room

services and ancillary facilities are available for tenants (Kim, 2015; Woo et al., 2019; Bergan et al., 2020; Kim et al., 2020). These are cases of private rental housing that secure the convenience of transportation and living space in metropolitan areas where the burden of housing costs is high. Since the 2000s, private rental housing has spread mainly among young adults (Hirayama and Ronald, 2007; Holton, 2016; Druta and Ronald, 2020; Kim et al., 2020). There is still controversy over whether a shared house is a reasonable or inevitable option as a housing choice (Kenyon, 1999; Kenyon and Heath, 2001). Because of different social, physical, and temporal interactions such as conflicts between residents and privacy issues around shared houses, it is still too early to judge if they can function as a long-term sustainable living place (Clark et al., 2017, 2019; Orlek, 2017; Nasreen and Rumung, 2020).

Economic instability and a poor residential environment for young adults are significant social issues in South Korea. Korea has experienced compressed modernization in Asia (Park, 2015, 2016; Byun et al., 2018). Until the present, the supply of public rental housing was based on households with married couples and households of those supporting elderly parents with residential vouchers offered to people with lower-incomes. This is the result of a long-held social perception that single young adults correspond only to the stage of living away from their parents prior to the formation of their own family in their life cycles due to studying at a university and finding a job (Kang, 2017).

The issue of housing for single-person households in the young adult generation has become a prevalent social problem. Together with the rise in the jobless population and delayed social entry, it takes a long time to find a job and economic independence is delayed. There has been no clear housing policy to support young adults who do not belong to a defined social class. A policy vacuum for young adults who do not qualify for any class places them in economic instability and a poor residential environment. The majority of shared houses are operated within a sublease framework, which creates a legal blind spot where the residential rights of tenants are not guaranteed. There is a lack of regulatory policies on house sharing, minimum hygiene conditions, and limitations on people sharing the same residence (Byun et al., 2018). In addition, the legislation is not transparent enough to regulate the legal responsibility and accountability of tenants, homeowners, and managers (Byun, 2020). For a long time, Korea's social perception that young adults were occupants of temporary households rather than independent households had an impact on housing policy and the housing market as well as housing choices. Although a stable residential environment must be secured, in-depth consideration of the housing of young adults has not been considered.

This study focuses on the phenomenon of shared house preferences of young adults in Korea. This research begins with living "place" matters and raises two research questions: will shared houses be settled living places? Can shared houses offer new place values in terms of living place based on the concept of place attachment?

The objective of the study is to examine shared houses as living places and the possibility of them being a home for the young adult generation. The study procedures include reviewing

place attachment theory, analyzing the operational structure of shared houses, and interviewing residents to discuss the place attachment of shared houses as residential environments.

## Place Attachment Theory

It is necessary to discuss the meaning of the environment at a spatial level and to consider person- and place-centered approaches. In particular, the features of the built environment are identified through the process of exploring the relationship between "place" and "person." The concept of place attachment is applied in various ways, from the relationship of a specific place and person (Hidalgo and Hernandez, 2001; Giuliani, 2003) to the "sense of place" that a person needs (Relph, 1976). In the study of housing, place attachment is the basis of the theoretical framework to understand the relationship between the behavior of residents and the residential environment (Raymond et al., 2010; Fornara et al., 2019). The place attachment of residents to their living place plays a significant role in helping them feel that they belong in a residential environment and neighborhood in a community (Kamalipour et al., 2012).

Scannell and Gifford (2010a) defined a "tripartite model of place attachment" as organized person-place-process dimensions. This mode has meaning as a general definition of place attachment, which comprehensively presents a common and consistent concept in the discussions of researchers on place attachments. This study is based on the place attachment theory of the Scannell and Gifford tripartite model to examine shared houses as living places.

First, in the model of place attachment, the person dimension can be explained at the individual level and group level (Scannell and Gifford, 2010a). The individual level involves experiences, realizations, and milestones, and the group level is close to meanings of genders, cultures, and religions (Scannell and Gifford, 2010a). In a range of living places, shared houses involve both the individual level and group level as personal connections and spatial sharing among members.

Second, the process dimension of place attachment is psychological for affect, cognition, and behavior (Scannell and Gifford, 2010a). Affect is an "emotional" meaning-happiness, pride, and love- involved in person-place bonding (Manzo, 2003). Cognition contains memory, knowledge, schemas, and meanings. The behavior level is an expression of actions by proximity, maintaining, or reconstructions of place. These three concepts are separate terms. However, it is necessary to consider the concepts comprehensively to review the process dimension of place attachment. In the living place, issues of residents' satisfaction with environments, relationships between residents (flatmates), and the meaning of living together in shared houses should be discussed.

The place dimension encompasses perception of "the place itself," but also measures the social and physical dimensions of attachment (Hidalgo and Hernandez, 2001; Scannell and Gifford, 2010a,b). Hidalgo and Hernandez (2001) suggest that community attachment was identified with social bonding and physical rootedness. Shared-house residents have a similar living range of spatial level from the house (or room) to the community area. This means that the physical place overlaps or is the same, but the

**TABLE 1 |** Management status of shared housing.

Components			Avg.	Min.	Max.
Housing cost (1,000 KRW)	Monthly rent	Lowest	360	110	570
		Highest	470	190	850
		Deposit Lowest	1,100	200	10,000
		Highest	1,500	200	50,000
Living condition	Utility/maintenance cost		47	10	120
	Residents' age	Youngest	19.8	18	22
		Oldest	35.9	50	50
	Minimum contract length (months)		4.6	0.5	12
	Number of residents (people)		7.5	1	48
Housing area (m <sup>2</sup> )	Total area		116.3	38.0	565.0
	Area per person	Min.	9.9	4.0	38.0
		Max.	17.7	6.6	67.0
Dwelling space	Number of bedrooms		4.3	1	37
	Number of toilets/shower booths		2.3	1	24

Data were collected from 1 December to 31 December, 2017.

social place can be different. Furthermore, the length of residence and plans to stay can be predicted with physical attachment or not “rootedness” in a living place (Riger and Lavrakas, 1981). These dimensions are highly related to the planning and design of the residential environment by considering sharable boundaries.

## MATERIALS AND METHODS

### Online Data Collection

We collected raw leasing data from online platforms and materials from shared house organizations that manage many units in metropolitan areas (Come&Stay, 2019). The first form of data was collected from related websites, and we further interviewed the representatives or managers of shared house organizations to obtain more detailed information. According to data announced by an online platform specializing in shared housing in Korea, based on the number of rented households, this began with four cases in the second half of 2012, which rapidly increased to 329 cases in the fourth quarter of 2017. There were 2,407 beds from 1,398 rooms rented, indicating that the majority were for two occupants in each room (Come&Stay, 2017). The principle that operates shared housing in Korea is an organization that specializes in the operation and management of shared housing. Although the status of the industry has not been accurately and specifically discerned, there is a trend toward an increase in the number of relevant operating organizations including limited companies, housing cooperatives, social corporations, and individuals (rental business operators). The activities of such operating organizations can be categorized into residential land purchasing, planning, design, construction, and maintenance, with cases in which the organization specializes in the consigned management of shared housing. From the data collected from online platforms, we confirmed that many tenants, with varying lease durations, were sharing a house (Table 1).

### Focus Group of Residents

The purpose of the focus group was to understand the livelihood of shared house residents based on user experience by identifying their current residence and their perception of that residence. We also tried to understand the social sharing of daily lives and interactions between residents in addition to the physical sharing of a place. Interviews were carried out with 26 residents, comprising five focus groups of the shared houses in a metropolitan city of Korea—five residents of “ABLE HOUSE” on February 2, 2018, in Seoul (SO), five residents of “Gumgultong” on January 10, 2018, in Daejeon (DJ), 5 residents of “BUNKERHOUSE” on February 12, 2018, in Daegu (DG), five residents of “Gongmyung” on January 26, 2018, in Gwangju (GJ), and 6 residents of “SONG’s VILL” on December 23, 2017, in Busan (BS). The cases of the shared houses in which the subjects of the interview lived represent the brand names of various branches in each of the regions. After creating respondent-specific and semi-structured questionnaires for five groups in each city, the author interviewed the residents regarding their living situations.

The focus groups were composed of three parts where discussion of current living, perception of shared houses, and social and physical sharing was based on place attachment concepts (Table 2). In the first part, the interviewer asked whether the room type is a shared room. On the satisfaction with current living, the residents evaluated each content of residential environment factors on a 5-point Likert-type scale (from 1 = not at all to 5 = completely). For discussion, the residents responded to the questions, and then talked freely about the questions related to issues or expressed their thoughts in no particular order.

The focus group was conducted as follows. In the preparatory stage, the status of shared house residents was identified with a written survey of operators of each sharehouse. Prospective interviewees were recruited and participated in interviews with

**TABLE 2 |** Focus group.

Method	Items	Interview questions	Place attachment concepts		
			Person	Place	Process
Semi-structured questionnaire	Current living	House information channels	–	–	–
		Room type (share or not)	–	v	–
		Length of residence / Plans to stay	–	v	–
		Past living experience of shared housing	v	–	–
		Advantages and disadvantages	v	v	v
		Satisfaction of residential environment.	v	v	v
Topic discussion	Perception of shared house	Appropriate length of stay	–	v	–
		Sharable scope	v	v	–
		Priorities in selecting a house	v	–	v
		Importance for life in a shared house	–	–	v
		Acquaintance and family perception	–	–	v
	Social and physical sharing	Activities or tasks shared among residents	v	–	v
		Current usage of common spaces	–	v	v
		Acceptance of other residents	v	v	–
		Willingness to live in other regions	v	v	v

the author. Interviews were conducted in five sessions for each interviewee, with each session lasting about 130 min. Interviews consisted of a warm-up interview and a subject interview. For the warm-up, a semi-structured questionnaire was distributed by the interviewer. The residents first replied to each question and then confirmed their answers in an interview. For the subject interviews, the interviewees freely answered the questions. A research assistant typed details of the interviews during the sessions with voice recordings.

## RESULTS

The five shared house organizations, marketed and recruited university students through online platforms, social media, and their websites from 2014 to 2017. They offer a wide range of unique tenant management and lifestyle services such as events and social meetings. The five organizations operate other businesses in addition to the shared houses. Able House manages 19 shared houses for exchange students and university students, develops computer software and applications, and manages other real estate properties. Gumgultong began to manage share houses by participating in local projects with government grants. Gongmyung focuses on residence building leasing services. Bunkerhouse operates residence databases in the local area and house makeovers. Song's Vill began its business as a shared house provider and has now expanded to room sharing management.

A summary of resident characteristics shows that 10 residents were male and 16 were female (**Table 3**). Their average age was 26 years, with those in their late 20s accounting for more than half the residents. In total, 67% (18) were college students (11) or those preparing to find a job (7), and all were unmarried. All residents of DG were university students and females. SO were university students, both male and female. Residents of BS were acquaintances. Residents of GJ and BS were students and

workers. DG, SO, and BS were in a similar living radius. GJ and BS were not in a similar living radius because they lived away from workplaces and universities. Although the residents' hometowns were different and they currently live together in the same shared houses, each group has a similar spatial range to live in. There is a possibility of place attachment based on a sense of community.

## Current Living

To summarize the results for current shared house living conditions, the respondents were mostly satisfied with living in shared houses. They stressed that there were no problems with sharing dwelling spaces such as living rooms, kitchens, and bathrooms because they decided to live in a shared house to save housing expenses. Online platforms were the central source for exchanging information and finalizing contracts, and the shared house management and tenants communicated and negotiated through social media.

Half of the respondents reported their channel for obtaining information on shared houses online (Internet search, blogs, and social media promotion), while 46% were referenced and introduced by acquaintances. For room type, 42% of respondents had single-occupancy rooms, 27% had double-occupancy rooms, and 23% had rooms for three or four persons. Twenty-four residents answered negative when asked whether they had previously resided in shared houses.

Most of the residents did not live in shared houses for a long period, and it was unclear whether some would continue to live in the same shared house. Of the respondents, 77% had lived <1 year in their shared houses, while 46% answered "don't know" regarding their future length of stay. This shows that the lengths of time of residence are not long and plans to stay in shared houses are not made based on a long period or are unclear. Considering that most of the residents rent rooms by the month



**TABLE 3 |** Summary of respondents.

Components	N (%)
Gender	
Male	10 (38.5)
Female	16 (61.5)
Age	
20–24	9 (34.6)
25–30	14 (53.9)
31–34	3 (11.5)
Education	
High school or less	4 (15.4)
2-year university	11 (42.3)
4-year university	10 (38.5)
Graduate school	1 (3.8)
Job	
Employed	8 (30.7)
Not employed (student)	11 (42.4)
Not employed (looking for a job)	7 (26.9)
Average monthly income (10,000 KRW)	
100	10 (38.5)
100–200	9 (34.6)
200–	3 (11.5)
None	4 (15.4)
Average monthly living cost (10,000 KRW)	
50	10 (38.5)
50–100	12 (46.1)
100–	4 (15.4)

in shared houses, these results mean that physical attachment is not strong or “rootedness” is weak at the home level.

For the pros and cons of shared houses, the largest portion of respondents cited “reduced housing cost” as an advantage and “common spaces” as a disadvantage. Next to reduced housing cost, shared house residents chose “sense of security and sense of belonging” as a further advantage. Sense of security and sense of belonging are related to social and physical attachment based on the living place. The functions of place attachments include security, which is relative when compared to living alone. Shared houses provide for more than one person, and a common physical environment such as a living room and kitchen for residents to use together. Therefore, residents feel like they belong in the shared house.

Housing costs were low, comprising 70–80% of the monthly rent, which varied with the number of bedroom occupants. However, the deposit was double the monthly rent. Maintenance fees, which included electricity, gas, and water charges, were either split among the residents or paid by the shared house operating body.

In terms of their satisfaction with the residential environment, the residents were very satisfied in every way. Most items in the residential environment were rated over the “satisfied (4)” level. It is necessary to attach to the place the appropriate level of satisfaction in the residential environment. In this context, the residents saw their shared house as a living place. The

interpretation of this outcome needs to take into consideration the fact that respondents had a pre-existing positive opinion because they had chosen to share houses instead of the other types of residences and had agreed to the interview. Nevertheless, the desire to use shared houses for a short period reflects the negative side for shared houses to become deeply established with place attachment.

## Perception

### Appropriate Length to Stay and Sharable Scope of Share Houses

The results of appropriate lengths of time to stay in shared houses are as follows. Most respondents answered that it is appropriate to live in shared houses for a short period rather than a long period. Thirty-six percent responded under 1 year, 34% under 2 years, 19% more than 3 years or as needed, and 11% (3 persons) answered: “I don’t want to live in share houses.” The results mean that residents regarded shared houses as short-term living places. That is assuming they moved in the next few years. Studies need to look at the results of the length of residency and plans to stay in the current living part. The sense of community contains a connected lifestyle or interest, but it is not clear if this will go on for a long time.

In shared houses, the physical sharing level such as rooms, bathrooms, kitchens, and living rooms, and the social sharing levels such as socializing were both quite high among the residents. For their perception of shared houses and their life in shared houses, 42% responded “OK except for the bedroom” and 34% responded “OK except for the bed,” referring to the sharable spaces and facilities, thus exhibiting the same results as the current type of residence in shared houses. Over half of the respondents were currently in a shared room, which matched the results of the room type questions. Regarding sharable facilities (such as furniture and electronics), a small number of respondents selected furniture such as storage closets and desks, while 50% answered that they could share food items, personal items such as computers, and other items according to personal tastes. Other specific items all registered high ratios. This differs from the outcome on “willingness to share spaces and facilities” in the survey of the young adults’ current residence and demand for housing.

### Selecting Houses and Perceptions of Others

The location and rent of shared houses are important considerations when selecting houses. The priorities are location, program by management, room type, and rental cost. When choosing a house (including a shared house), location and rent are key factors. Here, it is meaningful that location and rent fee come first rather than room type and others. The results showed that shared houses were set around a community of place because geographical location means a place dimension of attachment that overlaps community boundaries physically and socially.

The perceptions of the residents’ parents or acquaintances were positive. Some parents of residents thought that living in shared houses was safer than living alone from a security aspect. Some residents’ acquaintances worried about living in shared houses. They lacked information on shared houses and had

no experience living in them. However, they thought that the experience of living in shared houses might come in handy 1 day.

## Social and Physical Sharing

Social and physical sharing in shared houses involves three dimensions of place attachment: person, place, and process. The degree of social sharing among residents demonstrated the following: residents attended resident meetings as well as regular gatherings or meetings supervised by the shared house operators, and residents discussed regulations and provide suggestions. Sometimes, team leaders selected for different shared households served as points of contact for the operating body manager.

## Experience Activities Among the Residents

Activities and episodes can consider the person and process dimensions. It could be shown that a community among residents was formed. For example, episodes of congratulating co-residents for birthdays or taking language or music lessons together were often mentioned. House members went beyond mere exchanges of greetings among members and joined in collective life.

*BS\_A: When I was ill, a roommate offered me medication and accompanied me to the hospital. On birthdays, I have a party and I drink together with other residents on days when I feel particularly severe stress.*

*PS\_B: I learned to ride a bicycle from my roommate.*

*GJ\_E: It is great to live in a shared house since I do not become lonely and can share fried chicken whenever I want to eat it. House cleaning can be stressful, but can be markedly lessened by doing major cleaning together on a set date along with segregated disposal of waste and garbage.*

*DG\_A: All five people started sharing the house together at the same time, and we all do weight training and kick-boxing together.*

*SO\_D: I offered free Korean lessons and help in his major area of study to a French house mate.*

At the individual level of the person dimension, a resident has experience with other residents during their daily life through learning something from each other. The interview results showed both “community of interest” to connect lifestyle and “community of place” in the same house. Two community types are based on the networking among the residents. This means that residents agreed to the meaning of being together and interpersonal behavior. Thus, being together and interpersonal behavior are strongly involved in the three dimensions of place attachment.

## Current Use of Common Spaces

The current use of common spaces partially shows the physical sharing level and residents’ living behavior in shared houses. Residents expressed differences in how often they used and how they behaved in the living room. Some residents rarely used the living room, while others frequently used the living room for eating dinner or watching TV. This shows that social sharing, such as socializing and bonding activities between tenants, is also correlated with the physical sharing of the space.

Residents of BS, SO, and DG shared houses were open to using a common living room, whereas DJ and GJ residents did not prefer to use a living room. As to why a living room is not preferred, three DJ residents pointed out that there was a problem with air conditioning and heating in the living room. Two residents of GJ shared houses used the living room to dry their laundry and said that it becomes loud when non-resident friends visit. Such a difference in preferences may be explained by the types of shared house residents. DJ shared houses were occupied by young office workers and college students. GJ shared houses were occupied by college graduates seeking jobs and college students, and residents of other shared houses were college students. The residents who are agreeable to sharing a common living room were students attending the same college (their majors may differ), or students attending different colleges, which were located at a close distance, and whose students move in a close circle.

*SO\_D: We frequently have dinner together in the living room.*

*BS\_D: We all use the living room together.*

*DJ\_B: During the summer, we get together in the living room more often and for longer periods of time. I chat with the others a lot since I do a lot of work in the kitchen because it has a desk which I can work on.*

*GJ\_D: I am not able to use the living room as much as I want to since we hang laundry there on racks.*

*DG\_E: I tend to stay in the living room for quite a long time since I watch TV, take naps, eat meals and play games there.*

## Acceptable Residents

For the acceptance of other shared houses residents, the standard presented most frequently was “age.” Normally, generational differences could have an effect in many ways. The residents anticipated problems including limitations in communication and establishment of consensus due to differences in value systems if the age difference among occupants was too large. The results also mean that shared house residents want to live with similar age groups because, with the same generation peer group, the cultural and social background could be understood. The results showed that there are possibilities of place attachment at the group level in terms of personal dimensions.

There were no restrictions on foreigners. However, the problem of providing security for occupants in the case of the presence of mixed genders was highlighted by female respondents. The propensities of occupants were also mentioned from the perspective that there could be inconveniences in sharing opinions or considering others while living together.

*BS\_A: There is a need to restrict the age of occupants because there could be problems in communication if the ages differ significantly.*

*GJ\_A: Age-group peers would feel more comfortable living together.*

*SO\_C: There must be a limited range of occupant ages. It would be more possible to establish a consensus if the occupants are neither too young nor too old.*

*DG\_D: Difference in age is important.*

## Willingness to Live in Other Regions

In terms of their willingness to live in shared houses in regions other than their current location after they graduate from college, the respondents' answers were varied. Some respondents wanted to live in a standard house instead of a shared house if they were able to pay for their housing by finding a job after college graduation. They also said that they would positively consider a shared house for corporate employees if public transportation were convenient, depending on the shared house operator, residents, and housing costs.

*DJ\_A: I will be living in a sharehouse only until I save sufficient money for a security deposit to rent a single-room residence.*

*DJ\_C: I will live in a sharehouse if it is close to my workplace and then move to my own residence once I save sufficient funds to cover the security deposit.*

*SO\_A: I wish to live in a sharehouse for working people only. I want to live in a shared house or keep co-working even after I am employed.*

*SO\_C: Once I am employed, I think shared housing may not be appropriate due to the need for dating and marriage.*

The previous interview results showed that residents considered shared houses for short-term living. In the same vein, the results of willingness to live in other regions also showed that residents were subject to move their living place, but not to shared houses. What is interesting is that the results show an ambivalent attitude by residents. Other results of social and physical sharing showed that it is based on place attachment in part. However, the results of willingness to live in other regions weakly showed the concept of attachment in person-place bonding.

## DISCUSSION

The following implications could be derived from the results of interviews with the current residents of shared houses. First, there is hardly a tendency of rootedness in the current living situation in shared houses. The study results illustrated the characteristics of short-term residences in shared houses due to indefinite periods of residence in the future and signifies that temporary residence is prevalent rather than stable and continuous residence in shared houses. The main reason for living in a shared house was to save on the cost of residence, and subjects mostly wanted to live there for the short-term of <1 year. Current residents chose a shared house because the costs were lower than the market value of separate residences in the areas around universities.

Second, the person and place dimensions of place attachment showed strong social and physical sharing aspects. Those in their 20s accounted for the largest proportion of current residents with high levels of satisfaction and associated living in a shared house with the establishment of consensus among their peer group. If the housemates were students from the same university, they displayed a high level of understanding of each other's lives since their academic curriculum and schedules were similar. It was stronger in the case of DG, where female students lived. These could be collective cultural characteristics

of Korean society when compared to shared houses in other countries. In the case of exchange students, the operator of the shared house provided various amounts of information or linguistic support to aid their daily convenience. Where residents were working people, they highlighted the sense of belonging and stability through interactions with other residents after working hours, in comparison to living alone, as constituting the foremost advantage.

Third, place attachment concepts of shared houses showed conflicting results. Shared houses were considered an option for a residential format depending on specific situations. The results of the interviews illustrate that living in shared houses cannot be seen as simply an issue of choosing between living alone or with others. This is because the residents who consented to the interviews displayed conflicting attitudes about choosing to live in shared housing due to logistical issues such as high residential costs while having to endure the inconvenience and privacy issues associated with having to share living spaces with others. The conflicting attitude of residents showed a duality between the housing demands of young adults and real life. Moreover, despite the high level of satisfaction in the residential environment, the tendency of wishing to reside only for a short period of <1 year illustrates that shared housing needs to be approached in greater depth as a temporary residence and with consideration of resources available in the vicinity of the house (Druta and Ronald, 2020). This tendency is the most important implication to consider when approaching the concept of shared housing as an alternative residential model (Kim et al., 2020). This is because Korean house shares are at a crossroads on whether they will stay temporary residences or become homes, which is the principal difference from cases abroad. As a result, shared houses fundamentally provide physical attachment features, but are limited to developing place attachment like the home level today.

Those of the young adult generation who chose shared residences display indecision on the issue of residential choices and behavior in terms of spatial possession. The concept of place attachment was shown strongly in residents in relation to aspects of shared house living. However, some parts were shown slightly. These findings are an important basis for whether a shared house could be a settled living place. To be a settled living place, it is necessary to improve the residents' place attachment close to the level of a home. However, it is possible to be a settled living place for young adults even with the double meaning of residents. Shared houses include physical features such as the place itself and place as spatial level. To develop the place attachment of the residential environment, the values of living place could be expanded more. For the results of the focus group, although it was a realistic residential choice for the reduction of residential costs, the majority of young adults are experientially highlighting the values of "co-living" rather than acknowledging the real reasons behind their choices. This is illustrated in their behavior and spatial uses based on the process and place dimensions of place attachment. The tenants emphasized the advantages of being able to use spaces other than individual bedrooms by sharing the residential costs for the common areas, and the behavior in occupying the common areas such as the kitchen appeared to have a wide

variance depending on the extent of fellowship among the shared house tenants.

The duplicity of the shared house is based on the residents' conflicting data of high satisfaction level, but they did not live in a shared house long-term. This shows a cognitive dissonance and inconsistency in their attitude and behavior. The biggest reason to choose house sharing is to save on the costs, but they justified the reasons by expressing other positive points. The purpose of choosing a shared house to reduce housing costs and the value of living within a group are not always compatible. The co-living of the start-up class in other countries is consistent with the purpose of building and promoting human networks through collaboration and living values (Clark et al., 2019; Bergan et al., 2020), because of residents who are in the one-person band or professions. Korea's shared houses indicate that for some issues, co-living value, and culture can be discussed in a similar vein as other countries. However, the issues of sustainable living places and being a home need to be discussed in a different context. The increased use of shared houses has not been happening for long in Korea, and there are only a few cases of long-term residence, which is a limitation for the insufficient narrative approach (Nasreen and Ruming, 2020).

## CONCLUSION

For shared housing to be considered an alternative form of housing, there is a need to ponder the possibility of expansion of the prospective consumer base for such residences (Holton, 2016; Maalsen, 2018). This is because shared housing is currently in the transition stage, with inadequate preparation of foundations within the institutionalized system and a lack of social awareness despite the demand, mostly among those in their 20s. Therefore, Korean society is at a crossroads whereby shared housing continues to be considered only as a place of temporary residence for those in their 20s, rather than performing the function of providing more sustainable and stable homes. The possibility of shared housing functioning as an alternative form of housing does exist since the young adult generation is opting to save on economic costs and gain the social value of living together with others while residing practically in shared housing for short periods of time rather than living alone. However, shared housing is still seen as being limited to temporary residences. Adults in their 20s use it to reduce residential costs given their economic vulnerability at this point in their life cycle. At the same time, shared housing has the potential to become an alternative form of housing for a wider range of age brackets, given the increase

in the number of one-person households throughout the entire demographic range of Koreans.

This study has the following limitations. First, the sample size of five focus groups of 26 residents is small. Second, this study deals with urban shared homes and not rural shared homes since the research set bounds to major city regions. Third, it is common to be faced with a housing problem in a metropolitan area for young adults from Europe, America, Asia, and other regions, and young adult generational living is also different in terms of economic and socio-cultural aspects. However, the research results are meaningful and illustrate the that living place of young adults matters. Fourth, the results signify that young adults are recognizing limited residential choices as a means of temporary residence rather than an ordinal difference between the best and the second-best, and ultimately implying the need to further consider the issues of sustainable living places and lifestyle for the foundation of the perspective of the universal life cycle of the young adult generation.

## DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

NB carried out the research in general and wrote the manuscript with support from DS. DS investigated parts of the literature review and developed the discussion parts. Both authors discussed the results and contributed to the final manuscript. Both authors contributed to the article and approved the submitted version.

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# Antecedents of Tourists' Environmentally Responsible Behavior: The Perspective of Awe

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The promotion of tourists' environmentally responsible behavior (TERB) plays a central role in destination management for sustainability. Based on the stimulus–organism–response framework, this study proposes an integrated model for behavior management by examining the relationship between stimuli (natural environment and availability of infrastructure) and response factors (satisfaction and TERB) through the organism (the emotion of awe). Survey data from 458 tourists visiting Mount Heng in Hunan Province, Southern China, were used to empirically evaluate the proposed framework. The findings demonstrate that the perception of a destination's natural environment positively impacts tourists' sense of awe and satisfaction; the perception of availability of infrastructure positively and significantly influences awe, satisfaction, and TERB; and awe positively impacts satisfaction and TERB. Moreover, the emotion of awe plays a significant mediating role in this proposed model. The theoretical significance of this study and the implications for tourism destinations are discussed.

**Keywords:** natural environment, awe, tourist satisfaction, SOR framework, tourists' environmentally responsible behavior

## INTRODUCTION

In 2018, the number of international tourists reached 1.4 billion, and it is estimated that this number will reach 1.8 billion by 2030 (United Nations World Tourism Organization [UNWTO], 2011). An aspect of this large-scale tourism, the reckless and inconsiderate behavior of tourists, contributes significantly to the many environmental problems experienced by tourism destinations, such as environmental pollution, damage to plant and animal habitats, and degradation of ecological resources and the environment (Lee et al., 2013; Zhang et al., 2019). For example, more than 200 million tourists visit the Mediterranean each summer, leading to a 40% increase in plastic waste in the sea (United Nations Environment Program [UNEP], 2019). Globally, it is estimated that 4.8 million tons of trash are produced by tourists each year. This means that destinations worldwide, from Stonehenge to Machu Picchu, from Mount Everest to Bali, are all struggling to deal with an increasing amount of trash left behind by tourists (Somani, 2019). Therefore, the sustainable development of tourist destinations has been facing very significant challenges.

Some destinations, such as the island of Boracay in the Philippines and Maya Bay in Thailand (United Nations Environment Program [UNEP], 2019), have been forced to close temporarily to recover from the pollution and other damage caused by tourists. However, for most destinations, especially those in developing countries, the tourism industry makes significant

contributions to the GDP of the host countries and to employment opportunities. Therefore, halting tourism is not a straightforward matter. Moreover, as recognized by numerous researchers, to cope with the environmental challenges engendered by the fast-growing tourism industry, promoting tourists' environmentally responsible behavior (TERB) would be the most workable and effective way to reduce the negative environmental impacts of tourism. This strategy would also promote the protection of destination resources, ultimately resulting in the sustainable development of those destinations (Wang X. et al., 2020). Thus, the important practical significance of TERB research to the long-term and sustainable development of tourist destinations and the factors that inspire TERB have resulted in widespread concern in recent years and are becoming an important research frontier (Cheng and Wu, 2015).

Given the importance of understanding the mechanism of the formation of TERB, multiple theories have been developed and applied in existing studies. These theories include planned behavior theory (Han et al., 2010), normative motivation theory (Gao et al., 2017), value-belief-norm theory (Van Riper and Kyle, 2014), social capital theory (Li and Wu, 2020), goal-directed behavior (Han and Yoon, 2015), and an integrated analysis framework of the theories mentioned above (Lindenberg and Steg, 2007; Han and Hyun, 2017). The variables covered by these theoretical models, such as behavior attitude, perceived behavior control, ascription of responsibility, awareness of consequences, personal norms, and interpersonal trust, and the variables included in the extended model and framework, such as environmental attitude and tourism experience (Lee and Jan, 2015), environmental concern (Li and Wu, 2020), conservation commitment (Lee, 2011), and place attachment (Qu et al., 2017), focus more on personal intrinsic psychological factors than on contextual factors.

However, TERB as a sustainable behavior of an individual under unusual circumstances will not only be affected by the intrinsic attitude factors of tourists but also by external situational variables (Guagnano et al., 1995). Thus, compared with other theories and variable factors, the stimulus-organism-response (SOR) theory proposed in this study to understand the formation mechanism of TERB may be more effective in explaining tourist behavior. In addition to emphasizing the importance to TERB of situational factors, SOR also takes into account the driving effect on TERB of the positive emotions generated by the individual. However, when the original theoretical model was used to explain the formation of TERB, it was limited to the original variables in the model, making it difficult to select more effective variables according to the research situation. Based on the original theoretical chain, SOR theory can select research variables and explore the causal relationship between them according to the specific research situation, thereby explaining the tourist's response behavior more effectively.

Therefore, this study proposed SOR theory as the theoretical basis to explore the antecedents of TERB in a mountain-based natural destination. Other forms of tourism, such as eco-tourism, emphasize the tourism motivation of responsibility for the environment and the economy (Chiu et al., 2014). Urban tourism involves broader environmentally responsible

behaviors that stress the importance of habit (Miller et al., 2015). Cultural tourism focuses on the authenticity of its tangible and intangible qualities that arouse awe (Wang E. et al., 2020). Those who participate in mountain-based natural tourism are attracted by the impressive mountain scenery and are motivated by the intrinsic emotion derived from the contextual factors to engage voluntarily in TERB. Among the emotions that tourists experience, the emotion of awe is one of the most anticipated experiences for tourists in mountainous landscapes (Powell et al., 2012). This emotion can stimulate a close connection between the tourists and their environment (Pearce et al., 2017), prompting them to show positive local protective behaviors (Coghlan et al., 2012). Therefore, based on the SOR theory, it is meaningful and valuable to introduce the concept of awe and to explain the internal mechanism of the formation of tourists' TERB.

Arising from the preceding discussion, we propose an integrated model based on SOR theory, which considers the contextual factors (natural environment and availability of infrastructure) as the stimuli, awe as the organism, and tourists' satisfaction and environmentally responsible behavior (ERB) as the responses. We anticipate that the contextual factors may not only affect satisfaction and TERB directly (Cheng et al., 2013; Chubchuwong et al., 2015) but may even facilitate tourists' behavior response by stimulating their emotion (Wang et al., 2019), manifested as the perception of awe. In addition, the application of the SOR framework in the existing TERB literature has been limited (Su and Swanson, 2017; Su L. et al., 2020), and few researchers have considered the emotion of awe and contextual factors as antecedents of TERB (Coghlan et al., 2012; Wang and Lyu, 2019; Wang et al., 2019). Therefore, the conceptual framework we propose is necessary and valuable to understand the formation of the response of tourists to a destination. Thus, by exploring the SOR-based formation mechanism of satisfaction and TERB, this study will not only extend the application of the existing theory of awe and the SOR framework but will also provide suggestions for the sustainable management and development of destinations.

## THEORETICAL FOUNDATION AND HYPOTHESIS FORMULATION

### Stimulus-Organism-Response Framework

The SOR framework, first proposed by Mehrabian and Russell (1974), demonstrates that an internal state (O) is generated when an individual is exposed to external stimuli (S), subsequently dictating the responses of the individual (R). Specifically, stimuli, including object stimuli and social-psychological stimuli, will help an individual to elicit his or her internal cognitive and emotional states, thereby triggering a response of either approach or avoidance (Lee et al., 2011). The validity of the SOR model, as a parsimonious and robust framework in predicting individuals' responses, has been verified by studies in multiple settings, such as technology products (Lee et al., 2011), tourism destinations (Su and Swanson, 2017), hotel human

resource management (Su and Swanson, 2019), and restaurant consumption experiences (Jang and Namkung, 2009).

Individuals receive not only object stimuli but also social-psychological stimuli as environmental stimuli (Slama and Tashchian, 1987). Thus, in the context of a tourist destination, stimuli include tourists' perceptions of the physical environment (e.g., natural environment) surrounding them and how the destination is managed (e.g., the availability of infrastructure) (Su L. et al., 2020). When tourists are exposed to the object stimuli (natural environment) and social stimuli (availability of infrastructure) of the destination, an intrinsic positive emotion (e.g., awe) (Pearce et al., 2017) is evoked, and subsequently, tourists' responses change in response to that emotion. It is noteworthy that no complete consensus has been reached as to whether satisfaction is an organism variable or a response variable (Su L. et al., 2020). Although the marketing and tourism fields generally consider that satisfaction is the psychological state generated by the stimulation of a consumer experience, most empirical research models based on the SOR paradigm tend to consider satisfaction as a response component (Eroglu et al., 2003; Mummalaneni, 2005) because of its post-purchase attitude characteristic (Swan and Combs, 1976). For instance, in the empirical model of Eroglu et al. (2003), satisfaction, as with approach/avoidance behaviors, was considered the outcome variable of the consumption process. It was also specifically regarded as the response component of the SOR framework. Additionally, in the two studies by Mummalaneni (2005) and Su L. et al. (2020), satisfaction was also classified as a component of "response" rather than of "organism" in their proposed viable models of the SOR framework. Hence, based on these empirical studies, the present study proposes satisfaction as a response variable and an outcome variable.

In our model, satisfaction and TERB, as components of response (response), are triggered by tourists' emotional state of awe (organism) which, in turn, is generated from perceptions of the natural environment and the availability of infrastructure (Stimuli) (Figure 1).

## Stimuli: Natural Environment and the Availability of Infrastructure

The term "natural environment," sometimes used interchangeably with the term "nature," refers to "an environment with little or no apparent evidence of human presence or intervention" (Hartig et al., 2014). In the tourism field, the natural environment refers to the environment of the destination formed by natural resources, such as natural creatures (e.g., animals and plants), natural scenery (e.g., landforms, mountains, coasts, beaches, and oceans), and other natural attractions (e.g., weather) (Ross and Iso-Ahola, 1991; Lu et al., 2017). In the present study, the perception of the natural environment is considered to be the cognitive affiliation with nature (Basu et al., 2020) and a subjective evaluation of the natural features of a destination (Hartig et al., 2014).

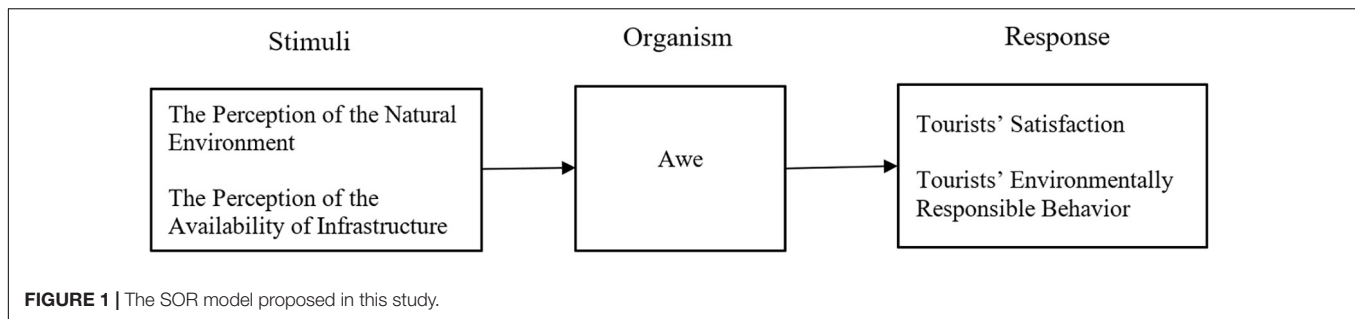
First, earlier research literature discussed the causal relationship between contact with the natural environment and the experience of awe. For example, Ballew and Omoto (2018)

found that compared to built environments, natural environments significantly enhanced feelings of awe and other positive emotions. More importantly, compared with other positive emotions, such as amusement and joy, the connection between the experience of awe and the perception of the natural environment was significantly stronger (Anderson et al., 2018). Joye and Bolderdijk (2015) showed that, when participants are shown an awe-inspiring natural slideshow, they usually feel small and humble, feelings that are the central appraisals of the experience of awe. In exposure to and connectedness with nature, the feeling of awe is an intense emotion, among other transcendent emotions triggered by nature (Bethelmy and Corraliza, 2019). It is noteworthy that in tourism, individuals' perceptions of the extraordinary natural environment are likely to elicit emotional reactions, such as awe (Powell et al., 2012). Therefore, in this study, we anticipated that tourists' perception of the destination's spectacular mountain scenes would have a positive impact on their experience of awe.

Second, previous studies discussed the direct relationship between tourists' perception of a destination's natural environment and their satisfaction. For example, the structural equation modeling (SEM) analyses of Chi and Qu (2008) and Lu et al. (2015) found that tourists' evaluation of a destination's natural attractions (e.g., scenic mountains and valleys, breathtaking scenery) significantly impacts their overall travel satisfaction. The finding of Chi and Qu (2008) further verified that tourists' satisfaction with natural attractions leads to their satisfaction with the tourism experience. The more that tourists appreciate the natural phenomena and scenery of a destination, the more satisfied they will be. The empirical research results of Buckley et al. (2014) further confirmed this conclusion in the context of river-based adventure tourism. Satisfaction with the nature of a destination is one of the important indicators of tourist satisfaction with the overall travel experience. In addition, the results of a quantitative study by Lu et al. (2017) indicated that the perception of an extraordinary natural landscape of a mountain destination was found to help improve tourists' levels of satisfaction. Thus, it is reasonable to infer that the tourists' perception and evaluation of the natural attractions of a destination will have a positive effect on their satisfaction.

Third, a close relationship between individuals and the natural environment was found to be conducive to general ERB in daily life in theory and correlation research (Vaske and Kobrin, 2001). For example, compared with people who spend more time in artificial environments (such as zoos), people who are often exposed to the natural environment are more likely to have attitudes and behaviors that reinforce environmental protection (Stewart and Craig, 2001). The results of three experimental studies by Zelenski et al. (2015) suggested that participants who were exposed to nature videos expressed stronger willingness to engage in environmentally sustainable behaviors. Moreover, the natural scenery of a tourist site, as part of the environmental background, usually encourages tourists to engage in valuable environmentally protective behaviors (Wang et al., 2019). Thus, given the significance of the individual's exposure to nature to their ERB, it would, therefore, be reasonable to infer that





the perceived evaluation of the natural environment influences TERB. Accordingly, we propose the following hypotheses:

- H1: The perception of the natural environment is positively related to the experience of awe.  
 H2: The perception of the natural environment is positively related to tourists' satisfaction.  
 H3: The perception of the natural environment is positively related to TERB.

The availability of infrastructure, not only refers to the basic facilities that tourists rely on to enjoy the tourism experience, in that, affect tourists' behavior of repeat visit and recommended to others (Sannassee and Seetanah, 2014); more importantly, it refers to the availability of pro-environment information, products, and facilities (Chubchuwong et al., 2015; Miller et al., 2015) that influence tourists' environmental attitudes and behaviors. Our search of the literature<sup>1</sup> showed that no empirical study had investigated the direct relationship between the perception of availability of infrastructure and awe and satisfaction. However, there have been findings on the relationship between ecological and environmental management variables (including destination and corporate contexts) and emotional experience. For example, Su L. et al. (2017) and Su and Swanson (2019), respectively, surveyed employees and guests of hotels in China and confirmed that the employees' or guests' perceptions of corporate social responsibility (including environmental corporate social responsibility) directly affect their emotional responses to the company in the form of trust, recognition, and positive emotions. Han et al. (2019) revealed that emotional factors, respect, and preference for brands are significantly influenced by customers' perceptions of the environmental corporate social responsibility of airlines. In addition, according to studies by Su and Swanson (2017) and Su L. et al. (2020), tourists experience positive emotions because their reactions will be triggered by the implementation of ecological and environmental practices in a destination or by the environmentally responsible operation of the destination.

In this study, the destination's environmental efforts (such as public transportation systems) facilitate access for most tourists (such as those who cannot reach the summit on foot) and remove barriers to experiencing a sense of awe. Other practices

(such as environmentally responsible tourism programs and information) can directly evoke a sense of awe in tourists because they focus on the harmony between man and nature and the future sustainability of natural resources, which, in turn, can make tourists feel small (Piff et al., 2015). Therefore, awe is proposed here as a form of positive emotion and is expected to be influenced by tourists' evaluations of the destination's eco-friendly facilities like other positive emotional responses.

Similarly, a good mall or shopping environment will positively affect customer satisfaction during the consumption process (Walsh et al., 2011). In a tourism study, Kwek et al. (2014) found that the overall level of satisfaction of groups of overseas tourists visiting China was affected by transport, tourist sites, and accommodation. Therefore, as an important aspect of the environment in which the tourist experience is consumed, the availability of infrastructure may also affect tourist satisfaction to the same extent as any other environmental factor. If a tourist considers that the destination provides sufficient environmental protection facilities, services, and programs, and that the destination has a good eco-friendly reputation, he or she will be more satisfied with his or her travel experience (Su L. et al., 2020).

Similar to the relationship between the natural environment and TERB, the availability of infrastructure as a stimulus may also directly affect TERB as a response. Previous studies found that if a destination does not have sufficient environmentally friendly services and facilities available, tourists may be hindered from implementing specific ERBs (Miller et al., 2015). Moghimehfar and Halpenny (2016) also confirmed that facility constraints at campsites directly and negatively influence the ERB intentions of campers. Also, in studies of international visitors to Thailand, Chubchuwong et al. (2015) found that the lack of availability of "green" infrastructure, products, and information had a negative effect on tourists' attitudes toward environmental protection and on their behaviors. Therefore, it is only when basic environmental protection facilities, such as recycling bins and public transport systems, are provided that tourists will adopt correct environmental behaviors (Miller et al., 2015). Combined with the findings of studies in the literature, we hypothesize that:

- H4: The perception of the availability of infrastructure is positively related to the experience of awe.  
 H5: The perception of the availability of infrastructure is positively related to tourists' satisfaction.  
 H6: The perception of the availability of infrastructure is positively related to TERB.

<sup>1</sup><https://scholar.google.com/>

## Organism: Awe

Awe is an emotional response to the comprehensive perception of the tourism experience generated in tourists as a response to a variety of destination factors, like the natural environment, sacred sites, majestic architecture, celebrity-related places, and other attractions of tourist destinations (Keltner and Haidt, 2003; Coghlan et al., 2012). As an intense positive emotion that individuals often experience when visiting nature-based destinations (Pearce et al., 2017), awe is an emotion that tourist products and tourist destinations strive to elicit (Coghlan et al., 2012). However, studies of tourism-generated awe are scarce (Pearce et al., 2017). The limited existing studies are, to a large extent, exploratory studies of awe and how it is elicited (Farber and Hall, 2007; Davis and Gatersleben, 2013). Few studies specifically examine the relationship between awe and tourists' levels of satisfaction and their resulting behaviors (Lu et al., 2017; Wang and Lyu, 2019).

According to H1 and H4, the intrinsic state of awe of tourists is evoked by stimuli of the natural environment and the availability of infrastructure. This state may exert an impact on tourists' levels of satisfaction and their resulting behaviors. First, the connection between awe and tourist satisfaction is based on the link between positive emotions and satisfaction. Su and Hsu (2013) conducted an empirical study on Chinese heritage tourists and found that positive emotions have a direct positive impact on tourist satisfaction. Second, the participants in the experiment who experienced awe also experienced greater life satisfaction in general (Rudd et al., 2012). Third, in the study by Powell et al. (2012) of tourists' perception, evaluation, and emotion of their Antarctic tourism experience, a positive correlation was confirmed between awe and satisfaction. In an investigation of 296 tourists who visited Mount Emei in Sichuan Province, Lu et al. (2017) also found that the effect of the experience of awe on tourists' levels of satisfaction was significant.

In addition, as a positive emotion with a transformative function, awe can strengthen the close connection between individuals and their environment, thereby generating prosocial motivation (Piff et al., 2015; Pearce et al., 2017). Most environmental protection behaviors are also prosocial. Therefore, there is a close connection between feelings of awe toward nature and environmentally protective behaviors (Zelenski and Desrochers, 2021). Taking college students as the experimental participants, Yang et al. (2018) proved that awe induced not only by natural scenery but also by powerful people could promote environmentally beneficial behaviors among the research subjects. Furthermore, based on three studies in the context of eastern and western cultures (including an on-site survey and two experimental studies), Wang and Lyu (2019) verified that the sense of awe induced by the travel experience could encourage tourists to implement ERBs by reducing their self-concern. Based on the above discussion, we hypothesize that:

- H7: The experience of awe is positively related to tourists' satisfaction.
- H8: The experience of awe is positively related to TERB.

## Response: Tourist Satisfaction and Tourists' Environmentally Responsible Behavior

### Tourist Satisfaction

Tourist satisfaction, proposed as one response component in this study, has been widely studied in tourism for its importance in repurchasing, recommending, or revisiting (Choo and Petrick, 2014; Lee et al., 2014). In the tourism context, the first proposed, and also the prevailing definition of satisfaction, is "the result of the interaction between a tourist's experience at the destination area and the expectations he (*sic*) had about that destination" (Pizam et al., 1978). This definition is inclined toward overall satisfaction, the more important type of the two common formulations of satisfaction due to its more profound and valuable role in predicting tourists' behavioral intentions and the future performance of tourism enterprises (Eid and El-Gohary, 2015). Therefore, satisfaction, as referenced in this study, refers to the overall formulation, as in the case in almost all satisfaction studies (Anderson et al., 1994).

However, due to the rapid development of mass tourism in recent decades, most popular tourist destinations have become overcrowded, especially in developing countries and regions that rely heavily on the tourism industry for revenue. This consideration means that it is vitally important to assess visitors' overall travel experience in these destinations. This is because the over-development of tourist destinations will, to a certain extent, prompt tourists to reevaluate their experience. Therefore, given the influence of the perception of the destination's core and augmented attributes on visitor's attitudes and behaviors (Cheng et al., 2013; Buckley et al., 2014), we propose to explore tourists' satisfaction associated with the stimuli factors of destinations. Based on the previous discussion, the natural environment and the availability of infrastructure are explored in this study. The intention is to confirm the extent to which these factors contribute to meeting tourists' travel expectations in the context of the rapid development of tourism.

### Tourists' Environmentally Responsible Behavior

Tourists' environmentally responsible behavior refers to the behaviors practiced by tourists "who strive to reduce environmental impacts, contribute to environmental preservation and/or conservation efforts, and not disturb the ecosystem and biosphere of a destination" (Lee et al., 2013) in the process of recreation/tourist activities. The term is usually used interchangeably with other terms such as pro-environmental behavior, environmentally concerned behavior, environmentally significant behavior, sustainable behavior, and eco-friendly behavior (Kiatkawsin and Han, 2017). Previous studies indicated that fostering TERB plays a central role in managing the sustainability of destinations (Wang X. et al., 2020) and appears to be the best practice for maintaining the latter (Lee et al., 2013).

Considering the importance of TERB for sustainability, existing studies have investigated the TERB in various fields of tourism, such as destination TERB (Cheng et al., 2013), hotel TERB (Han and Yoon, 2015), event TERB

(Mair and Laing, 2013), cruise TERB (Han et al., 2016), and museum TERB (Han and Hyun, 2017). The antecedents covered aspects ranging from demographic to internal psychological factors, from contextual to habitual factors, and they also incorporated various mature theoretical and modified models to provide a comprehensive understanding of TERB (Van Riper and Kyle, 2014; Kiatkawsin and Han, 2017). In brief, given that TERB is not only important for the sustainable development of tourism (Kafyri et al., 2012) but also has a positive impact on the ERB of daily life (Ramkissoon et al., 2012), the investigation of the potential determinants that would prompt tourists to implement ERB will become increasingly important.

Therefore, this study focuses on the emotion of awe and other external stimulus factors as the antecedents of TERB that have been ignored to a certain extent. This approach is not only an innovative application of the SOR framework based on the experience and perception of awe but also an effective supplement to the existing research on the driving factors of TERB.

## Mediating Effect

Previous studies have found that the relationship between the natural environment and satisfaction is linked by the experience of awe. Specifically, awe has been found to partially mediate this relationship (Lu et al., 2017). However, to the best of our knowledge, there are no published studies that have investigated the role of awe in the relationship between the natural environment and TERB, the availability of infrastructure and satisfaction, or the availability of infrastructure and TERB. According to the SOR framework, there should be a connection between the external factors of a destination and satisfaction/TERB through the emotion of awe. For example, building on the SOR framework (Mehrabian and Russell, 1974), Su and Swanson (2017) and Su L. et al. (2020) proposed that tourists' emotional responses during an experience are generated by the external stimuli of the destination itself and that tourists then exhibit different behaviors. Tourists experiencing positive emotions are more likely to adopt behaviors that follow social norms. Subsequently, these researchers found that tourists' positive emotions (organism) were elicited by information about the eco-friendly reputation of a destination or its sense of social responsibility (stimuli), leading to tourist satisfaction and ERB (response).

Therefore, it is reasonable to consider that, just as with a destination's eco-friendly reputation and sense of social responsibility, other external factors of the destination, in this study, specifically referring to the natural environment and the availability of infrastructure, may also affect tourist satisfaction and TERB through the intermediary effect of the perception of awe. Based on this discussion, the following hypotheses are proposed:

H9: The experience of awe mediates the effect of tourists' perception of the natural environment (a) and the perception of the availability of infrastructure (b) on tourists' satisfaction.

H10: The experience of awe mediates the effect of tourists' perception of the natural environment (a) and the perception of the availability of infrastructure (b) on TERB.

Based on these hypotheses, **Figure 2** provides a conceptual framework for the present study, which includes the hypotheses and the relationships between the five constructs. More importantly, in the field of TERB research, this study is the first to empirically consider awe as a connection between external stimuli and the responses of tourists.

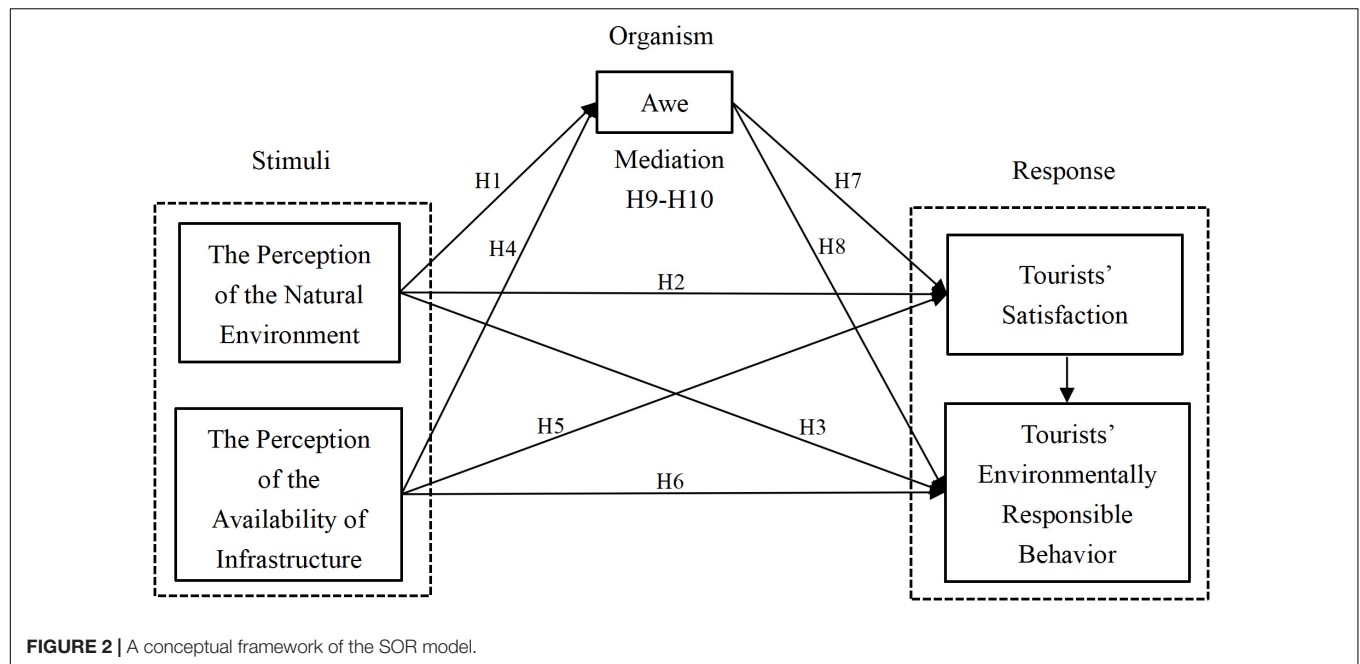
## MATERIALS AND METHODS

### Study Area

In the traditional culture of China, Mount Heng, regarded as the Southern Great Mountain, together with the Eastern Great Mountain, the Western Great Mountain, the Northern Great Mountain, and the Central Great Mountain, is known as one of the sacred mountains. Of the five sacred mountains, Mount Heng is located in south-central Hunan Province and is the only one in the south of China (**Figure 3**). It is known for its beautiful scenery and long history and was included in the Natural and Cultural Heritage List of China in 2006 for its excellent natural and religious cultural resources. It is also famous for its more than 200 Buddhist and Taoist temples, and for the god of Mount Heng, Zhurong, the god of fire. Zhurong Peak (1,300.2 m) is the main and the highest peak of the 72 peaks of Mount Heng, named in memory of Zhurong. Mount Heng refers to the scenic area with Zhurong Peak at its center. Every year, millions of tourists go to Mount Heng to watch the sunrise, see the sea of clouds, and enjoy the snowy scenery and the beautiful peaks (**Figure 3**). The emotion of awe is easily inspired in tourists by the magnificent and impressive natural scenery.

According to the annual report released by the Hengyang City Statistics Bureau for the period from 2010 to 2019, millions of tourists visit the mountain every year, with more than a hundred thousand visitors per day during the peak season. For example, on the "May Day" and "National Day" holidays in 2019, there were more than 160,000 tourists and 600,000 tourists, respectively, resulting in enormous challenges to the environmental protection practices of the scenic area and affecting the satisfaction experience of tourists. As a response to the pressure brought to bear by tourism development, the local authorities formulated the "Regulations on the Protection of Mount Heng," strengthened the daily maintenance of environmental protection and cleanliness and provided environmentally friendly transport for tourists. Additionally, a natural protection public center was established to engage in special pro-environment activities, such as tree planting, preservation of ancient roads, and environmental cleaning. These environmental protections are effective. The improvements bring more tourists into close contact with the destination by reducing the number of private vehicles, allowing larger numbers of visitors to access and appreciate the magnificent natural wonders. In addition, the new environmental protection activities help preserve the scenic locale and ensure the quality of tourism experience.







Therefore, Mount Heng was chosen as the study area because it is a representative nature-based tourist destination. More importantly, it is a suitable site for our proposed model, which utilizes awe as the mediating variable that explains the effect of the perception of the natural environment and the availability of infrastructure on tourists' satisfaction and TERB.

## Questionnaire Design and Instrument Development

The questionnaire consisted of two parts. The first part included 24 items designed to measure the five constructs of the model. All scales except for awe were based on a seven-point Likert scale, from "strongly disagree (1)" to "strongly agree (7)." A semantic difference scale was used to measure awe. The second part of the questionnaire related to demographic information.

The scales for evaluating each variable were developed from previous studies. The scales for natural environment (four items), awe (four items), and tourist satisfaction (three items) were based on the study by Lu et al. (2017) in which the study context was similar to the present study. The scale of availability of infrastructure (seven items) from the study by Chubchuwong et al. (2015) was also included. Finally, the six items used to measure TERB were adapted from the study by Su and Swanson (2017). **Table 2** shows the questions included; some of which were modified slightly to adapt them to the context of the present study.

The questionnaire was in Chinese (Mandarin) because most of the tourists to Mount Heng are Chinese. Following the guidelines recommended by Brislin (1970), the Chinese questionnaire derived from the original English scales was back translated to the English version to ensure that the translated version accurately expressed the original semantics.

## Sampling and Data Collection

Tourists who had just completed a visit to Mount Heng were surveyed at the main exit of the scenic spot. The two places (the tourist service center and the leisure shopping street) where tourists who have finished their tourism experience can rest are next to the main exit. Both places provide a large number of seats for tourists to facilitate their short stay. Therefore, the tourists who chose to rest had sufficient time to complete the questionnaire, and they were not under pressure to leave.

On December 10, 2019, before the formal survey, a face-to-face pilot study of the questionnaire was conducted at Mount Heng to evaluate its content validity. Thirty tourists participated in this survey, and all of them completed the questionnaire within 5 min. According to the feedback, none of them had any questions about the content and design of the questionnaire. We conducted our data collection from January 11 to 20, 2020, over 6 working days and 2 weekend holidays. Self-administrated questionnaires were distributed randomly in the peak periods during weekdays (3:00 p.m. to 6:00 p.m.) and weekends (2:00 p.m. to 6:00 p.m.). The tourists were asked whether they were willing to complete a questionnaire. They filled in the questionnaire voluntarily under the premise of knowing the academic purpose of the questionnaire. The number of questionnaires distributed

every day was limited to ensure a wide range of tourists, thereby minimizing the bias caused by convenience sampling. On weekdays, 45 questionnaires were distributed per day, and on weekends, 60 questionnaires were distributed per day. In all, 510 questionnaires were distributed, 497 were returned, and there were 458 valid questionnaires.

## RESULTS

### Demographic Information

Among the 458 respondents, over half (55.9%) were female, and a large proportion (71.9%) of the participants were aged between 18 and 35. This may have been because of the nature of the destination, a mountain area tends to attract younger tourists. Nearly 90% of the respondents had junior college education or above. More than 80% of the respondents were individual tourists. Almost half of the respondents had visited the destination previously. Detailed demographic information is presented in **Table 1**.

### Results of Statistical Analyses

The SmartPLS 3.2.8 software for variance-based SEM using the partial least squares (PLS) path modeling method was employed to explore the causal relationships between stimuli, organism,

**TABLE 1** | Background information about the respondents (*N* = 458).

Demographic	Frequency	Percentage (%)
<b>Gender</b>		
Male	202	44.1
Female	256	55.9
<b>Age group</b>		
18–25	167	36.5
26–35	162	35.4
36–45	98	21.4
46–55	24	5.2
≥56	7	1.5
<b>Education</b>		
Middle school	54	11.8
Junior college	132	28.8
Undergraduate	244	53.3
Postgraduate	28	6.1
<b>Travel type</b>		
Group	85	18.6
Individual	373	81.4
<b>Income level (RMB)</b>		
≤ 3000	82	17.9
3001–6000	136	29.7
6001–10000	171	37.3
≥ 10,001	69	15.1
<b>Frequency of visit</b>		
1	231	50.4
2	127	27.7
3–4	58	12.7
≥5	42	9.2

**TABLE 2 |** Construct reliability and convergent validity.

Item	Factor loading	Cronbach's $\alpha$	CR	AVE
<b>The Perception of the Natural Environment</b>		0.785	0.861	0.609
Mount Heng shows me how strong the nature is	0.786			
Mount Heng impresses me with its majestic and precipitous appeal	0.782			
I feel Mount Heng is magnificent	0.839			
Mount Heng gives me a fantastic display of many beautiful peaks	0.710			
<b>The Perception of the Availability of Infrastructure</b>		0.813	0.869	0.572
Information on how to act responsibly toward the environment	0.758			
Environmentally responsible tour programs	0.793			
Environmentally responsible food and drink containers	0.745			
Normal garbage bins	0.703			
Recycling garbage bins	0.779			
<b>Awe</b>		0.800	0.870	0.627
Boring–exciting	0.863			
Usual–unusual	0.820			
Expected–unexpected	0.711			
Arrogant–humbling	0.765			
<b>Tourists' Satisfaction</b>		0.839	0.903	0.757
In general, this site was much better than I expected	0.855			
This visit was well worth my time and effort	0.874			
Overall, I was very satisfied with my holiday at Mount Heng	0.880			
<b>Tourists' Environmentally Responsible Behavior</b>		0.848	0.887	0.568
When I see garbage and debris at the Mount Heng destination, I put it in the trash	0.746			
I comply with the rules so as to not harm the environment of Mount Heng	0.791			
I try to convince others to protect the natural environment at the Mount Heng destination	0.774			
If there are environmental improvement activities at the Mount Heng destination, I am willing to attend	0.737			
I try not to disrupt the fauna and/or flora when visiting the Mount Heng destination	0.756			
I report to the appropriate destination administration any environmental pollution or destruction at the Mount Heng destination	0.716			

and response factors. The PLS method is more reliable and efficient when processing non-normal distribution data (Hair et al., 2011) and when working with a small sample size because of its powerful statistical analysis functions. The conceptual model was analyzed in two steps in line with the instructions of Hair et al. (2017).

### Measurement Model Assessment

First, the reliability and validity of the measurement model were evaluated. **Table 2** shows the factor loadings, Cronbach's  $\alpha$  values, the average variance extracted (AVE), and the composite reliability (CR) of the constructs. The items “information about public transport” and “environmentally friendly transportation” were deleted due to a low factor loading ( $<0.60$ ). The factor loadings of all other items were greater than 0.7, which is satisfactory. CR ( $>0.7$ ) and Cronbach's  $\alpha$  ( $>0.7$ ) were used to evaluate reliability, indicating a gratifying internal consistency of the five constructs (Hair et al., 2017). AVE was used to assess convergent validity. All values of AVE exceeded 0.5, suggesting that the convergent validity was satisfactory.

As shown in **Table 3**, the square root of all AVE variables was greater than its correlations with other variables. This is one method of confirming discriminant validity (Gefen and Straub, 2005). The second method is based on the value of the

**TABLE 3 |** Correlation matrix of all variables.

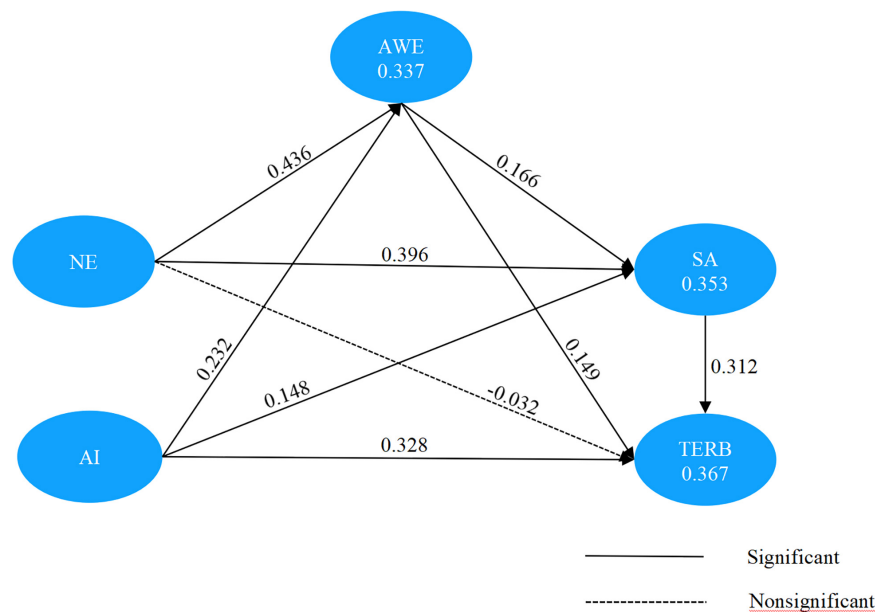
Variable	AI	AWE	NE	SA	TERB
AI	<b>0.756</b>				
AWE	0.432 (0.534)	<b>0.792</b>			
NE	0.459 (0.568)	0.543 (0.682)	<b>0.781</b>		
SA	0.401 (0.478)	0.445 (0.540)	0.554 (0.680)	<b>0.870</b>	
TERB	0.502 (0.591)	0.412 (0.489)	0.372 (0.450)	0.492 (0.573)	<b>0.754</b>

*NE, the perception of the natural environment; AI, the perception of the availability of infrastructure; AWE, the experience of awe; SA, tourists' satisfaction; TERB, tourists' environmentally responsible behavior. The bold diagonal elements are the square roots of each AVE value; variable correlations are shown off-diagonal. The HTMT ratios are shown in parentheses.*

heterotrait–monotrait ratio of correlations (HTMT). All values of HTMT were less than 0.85, indicating that the discriminant validity was satisfactory (Henseler et al., 2015). In addition, all values of the variance inflation factor (VIF) were between 1.266 and 2.123, indicating that multicollinearity was not an issue (Becker et al., 2015).

### Structural Equation Model

$R^2$  and  $Q^2$  were used to measure the relationship of a latent variable's explained variance to its total variance and the extent



**FIGURE 4 |** Completely standardized path coefficients among NE, AI, AWE, SA, and TERB. NE, the perception of the natural environment; AI, the perception of the availability of infrastructure; AWE, the experience of awe; SA, tourists' satisfaction; TERB, tourists' environmentally responsible behavior.

to which each prediction was successful, respectively (Urbach and Ahlemann, 2010). As shown in **Figure 4**, the  $R^2$  values of endogenous variables (awe: 0.337; satisfaction: 0.353; TERB: 0.367) were all greater than the definition of the critical value of  $R^2$  (low: 0.25; medium: 0.50; high: 0.75) (Hair et al., 2011), and the  $Q^2$  values were all greater than 0 (AWE: 0.197; satisfaction: 0.249; TERB: 0.190), indicating that the dependent variables are well explained, and the predictive power of the structural model is satisfactory (Urbach and Ahlemann, 2010).

In the second step of the assessment of the structural model, a bootstrapping resampling approach (3,000 samples) was used to evaluate the path coefficients between the model's latent variables. The results of the model analysis (see **Table 4** and **Figure 4**) show that natural environment perception significantly and directly influenced tourists' awe ( $\beta = 0.436$ ,  $p$ -value < 0.001)

and satisfaction ( $\beta = 0.396$ ,  $p$ -value < 0.001). Therefore, H1 and H2 are supported. This means that the perception of the natural environment of a destination is an important antecedent variable in the generation of tourists' sense of awe and satisfaction. The perception of availability of infrastructure significantly influenced tourists' awe ( $\beta = 0.232$ ,  $p$ -value < 0.001), satisfaction ( $\beta = 0.148$ ,  $p$ -value < 0.01), and TERB ( $\beta = 0.328$ ,  $p$ -value < 0.001). Therefore, H4, H5, and H6 are supported. In light of these results, the more sufficient and available the tourists perceived the infrastructure, the stronger their awe and satisfaction, and their TERB increased. Awe positively and significantly affected satisfaction ( $\beta = 0.166$ ,  $p$ -value = 0.001) and TERB ( $\beta = 0.149$ ,  $p$ -value < 0.01). Therefore, H7 and H8 are supported. The results show that tourists who experienced awe are more likely to have a high level of satisfaction and TERB. However, H3, that TERB was directly influenced by the perception of the natural environment, was rejected ( $\beta = -0.032$ ,  $p$ -value = 0.536), indicating that perception of the natural environment is not necessarily an antecedent variable of TERB.

### Mediation Effect

The bootstrapping method (3,000 samples) was also utilized to test the mediation effect of the sense of awe to explore further the relationship between the perception of the natural environment and TERB. The results of PLS analysis on the mediating effects indicate (see **Tables 4, 5**) that H9 and H10 are both supported. Given the non-significant direct relationship between the perception of the natural environment and TERB, awe fully mediates the effect of the perception of the natural environment on TERB ( $\beta = 0.065$ ,  $p$ -value < 0.01). Therefore, although a direct effect does not exist, the effect of the perception of the natural environment on TERB is assumed from the two mediating effects,

**TABLE 4 |** Results of the structural model.

Hypothesis	Path	Original sample	Standard error	t-value	p-value	Support
H1	NE → AWE	0.436	0.045	9.721	0.000	Yes
H2	NE → SA	0.396	0.055	7.180	0.000	Yes
H3	NE → TERB	-0.032	0.052	0.619	0.536	No
H4	AI → AWE	0.232	0.050	4.628	0.000	Yes
H5	AI → SA	0.148	0.049	2.989	0.003	Yes
H6	AI → TERB	0.328	0.048	6.861	0.000	Yes
H7	AWE → SA	0.166	0.050	3.330	0.001	Yes
H8	AWE → TERB	0.149	0.052	2.863	0.004	Yes

NE, the perception of the natural environment; AI, the perception of the availability of infrastructure; AWE, the experience of awe; SA, tourists' satisfaction; TERB, tourists' environmentally responsible behavior.

**TABLE 5 |** Hypotheses tests of the mediating effects.

Hypothesis	Path	Original sample	Standard error	t-value	p-value	Support
H9	NE → AWE → SA	0.072	0.023	3.088	0.002	Yes
	AI → AWE → SA	0.038	0.015	2.634	0.008	Yes
H10	NE → AWE → TERB	0.065	0.023	2.791	0.005	Yes
	AI → AWE → TERB	0.035	0.015	2.306	0.021	Yes
	NE → AWE → SA → TERB	0.023	0.008	2.860	0.004	Yes

NE, the perception of the natural environment; AI, the perception of the availability of infrastructure; AWE, the experience of awe; SA, tourists' satisfaction; TERB, tourists' environmentally responsible behavior.

including the effect of remote mediation: NE → AWE → SA → TERB ( $\beta = 0.023$ ,  $p$ -value < 0.01). In addition, awe partially mediates the effect of the perception of the natural environment on satisfaction ( $\beta = 0.072$ ,  $p$ -value < 0.01), the perception of the availability of infrastructure on satisfaction ( $\beta = 0.038$ ,  $p$ -value < 0.01), and the perception of the availability of infrastructure on TERB ( $\beta = 0.035$ ,  $p$ -value < 0.05), respectively. The results confirmed the mediation effect of awe between stimuli and response factors in the proposed conceptual framework.

## DISCUSSION

The present study aimed to deepen our understanding of the relationships between the perception of the external factors of destinations (natural environment and availability of infrastructure), the emotion of awe, tourists' satisfaction, and TERB. First, the findings of this study demonstrate that the perception of the natural environment positively influenced the awe and satisfaction of tourists (H1 and H2 were supported), but the positive effect of the natural environment on TERB was not found to be statistically significant (H3 was not supported). The tourists' perceptions of the natural environment were shown to have a positive effect on their levels of awe and satisfaction, which is consistent with logic and with the findings reported in the literature (Lu et al., 2017; Pearce et al., 2017). Therefore, in our study, the extraordinary scenery of the destination directly affected the tourists' satisfaction. The tourists' perception of the vastness of the natural environment was shown to be an important precondition for eliciting awe.

Notably, in the present study, the natural environment was found to have no direct positive effect on TERB, thereby contradicting the findings of a previous study (Stewart and Craig, 2001). This discrepancy may be due to the differences in the degree of connection between individuals and the natural environment in different studies. The study by Stewart and Craig (2001) showed that individuals who are often exposed to the natural environment are more likely to adopt environmental protection behaviors. However, in the present study, the tourists' perception of the natural environment was based on infrequent and occasional contact with nature at the destination. This

connection is not enough to prompt tourists to implement ERB directly. For this to happen, an emotional connection must be established between the tourists and the natural environment (Vaske and Kobrin, 2001). Therefore, in this study, although the natural environment did not directly affect the behavior of the tourists, the perception of the natural environment elicited their awe and stimulated TERB through the mediating role of the awe connection.

Second, the perception of the availability of infrastructure was found to be an important antecedent variable of awe, satisfaction, and TERB (H4, H5, and H6 were supported). The positive relationship between the perception of the availability of infrastructure and awe is consistent with and constitutes an extension of the findings of Su and Swanson (2017) and Su L. et al. (2020) that the ecological and environmental practices adopted in particular destinations had an impact on tourists' positive emotions. Our study confirmed that when tourists perceived the availability of pro-environment information, programs, products, and the facilities of the destination, the response was a specific positive emotion, a sense of awe. We suggest that the concern and emphasis on the environment underlying these environmental management practices were perceived by the tourists, and the destination's eco-friendly reputation was recognized by the tourists, in turn, triggering their feelings of awe.

Moreover, the findings also suggest that the availability of infrastructure and satisfaction were positively correlated, which is consistent with the findings of Walsh et al. (2011) and Su L. et al. (2020). It is known that tourists' satisfaction with their travel experience is affected by the main attributes of the destination, including the availability of destination facilities. Some environmental protection facilities, such as (recycle) bins and public transport, belong to the necessary infrastructure of the destination. If the destination cannot provide these infrastructural features, it is difficult for tourists to have a satisfactory experience. In other words, more available facilities, including environmental facilities, help to enhance tourists' satisfaction. Also, the availability of suitable infrastructure was shown to have a positive impact on TERB, which is consistent with the findings of Chubchuwong et al. (2015) and Miller et al. (2015), whereby, if tourists consider that structural constraints preventing environmentally friendly facilities no longer exist, and that suitable facilities and services are provided, the objective conditions for implementing TERB are guaranteed. As a result, they are more likely to act responsibly toward the environment.

Third, according to the findings of our study, awe significantly influenced the tourists' satisfaction and ERB (H7 and H8 were supported), in line with the findings of previous studies (Lu et al., 2017; Wang and Lyu, 2019). When tourists experience awe in a destination, they will be more satisfied with their tourism experience, and they will act more responsibly toward the environment. These findings extend the important role of positive emotion on tourist satisfaction (Su and Hsu, 2013) and TERB (Su L. et al., 2020), thereby supporting the importance of awe in tourists' experiences and in destination development (Coghlan et al., 2012).



Finally, the results also confirm that awe is an emotional organism (O) that plays an important mediating role between stimuli and responses (H9 and H10 were supported). In light of the above, the direct relationship between stimuli and responses is not always consistent, but the awe experienced by tourists has always played a stable mediating role in that relationship. As proposed by the SOR framework, the stimuli can only change the responses of tourists after psychological changes (Su L. et al., 2020), such as the tourists' experience of awe, have been induced. In the present study, the basic external factors of the destination (natural environment and availability of infrastructure) induced the tourists' emotional responses (awe) and resulted in satisfaction with the overall tourist experience (satisfaction) and positive behaviors (TERB). The above results of this mediating effect reaffirm that it is essential to increase the levels of awe experienced by tourists.

## CONCLUSION

This study attempted to explore how the emotion of awe explains the influence of external factors of a destination on tourists' levels of satisfaction and TERB. The empirical results showed that the direct relationships, with the exception of the link between the perception of the natural environment and TERB, were all supported. The mediating effects of awe were confirmed. This indicates that the model based on awe as a psychological organism and on the SOR framework can effectively explain the formation mechanism of satisfaction and TERB. These findings are important for academic research in the field of tourism and environmental psychology and also suggest useful implications for the management and development of particular destinations.

## Theoretical Significance

Based on the above results, this study contributes to the existing TERB literature through an integrated model built on the SOR framework as an innovative extension. The theories applied in existing studies to explain the formation mechanism of TERB have concentrated on tourists' personal psychological and social factors. However, the contextual factors of the destination are often neglected. In the present study, building on the SOR theory, we have filled this gap in our attempt to understand the formation mechanism of TERB and the contextual factors affecting it. We anticipate that this extension of the application of the SOR framework will enrich future theoretical literature relating to TERB.

The introduction of the concept of awe and the verification of awe as an organism playing a mediating role in the relationship between stimuli and responses mean that this study provides not only a new theoretical perspective for research into the antecedent variables of TERB but also an effective supplement to awe research in the field of tourism. As a type of positive emotion, awe is often overlooked and has received less attention than other research topics in tourism literature (Pearce et al., 2017). Few tourism studies have specifically examined the relationship between awe and tourists' attitudes and their behavioral intentions (Lu et al., 2017; Wang and Lyu, 2019;

Su X. et al., 2020), especially on the effect of tourists' perception of awe on TERB through on-site surveys. Such a study would extend the existing literature of tourists' perception of awe and would contribute to the wider application of the findings of research into awe.

The effect of the availability of infrastructure on tourists' experiences of awe was empirically tested for the first time in the present study, thereby enriching the theoretical research on the factors affecting tourists' experiences of awe. Previous studies concentrated on how nature, religious and spiritual beliefs (Lu et al., 2017), artistic creation (Keltner and Haidt, 2003), and artificial landscapes (Wang and Lyu, 2019) elicit the experience of awe in individuals and identified three types of "awe elicitors" (tangible, sociocultural, and cognitive) (Keltner and Haidt, 2003). The perceived availability of infrastructure, as evidence of recognition and evaluation of the environmental management and the services provided by a destination, is not only a tangible factor enabling tourists to feel nature-induced awe but also a cognitive factor emphasizing the vastness and importance of nature. The result can be a feeling of the diminishment of an individual. It calls on tourists' capacity for cognitive accommodation and directly inspires a sense of awe (Keltner and Haidt, 2003; Su and Swanson, 2017). However, to the best of our knowledge, no studies have examined the impact of the availability of infrastructure as a stimulus for experiencing awe. Therefore, our proposition, namely, that the availability of infrastructure acts as a stimulus and that awe acts as an organism, will enrich theoretical research on the characteristics of awe and the factors that affect it.

## Practical Implications

With regard to the practical implications, the findings of our study provide the most direct and effective way forward for the sustainable development of tourist destinations, a way to improve satisfaction and stimulate the implementation of tourists' ERB by focusing on the controllable stimulus factors of a destination.

First, according to the coefficients of the influence path, the perception of the natural environment has a higher effect on tourists' awe and satisfaction, indicating that it is a key factor in eliciting a sense of awe and meeting tourists' needs. Therefore, enhancing tourists' evaluation of the natural environment is essential and crucial for successful tourist destination management. The tourism administration department of nature-based destinations should provide tourists with easy access to nearby vantage points where they can experience the vast natural scenery. For example, reasonably located viewing platforms enable visitors to have a good view of the mountain scenery. Updated weather forecasts can ensure that tourists do not miss the sunrise, icy landscapes, snowy scenes, and other natural wonders, often the primary motivation for a visit. Tourists' perception of beautiful natural scenery can also be enhanced and supplemented from multiple perspectives through guidebooks, videos, and even augmented reality experiences in the scenic area, thereby inducing awe and effectively increasing tourists' satisfaction.

Second, the findings demonstrate that the perception of the availability of infrastructure at the destination is the key direct

driver of TERB. An effective and feasible way for managers to promote tourists' ERB is to remove the barriers to facilities. On the one hand, it is necessary to provide tourists with sufficient and available fundamental environmental protection facilities, such as environment-friendly transport, products, bins, and toilets. These facilities can not only facilitate tourists to visit to help them to experience awe but, more importantly, they can reduce the frequency of tourists' unfriendly environmental behaviors, thereby indirectly or directly enhancing tourists' TERB. On the other hand, information and services should be provided to advise tourists on "why to protect," "how to protect," and "what to do to protect," thereby stimulating their actual participation in the environmental protection work. Tourists and their families who actively participate in scenic resources and environmental protection can enjoy preferential policies such as reduced ticket prices or exemptions designed to encourage their positive behaviors.

Third, our results also show that tourists' emotional experiences, especially of awe, have an important effect on satisfaction and TERB, which should be of particular interest to tourism managers. To increase the awareness of awe by tourists, two basic characteristics of prototype theory that relate to the factors that inspire awe, namely, vastness and accommodation (Keltner and Haidt, 2003), must be taken into account. These factors should be incorporated into the design and development of the elements that create an attractive destination. In addition, destination management organizations should consider other socially contextual factors of the destination (Wang and Lyu, 2019), such as the perception of the availability of infrastructure as proposed in this study. This perception makes tourists' visits feasible, and therefore, tourists can be exposed to a dramatic landscape and can experience awe. Notably, in a nature-based destination that also incorporates cultural resources, the studied area could promote the religious atmosphere (Lu et al., 2017), the perceived authenticity (Wang E. et al., 2020), the involvement (Su X. et al., 2020), and other variables based on the resource characteristics to stimulate tourists' sense of awe and ultimately, to stimulate their responses such as satisfaction, loyalty, and ERB.

Furthermore, destination management should consider the carrying capacity of the popular scenic spots in the area and avoid over-development problems caused by convenient facilities (e.g., a convenient and environmentally friendly transport system). This action would limit the degree of damage and maintain the quality of the tourism experience. For example, the ecological environment carrying capacity analysis and warning system can be activated to conduct real-time analysis of a real-time number of visitors, visitor routes, preferred scenic spots, and other aspects. Based on the results of the analysis, the managers can promptly adopt measures such as tourist flow restriction and diversion, opening up new tourist routes, and adjusting opening times to improve the visitors' evaluation of their experience. It is noteworthy that in the marketing of natural scenic spots similar to the case in this study, managers should avoid the impact of high expectation promotional materials on tourist satisfaction. For example, sometimes, due to bad weather, some tourists cannot reach the peak because the environmentally friendly vehicles are not running. Zhurong Peak, which has ice and snow, is the main

marketing attraction in winter. Tourists who are not able to walk to the peak may not have a satisfactory travel experience. Taking this possibility into consideration, marketing materials should warn that this might be a possible outcome of a visit to Zhurong Peak. Alternatively, managers must carefully consider feasible solutions to potential obstacles, thereby helping tourists to be in close proximity to natural wonders.

Finally, based on the findings of this study, faced with environmental pressures and the difficulties of maintaining the ecological environments of destinations, managers need to cultivate positive emotional responses by optimizing the design and construction of destination environments (Mair and Laing, 2013) and, ultimately, by delivering memorable and satisfying experiences to visitors and promoting their pro-environmental behaviors. It is true that to better guide and facilitate tourist behavior, destination planners and developers should also consider other feasible and straightforward methods. For example, while providing environmental protection facilities, the destination should also explain and demonstrate the importance of environmental protection and the negative consequences of destroying the environment, respectively, that is, through environmental education and explanation (Gao et al., 2018), help inspire tourists' social awareness of responsibility (Luo et al., 2020). In addition, managers can also emphasize reward and punishment strategies for different behaviors in the scenic area (Li and Chen, 2019), thereby correspondingly triggering positive behaviors of tourists and reducing their deviant behaviors. All these direct and indirect management practices will contribute to the environmental sustainability of TERB and the destination.

## LIMITATIONS AND FUTURE RESEARCH

Several limitations of this study should be noted and resolved in future studies. The first limitation is the lack of generalizability of the research results. The present study chose a mountain-based natural destination in mainland China as the location for collecting data to test the relationships between the variables. The different cultural backgrounds and the attractions of the destination might make replication of this research, built on the SOR framework, in the context of other destinations challenging. Researchers would still need to consider the environmental stimulus characteristics of destinations and the perception of tourists' experiences to confirm the validity of the findings. Furthermore, as the study design and data collection were pre-pandemic, the impact of COVID-19 was not considered in this study. Its impact need be further studied in the future. As the COVID-19 pandemic persists, there may be greater awareness of the importance of environmental responsibility, which can influence tourists' behavior. Whether the pandemic will affect tourists' attitude toward environmental responsibility deserves further study.

Another limitation of this study is that the experience of awe was examined only in the context of a nature-based mountain tourism destination. In the future, it will be necessary to study tourists' experience of awe and the factors that affect it in other settings, such as historical destinations, high-tech tourist

destinations, and the residences of celebrities. Since tourists' experience of awe can encourage them to prolong, remember, or relive past experiences, resulting in a sense of a place (Coghlan et al., 2012), future studies can further explore the relationships between place attachment and tourists' memorable experiences of awe, with a view to their eudemonic value and contribution to well-being of individuals in their daily lives.

Some concepts, such as perceived value, are advocated to contain affective, social, hedonic, and utilitarian dimensions. Those are essential for building positive emotions that lead to tourist satisfaction. Perceived value is considered a reliable concept to better explain behavior (Kim and Thapa, 2018). Consequently, some consideration should be given in follow-up research to building a comprehensive model incorporating perceived value, specific positive emotions, and tourist attitudes to better understand tourist behavior. TERB can also extend to their everyday life situations (Ramkissoon et al., 2012). The broader social environmental value this could create deserves special exploration in the future.

Finally, the emotion of awe elicited by the natural landscape in our study is a component of the sublime emotion in response to nature (Bethelmy and Corraliza, 2019). We recommend further research on the role of the sublime as an antecedent to the tourism experience and to potential tourist behaviors, and its relation to awe in various tourism contexts (e.g., dark tourism).

## DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

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## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

## AUTHOR CONTRIBUTIONS

JJ and BG conceived the study. JJ and XS collected and analyzed the data. JJ, BG, and XS wrote the manuscript. All authors designed the study, read and approved the manuscript, and agreed to be accountable for all aspects of the work.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2022.619815/full#supplementary-material>

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# The Impact of Pro-environmental Awareness Components on Green Consumption Behavior: The Moderation Effect of Consumer Perceived Cost, Policy Incentives, and Face Culture

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Based on the survey data of 839 consumers in Jiangsu and Anhui provinces, this article explores the formation mechanism and internal driving force of Chinese consumers' green consumption, and clarifies the effect of consumers' pro-environmental awareness components on green consumption and the moderating effect of perceived cost, policy incentives, and face culture. The results of the study show that pro-environmental awareness is the basis for green consumption. However, groups with pro-environmental awareness do not choose green consumption for sure. The transformation from awareness to behavior is also affected by many factors. Consumers' perceived cost is an important obstacle to green consumption, while the face culture in Chinese society has a certain role in promoting green consumption. In this study, government policy incentives have no significant direct impact and moderating effect on consumers' green consumption.

**Keywords:** pro-environmental awareness, green consumption, perceived cost, policy incentives, face culture

## INTRODUCTION

In recent years, resource constraints have been tightened, environmental pollution has become increasingly serious, and ecosystems have been continuously degraded. This not only constrains the development of social production, but also affects the quality of life for residents. Global environmental problems are mainly caused by human activities (Dong et al., 2017). The unrestrained consumption of various natural resources has brought a huge extra load to the earth, destroyed the ecological environment, and broke the natural balance (Maloney and Ward, 1973). The research of McDougall (1993) pointed out that unreasonable human consumption patterns have caused nearly 40% of the environment to deteriorate. Our individual actions have global repercussions, and our consumption is directly linked to the use of resources and the destruction of nature and its ecosystems (Mónica et al., 2020). Therefore, it is an inevitable trend and an important choice to build a green society and promote the greening of production and life in human society. In daily life, consumers changing traditional consumption patterns and practicing green consumption have an important positive effect on the construction and development of a green society.

Green consumption is a pro-environmental behavior, referring to that consumers pay attention to protecting the ecological environment in the three links of purchase, use, and disposal of commodities and weaken individual behaviors to have a negative impact on the environment as much as possible (Carlson and Kangun, 1993). Green consumption considers the needs of contemporary people and the needs of future generations. In order to promote green consumption, we need to sort out how consumer's pro-environmental awareness affects green consumption and how the perceived costs of consumers and government policy interventions affect green consumption. In addition, everyone's behavior is rooted in a specific cultural background, and consumer behavior is no exception (Wang, 2013). "Mianzi" is a concept with Chinese cultural characteristics (Zhao et al., 2018), and it is usually translated as "face concept" or "face culture." Face culture is a cultural background variable that has the greatest impact on Chinese behavior (Wang, 2013), so it is also necessary to identify the effect of face culture on consumers' green consumption behavior.

In this context, this study constructed an experimental model based on pro-environmental awareness, with perceived costs, policy incentives, and face culture as moderator variables, to explore the formation mechanism and internal driving force of Chinese consumers' green consumption, and provide some theoretical bases and opinions for the development of China's green market.

## LITERATURE REVIEW AND HYPOTHESES

To study the impact of pro-environmental awareness on green consumption behavior, it is necessary to understand the psychological mechanism behind individual behavior. From the relevant literature, scholars have proposed different theories to explain individual behavior and the psychological mechanisms behind it.

The social psychologist Lewin (1976) proposed Lewin's Behavior Model based on a large number of analytical experiments. He believes that the performance, tendency, and intensity of individual behavior are affected and restricted by both individual internal factors and external environmental factors. Individual internal factors are the specific conditions and characteristics inherent in an individual, including two basic dimensions: physiology and psychology. External environmental factors represent the external environment in which individuals live, including two basic dimensions: natural environment and social environment. Lewin's (1976) Behavior Model states that human behavior is the product of the interaction between the individual and the environment. The model reveals and summarizes the general laws of human behavior to a certain extent, and has a high degree of generality and applicability. It has become the basic theory for the study of individual behavior.

Fishbein and Ajzen (1977) put forward the Theory of Reasoned Action (TRA) on the basis of the multi-attribute attitude theory, and in Ajzen and Fishbein (1980), further developed it. TRA argues that individuals are inherently rational,

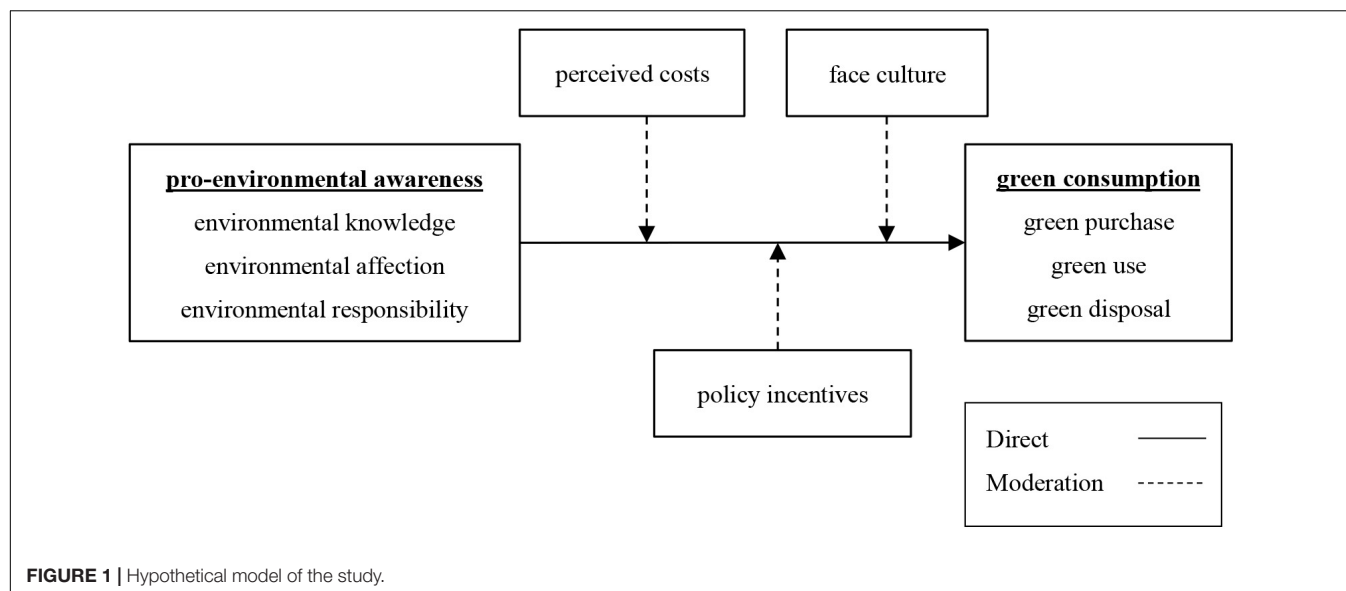
using all the information they can obtain in an orderly manner and taking action only after considering and weighing the meaning and consequences of taking a certain action. An individual's behavior directly depends on the individual's behavioral intention. Behavioral intention is the result of the combined effect of two factors, the individual's attitude and subjective norm. Other factors can only indirectly influence an individual's behavior through attitudes and subjective norms.

In order to explain and predict individual behavior more reasonably, Ajzen (1991) introduced the variable of Perceived Behavioral Control (PBC) on the basis of TRA and proposed the Theory of Planned Behavior (TPB). TPB measures how easy or controlled an individual is expected to feel when performing a particular action, similar to the concept of self-efficacy. When individuals perceive that they are more competent and have more resources, the more confident they will be to carry out their actions. TPB has been empirically tested by numerous studies, proving that the theory has high reliability and validity for analyzing individual behavior. However, TPB emphasizes the instrumental component of attitude, ignoring the emotional component of attitude, and to a certain extent reduces the theory's explanation of individual behavior.

The Motivation–Opportunity–Ability Model (MOA) was proposed by Ölander and Thøgersen (1995), which explains the motivation and mechanism of individual behavior from three aspects: the subjective possibility (motivation), the objective possibility (opportunity), and the possibility of subjective individuals to know objective things (ability). The construction of MOA is based on two basic assumptions: one is to emphasize the important driving effect of motivation on individual behavior, and the other is to believe that the three elements of motivation, opportunity, and ability are complementary, and the three elements need to exist at the same time to achieve specific behavior. The individual's motivation can directly affect behavior, and the two variables of ability and opportunity play a moderating role in the influence path from motivation to behavior. MOA is extremely inclusive and open, and it provides an effective analytical framework for later researchers to explore the dynamics of behavior.

Guagnano et al. (1995) found that the environmental-friendly behavior of individuals is the result of the interaction between environmental attitudes and specific situational factors when studying residents' garbage recycling behavior. Based on this, a set of Attitude–Context–Behavior (ABC) theories was developed. Behavior is the interaction function of Attitude and Context. When the situational variables tend to be favorable, it may greatly promote the occurrence of residents' environmental behavior; when the situational variables tend to be unfavorable, it may greatly hinder the production of environmental behaviors. The value of ABC is to demonstrate the relationship between the individual's internal attitude elements and the external situational elements of the individual's environment, and to verify that situational factors have moderating effects on the path of environmental attitudes to environmental behaviors.

To sum up, Lewin's (1976) Behavior Model believes that behavior is the product of the interaction between the individual



and the environment, and makes a basic induction and division of the individual's internal elements and external environmental factors. TRA holds that individuals are inherently rational, using all the information available to them in an orderly manner, and take action after taking into account the meaning and consequences of taking a certain action. TPB, based on the theory of rational behavior, introduces the variable of PBC and believes that when individuals perceive their own abilities as stronger and possess more resources, they are more confident in carrying out their actions. In order to solve the problem that TPB does not consider emotional factors, based on the TPB, many scholars have introduced many variables, including emotional factors, into the model, and conducted continuous testing, supplementation, and integration, which greatly enhanced the model's interpretation of individual pro-environmental behavior. MOA explains the motivation and mechanism of individual behavior from three aspects: the subjective possibility, the objective possibility, and the possibility of subjective to objective cognition. ABC holds that an individual's environmental behavior is the result of the interaction between environmental attitudes and situational factors, and verifies that situational factors have a moderating effect on the path between attitudes and behaviors.

Based on the above model, Wang (2012) constructed an exploratory theoretical model, namely the Consciousness-Context-Behavior System Model, when he studied the low-carbon consumption behavior of Chinese consumers. The theory analyzes the dimensional structure and interaction effects of consciousness, situation, and behavior, and examines the moderating effect and direction of internal and external situational variables in the path of awareness to behavior. It is an extension and development of TRA and TPB, as well as a supplement to MOA and ABC. Empirical research pointed out that consumers' low-carbon consumption awareness is an important pre-variable for low-carbon consumption behavior. The influence path of low-carbon consumption awareness to behavior is also moderated by internal context variables

(individual implementation costs) and external context variables (social reference norms). In order to verify this model, Wang (2013) used the Consciousness-Context-Behavior System Model to explore residents' resource-saving awareness and behaviors, and proved that this model is also valid in the research on residents' resource-saving behaviors.

This study follows the Consciousness-Context-Behavior System Model, trying to construct a research framework to explore the green consumption behavior of Chinese consumers. In this model, consciousness is represented by environmental awareness (environmental knowledge, environmental affection, and environmental responsibility). Behavior is represented by green consumption. Context is the moderator variable in this model, represented by consumers' perceived costs, policy incentives, and face culture.

## Role of Pro-environmental Awareness

Consumer behavior theory believes that individual consumer behavior is formed by a complex purchasing decision process under the influence of various stimulating factors. Green consumption, as an environmentally friendly lifestyle and consumption pattern, is also affected by many factors (Sheng et al., 2019). A large number of studies have proved that pro-environmental awareness has a significant role in promoting an individual's green consumption (Wang, 2013; Liu et al., 2017; Eze, 2020). Environmental knowledge, environmental affection, and individual environmental responsibility are all important components of pro-environmental awareness (Liu et al., 2014; Mei et al., 2016; Vasiljevic-Shikaleska et al., 2018).

Ecological cognition is the driving factor of ecological consumption, and it can positively affect consumers' ecological consumption (Fransson and Gärling, 1999). Having certain environmental knowledge is the prerequisite to generate environmental awareness (Maloney et al., 1975). Therefore, when consumers have a deeper understanding of the environment and environmental pollution issues, they are more inclined to



**TABLE 1 |** Reliability and validity test results.

Latent variables	Manifest variable	factor loading	CR	Cronbach's $\alpha$	KMO	Bartlett's test		
						$\chi^2$	df	Sig
Environmental knowledge (EK)	EK1	0.869	0.914	0.874	0.815	1728.124	6	0.000
	EK2	0.895						
	EK3	0.809						
	EK4	0.837						
Environmental affection (EA)	EA1	0.593	0.843	0.773	0.815	1303.501	15	0.000
	EA2	0.612						
	EA3	0.825						
	EA4	0.815						
	EA5	0.700						
	EA6	0.557						
Environmental responsibility (ER)	ER1	0.788	0.847	0.728	0.676	523.730	3	0.000
	ER2	0.834						
	ER3	0.794						
Perceived cost (PC)	PC1	0.855	0.845	0.721	0.500	201.434	1	0.000
	PC2	0.855						
Government policy (GP)	GP1	0.929	0.926	0.841	0.500	629.035	1	0.000
	GP2	0.929						
Face culture (FC)	FC1	0.742	0.816	0.713	0.775	758.600	10	0.000
	FC2	0.717						
	FC3	0.524						
	FC4	0.791						
	FC5	0.639						
Green consumption (GC)	GC1	0.604	0.842	0.747	0.736	830.619	6	0.000
	GC2	0.758						
	GC3	0.852						

**TABLE 2 |** Discriminant validity test results.

	Environmental knowledge	Environmental affection	Environmental responsibility	Perceived cost	Government policy	Face culture	Green consumption
Environmental knowledge	0.853						
Environmental affection	0.374**	0.879					
Environmental responsibility	0.592**	0.529**	0.853				
Perceived cost	−0.483**	−0.379**	−0.547**	0.794			
Government policy	0.509**	0.394**	0.635**	−0.489**	0.917		
Face culture	0.434**	0.331**	0.513**	−0.382**	0.459**	0.844	
Green consumption	0.441**	0.432**	0.488**	−0.576**	0.377**	0.445**	0.864

\*\*Indicates significance at the level of 0.01, and the diagonal value is  $\sqrt{AVE}$ .

adopt environmentally friendly green consumption. Research by Liobikien et al. (2016) proved that when consumers have a wealth of green consumption knowledge, they are more likely to adopt green consumption behaviors. Dursun et al. (2019) found that objective environmental knowledge's effect can be used to break down young consumers' psychological barriers that are unwilling to engage in pro-environmental actions, and to facilitate the change toward more sustainable energy consumption patterns.

The research of Han et al. (2007) pointed out that both cognition and affection can have effects on environmental protection behaviors, but the impact of affection on environmental protection is more direct and significant.

Carrus et al. (2008) also reached a similar conclusion. Although environmental affection and environmental knowledge are both important components of pro-environmental awareness, environmental affection is more important than environmental knowledge. For example, in real life, some rural residents have insufficient environmental knowledge reserves due to low education, but they still bring positive affection to the environment. Newton et al. (2015) and Ritter et al. (2015) directly proved that environmental affection can significantly affect consumers' willingness to purchase green products.

In addition, many studies have shown that consumers' sense of environmental responsibility has a significant positive impact

**TABLE 3 |** Test results of the main effects and interaction effects of various components of pro-environmental awareness on green consumption.

	Model I			Model III		
	Standard regression coefficient	T-value	Sig.	Standard regression coefficient	T-value	Sig.
X <sub>1</sub> (EK)	0.214	5.966	0.000	0.218	5.957	0.000
X <sub>2</sub> (EA)	0.224	6.574	0.000	0.190	5.363	0.000
X <sub>3</sub> (ER)	0.243	6.208	0.000	0.269	6.691	0.000
X <sub>1</sub> × X <sub>2</sub> (EK × EA)				0.004	0.107	0.915
X <sub>1</sub> × X <sub>3</sub> (EK × ER)				−0.014	−0.401	0.688
X <sub>2</sub> × X <sub>3</sub> (EA × ER)				0.099	2.730	0.006
R	0.556			0.564		
R <sup>2</sup>	0.309			0.318		
Adj. R <sup>2</sup>	0.307			0.313		
F	124.722			64.577		
Sig.	0.000			0.000		

on the willingness to purchase green products. Environmental responsibility is the sense of responsibility and obligation that individuals have when they are willing to make efforts to solve ecological and environmental problems, and it is an important explanatory variable for pro-environmental behaviors (Sheng et al., 2019). Hines et al. (1987) proposed a model of responsible environmental behavior after a meta-analysis of 128 articles on pro-environmental behaviors. The research pointed that consumers with a high sense of environmental responsibility can better understand the relationship between themselves and the environment, and believe that it is everyone's duty to solve environmental problems. Compared with consumers with low environmental responsibility, consumers with high environmental responsibility are more willing to adopt pro-environmental behaviors. A study on the consumer behavior toward energy-saving household appliances in China also proved that consumers' environmental responsibility will drive them to pay attention to environmental issues and actively practice green consumption (Sheng et al., 2018). Therefore, this study proposes the following hypotheses:

*H1: Environmental knowledge has a positive impact on green consumption.*

*H2: Environmental affection has a positive impact on green consumption.*

*H3: Environmental responsibility has a positive impact on green consumption.*

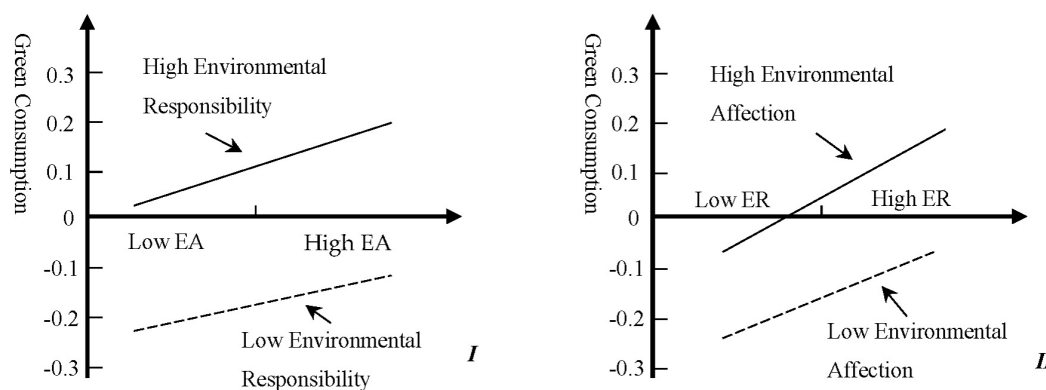
The effect of one explanatory variable on the outcome variable will vary with the level of another explanatory variable (Wang, 2013). The effects of different components of awareness on behavior are not necessarily independent. The interaction effects of explanatory variables ultimately affect individual behavior choices. Tentatively, an explorative hypothesis is tested about the possible interaction effects between environmental knowledge, affection, and responsibility, in relation to green consumption.

*H4: Interaction effects between different components of pro-environmental awareness exist.*

## Role of Consumers' Perceived Costs

However, pro-environmental awareness does not necessarily lead to pro-environmental behaviors. The conversion rate of eco-conscious to actual eco-consumption is far below the conversion rate between non-ecological awareness and behavior (Bamberg and Möser, 2007). Moderator variables can systematically change the form, strength, and direction of the relationship between the predictor and the criterion variable (Baron and Kenny, 1986; Aguinis et al., 2017). Thus, the study speculates that there may be moderator variables that influence the path from pro-environmentally awareness to behaviors. Several studies have demonstrated this speculation. Although ecological consumption can be achieved through intrinsic motivation efforts, it will also be limited by external conditions, such as household income, scale, and economic cost (Abrahamse and Steg, 2009). Zhang and Qing (2011) also found that energy consumption consciousness has an important influence on energy consumption in the study of Chinese residents' energy consumption, but the degree of influence is interfered by the economy, households, and related groups.

The Motivation–Opportunity–Ability Model proves that individual motivation can directly act on behavior, while ability and opportunity have a moderating effect on the influence path from motivation to behavior. ABC verifies that contextual factors have moderating effects on the influence path of environmental attitudes to environmental behaviors. Wang (2013) conducted qualitative research on the resource conservation behavior of the Chinese public, and proved that internal and external context variables have a significant moderating effect on the influence path of conscious behavior. This study selects three contextual variables of consumers' perceived cost, policy incentives, and social culture to specifically analyze the moderating mechanism of internal and external contextual variables on pro-environmentally aware green consumption behavior.

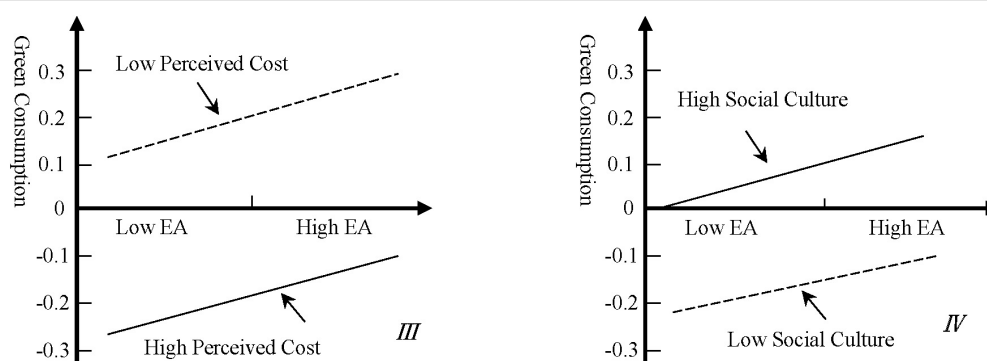


**FIGURE 2 |** The interaction between environmental affection and environmental responsibility.

**TABLE 4 |** Test results of the moderating effects of perceived cost, policy incentives, and face culture.

	Perceived cost			Policy incentives			Face culture		
	Mode I	Mode II	Model III	Mode I	Model II	Model III	Mode I	Model II	Model III
$X_1$	0.214***	0.122***	0.109**	0.214***	0.205***	0.199***	0.214***	0.172***	0.187***
$X_2$	0.224***	0.183***	0.165***	0.224***	0.221***	0.215***	0.224***	0.209***	0.184***
$X_3$	0.243***	0.105**	0.118**	0.243***	0.221***	0.222***	0.243***	0.164***	0.170***
$Y_i$		-0.391***	-0.388***		0.045	0.045		0.217***	0.227***
$X_1 \times Y_i$			0.043			-0.001			-0.002
$X_2 \times Y_i$			-0.092**			0.029			0.062*
$X_3 \times Y_i$			0.023			-0.038			0.036
R	0.556	0.640	0.645	0.556	0.557	0.558	0.556	0.585	0.591
$R^2$	0.309	0.409	0.416	0.309	0.311	0.312	0.309	0.343	0.349
Adj. $R^2$	0.307	0.406	0.411	0.307	0.307	0.306	0.307	0.340	0.344
F	124.722	144.382	84.479	124.722	93.923	53.751	124.722	71.803	63.738
Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

The symbols \*\*\*, \*\*, and \* indicates significance at the level of 0.001, 0.01, and 0.05, respectively.



**FIGURE 3 |** The moderating effect of perceived cost and social culture.

Consumers always make rational choices when it comes to environmental behavior. They always choose low-cost, high-yield options. Abrahamse and Steg (2011) classified garbage collection and support for an environmental policy as low-cost pro-environmental behaviors, while green consumption and the

use of environmentally friendly equipment were classified as high-cost pro-environmental behaviors. Green products usually have a higher premium than ordinary products (Grisevicius et al., 2010). Also, green products are difficult to buy in traditional markets, and generally need to be purchased in

supermarkets and large shops. This requires consumers to make certain sacrifices in terms of personal benefits, such as economy and convenience. Customer Perceived Value theory believes that when consumers make any purchase decision, they will weigh the total benefit and the total cost. Consumers also make the same value judgment when they conduct green consumption. The benefits of green products have an externality, and the value to the environment is higher than the value to the customers themselves. Green products with higher prices tend to weaken consumers' concern and sense of responsibility for the environment, which in turn makes consumers with high price sensitivity reduce their willingness and behavior to purchase green consumption (Wang et al., 2015). In sum,

*H5: The relation between pro-environmental awareness and green consumption behavior will be weaker (stronger) for consumers with stronger (weaker) perceived costs.*

## Role of Policy Incentives

Policy incentives are important external situational factors that affect consumers' green consumption. In order to protect the environment and promote the development of the green consumption market, the government would take a series of economic measures. For example, the government would reduce the production cost of green products through the reduction of taxes and stimulate consumers' green purchase demand by preferential subsidies. But it is worth discussing whether the policy incentives are effective. Iyer and Kashyap's (2007) research shows that the government's incentive policies can effectively stimulate residents' garbage collection. However, Slavin et al. (1981) and Abrahamse et al. (2005) pointed out that economic incentives can only temporarily stimulate energy-saving behaviors. Based on the literature, this study believes that policy incentives have a moderating effect on the conversion path of the consumer's pro-environmental awareness to green consumption. In short,

*H6: The relation between pro-environmental awareness and green consumption behavior will be stronger (weaker) with stronger (weaker) policy incentives.*

## Role of Face Culture

When studying ecological consumption, the influence of cultural factors cannot be ignored (Liu et al., 2017). Culture is a comprehensive concept, covering every aspect of individual thinking and action, affecting people's preferences and motivations, and influencing people's behavior choices. According to this logic, pro-environment awarenesses and pro-environment behaviors are also rooted in a specific cultural environment. Face culture has a strong Chinese cultural flavor and occupies an important position in Chinese society. It is an informal system that describes the psychological process of interpersonal relationships in daily life (Wu, 2004). Huang (1985) believes that face culture refers to the social status or prestige that an individual has achieved because of his achievements in society. Face culture has a profound impact on Chinese consumption

decisions (Pan et al., 2014). When the Chinese conduct consumption activities, there are some psychological motives for improving and maintaining self-image and preventing losing face (Zhu, 2006). The consumption of "mianzi" exists in all societies, including favor consumption, fashion consumption, conspicuous consumption, comparison consumption, and other types (Jiang, 2009). Therefore, we regard face culture as an important epitome of social culture and speculate that, under the effect of face culture, the public would pay attention to whether adopting green consumption can enhance their own personal image, and can demonstrate their personal qualities, economic conditions, and social status. In sum,

*H7: The relation between pro-environmental awareness and green consumption behavior will be stronger (weaker) for consumers with a stronger (weaker) tendency to face culture.*

Regarding green consumption, most studies believe that green consumption focuses on reducing pollution, protecting the environment, and conserving resources and energy, including not only purchase behavior but also use and disposal behavior (Carlson and Kangun, 1993; Wang and He, 2011; Sun et al., 2015; Liu et al., 2017). Therefore, this study divides green consumption into three dimensions (green purchase, green use, and green disposal), investigates the direct impact of pro-environmental awareness (consisting of environmental knowledge, environmental affection, and environmental responsibility) on green consumption, and assesses whether the degree of its influence is moderated by consumers' perceived costs, policy incentives, and face culture. The specific model assumption is shown in **Figure 1**.

## RESEARCH DESIGN

### Measures

Environmental awareness includes three components, environmental knowledge, environmental affection, and environmental responsibility, and each one is measured by a specific scale.

The environmental knowledge scale mainly draws on the ecological cognition scale of Bohlen et al. (1993) and is measured using four items, including "I know oceans and rivers are being polluted," "I know the hazards of the ozone hole," "I know the pollution caused by pesticide residues to the soil," and "I know the global warming is happening."

The environmental affection scale mainly draws on the affection part of the ecological product selection scale of Fraj and Martinez (2007) and is measured using six items, including "I think most of the things I eat are contaminated with pesticides, which makes me very scared," "Environmental pollution poses a great threat to the survival of animals and plants, which makes me very angry," "The government has not taken more measures to control pollution, which makes me very indignant," "The development of industry has caused serious pollution to the environment, which makes me very frustrated," "I feel frustrated and angry about the smog," and "The government has taken many measures to



protect the ecological environment, which makes me very pleased."

The environmental responsibility scale refers to the environmental scale of Fransson and Gärling (1999) and is measured using three items, including "Unless each of us recognizes the need to protect the environment, our future generations will bear the consequences," "If each of us contributes a little to environmental protection, it will have a significant impact on the environment," and "If everyone chooses green consumption, it is meaningful to environmental protection."

The consumer perception cost scale mainly draws on the consumption perception risk scale of Jacoby and Kaplan (1972) and Mitchell and Greathorex (1993), measured using two items, including "I will worry that the value of the product is not worth its price" and "I will worry if this consumption is unsuccessful, it will waste my time to buy again."

For the policy incentive scale, this study refers to the items in the research on ecological consumption awareness and behavior of rural residents by Liu et al. (2017), and is measured using two items, including "If there are discounts for buying eco-friendly products (low carbon, energy saving, etc.), I will choose to buy" and "If the government has subsidies, I would prefer to buy eco-friendly products (such as home appliances, solar energy, etc.)."

In terms of face culture, this study mainly refers to Pan et al. (2014) consumer value scale in the context of Chinese culture, and is measured using five items, including "I hope to show my best side in front of others so as not to be looked down on," "Being rejected by others is a shameful thing," "Do not directly or publicly accuse others of their mistakes," "Even if the husband's income is sufficient to support the family, the wife should also have her own career," and "Appropriate praise can show respect for others."

For the measurement of green consumption, the research has adjusted and amended the questionnaire based on the synthesis of relevant literature (Richins and Scott, 1992; Bohlen et al., 1993; Chan, 2001; Fraj and Martinez, 2007), combined with the context of Chinese culture and the actual situation, measured purchasing, using and disposing behavior in the process of green consumption with three items, including "I would recycle paper, glass, plastic bottles, cans, and other recyclable items," "I would give priority to purchase environmentally friendly detergents, recycled paper products, etc.," and "I have replaced a product I used before for environmental reasons."

Each item is measured using the Likert scale and is assigned a value from 1 to 5 points, which correspond to the five levels of "strongly disagree" to "strongly agree" through individual subjective assignments.

## Sample Selection

Since a complete sampling frame was not available, a quota sampling method was used. In order to ensure the validity of the questionnaire, a small-scale pre-survey was conducted in the city of Wuxi before the formal investigation. The questions with unclear meaning and ambiguity in the questionnaire were adjusted and corrected based on the pre-survey feedback information. To ensure the authenticity of the investigation

results, all investigators were uniformly trained before the formal investigation.

Data were collected in Jiangsu Province and Anhui Province, including four representative cities in Jiangsu Province (Southern Jiangsu: Wuxi; Central Jiangsu: Yangzhou; Northern Jiangsu: Huai'an and Lianyungang) and eight representative cities in Anhui Province (Southern Anhui: Xuancheng, Tongling, and Ma'anshan; Central Anhui: Anqing and Hefei; Northern Anhui: Huainan, Huaibei, and Fuyang). The sample selection range includes multiple prefecture-level cities with different geographic locations in the two provinces. In this sense, different places across geography were selected to ensure representative sampling.

In each surveyed city, the investigators identified respondents based on a 1:1:1:1 ratio of urban areas, suburbs, counties, and rural areas to ensure that the sample can cover consumers in all areas as much as possible. Then following the convenience sampling method, consumers aged 18 years old or above were selected to complete a face-to-face interview. Each interview took 2,030 min to finish. In total, 917 questionnaires were distributed. Among them, 839 of them were deemed valid, including 519 valid questionnaires from Jiangsu Province and 320 valid questionnaires from Anhui Province. The validity rate was 91.49%.

## Descriptive Statistics

The statistical data of the questionnaire show that women accounted for 55.30% and men accounted for 44.70% in terms of gender structure. The sample's age distribution was relatively even, with the 18–35 age group accounting for 57.33% and 35 years old and above accounting for 42.67% of the sample. In terms of education distribution, junior high school and below accounted for 24.08%, high school or vocational school accounted for 25.39%, college or undergraduate accounted for 46.25%, and graduate and above accounted for 4.29% of the sample. In terms of family size, the sample was mainly based on the family size of 2–3 or 4–6 people, accounting for 35.28 and 58.88%, respectively. From the perspective of annual household income, the annual income of 66.03% of the sample was above 80,000 yuan, indicating that the majority of respondents have a relatively high standard of living. In terms of residence, urban areas accounted for 33.25%, suburbs accounted for 17.52%, counties accounted for 26.94%, and rural areas accounted for 22.29%. The sample residence distribution was relatively even.

## Reliability and Validity Test

The study used SPSS24.0 to analyze the internal reliability of the seven variables: environmental knowledge, environmental affection, environmental responsibility, perceived cost, government policy, face culture, and green consumption. The analysis results are summarized in **Table 1**. The Cronbach's  $\alpha$  coefficients of the variables are all above 0.7. It indicates the scale has comparable reliability to ensure good internal consistency between the variables. The pre-survey and modification of the questionnaire ensure the content validity of the questionnaire. In order to test the convergent validity of the scale, the researchers selected three test indicators: CR (construct reliability), KMO

(Kaiser–Meyer–Olkin) value, and Bartlett's test. The results show that the CR values of all items are above the standard value of 0.8, most of the KMO values are above the acceptable level of 0.7, and the significance level is 0.000, all of which pass Bartlett's test. Among them, the KMO values of perceived cost and government policy are measured at 0.500, for the reason that these two items are composed of two observation variables. Since the other measurement indicators are perfect, this study believes that the scale validity of the scale passes the test.

In addition, the study examines the discriminant validity between variables by comparing Pearson's correlation coefficient between the variables and the AVE square root of each variable. The results are presented in **Table 2**. The absolute values of the correlation coefficients between the variables are smaller than the square root of the AVE of the variables listed on the diagonal. This means that the internal correlation between the observed variables is greater than the external correlation, and there is a high degree of discriminatory validity between the variables.

## RESULTS

### The Main Effects and Interaction Effects of Pro-environmental Awareness Components on Green Consumption

In order to deeply explore the effect of pro-environmental awareness components on green consumption, the study used multiple regression analysis to test the main effect and interaction effect, and constructed the following multiple regression model:

$$Z = \alpha + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_{1i} X_1 X_2 + \alpha_{2i} X_1 X_3 + \alpha_{3i} X_2 X_3 + \mu_m$$

Among them,  $\alpha$  is a constant term,  $\alpha_i$  represents the regression coefficient,  $\mu_m$  represents the error term,  $X_j$  represents the various components of pro-environmental awareness, and  $X_j X_k$  represents the interaction of two components. Specifically,  $X_1$  represents environmental knowledge,  $X_2$  represents environmental affection,  $X_3$  represents environmental responsibility,  $X_1 X_2$  is the interaction between environmental knowledge and environmental affection,  $X_1 X_3$  is the interaction between environmental knowledge and environmental responsibility, and  $X_2 X_3$  is the interaction between environmental affection and environmental responsibility. The test results are presented in **Table 3**. Model I only considers the main effects of each component of consciousness on behavior, and model II analyzes the effects of pairwise interactions between various components of pro-environmental awareness on behavior in addition to the main effects.

In the effect of pro-environmental awareness on green consumption, the impact of environmental knowledge, environmental affection, and environmental responsibility on green consumption is positively significant at the level of 0.001. Therefore, H1, H2, and H3 are confirmed. This shows that a certain amount of knowledge, a strong emotional expression,

and individual responsibility for environmental issues effectively promote consumers' green consumption in daily life.

From the perspective of interaction effects, the interaction between environmental affection and environmental responsibility is positively significant at the level of 0.01 for green consumption, while the interactions between environmental knowledge and environmental affection, and environmental knowledge and environmental responsibility are not significant. Therefore, H4 is proved. Interaction effects between different components of pro-environmental awareness exist. In this study, the interaction effect between environmental affection and environmental responsibility is confirmed.

Based on the orthogonal interaction coefficients of environmental affection and environmental responsibility, we plotted **Figure 2**. It can be seen from Figure I that, for groups with a high degree of personal responsibility for environmental issues, enhancing their emotional perception of environmental issues can significantly increase the group's preference for green consumption behaviors. From Figure II, we can see that groups with strong emotional responses to environmental issues, guiding them to correctly understand their relationship with the environment and cultivating environmental responsibility, can also play a positive role in inspiring their green consumption behavior.

### The Moderating Effect of Perceived Cost, Policy Incentives, and Face Culture

In order to examine the moderating effects of perceived costs, policy incentives, and face culture on the paths between pro-environment awareness components and green consumption behavior, this study selected hierarchical regression analysis and constructed the following multiple regression models:

$$Z = \alpha + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_i Y_i + \alpha_{1i} X_1 Y_i + \alpha_{2i} X_2 Y_i + \alpha_{3i} X_3 Y_i + \mu_m$$

In the formula,  $\alpha$  is a constant term,  $\alpha_i$  represents the regression coefficient,  $\mu_m$  represents the error term,  $X_j$  represents the various components of pro-environmental awareness,  $Y_i$  represents the moderator variable, and  $X_j Y_i$  represents the moderating effect of the variable  $Y_i$  on the path relationship between  $X_j$  and  $Z$ , such as  $X_1 Y_1$  is the moderating effect of the perceived cost of consumers on the relationship between environmental knowledge and green consumption.

In model I, the moderating variables are not considered initially, and only the main effects of each dimension of awareness on behavior are analyzed. In model II, moderating variables are also included in the model and their main effects are analyzed. In model III, the study examines the moderating effects of perception cost, policy incentives, and face culture. The test results are presented in **Table 4**.

Model I results are the same as summarized in **Table 3**. In model II, the main effect of perceived cost on green consumption is significantly negative at the level of 0.001. Consumers' perceived cost has a significant inhibitory effect on green consumption behavior, for high premium and relatively few purchase channels. The main effect of face culture on green

consumption behavior is significantly positive at the level of 0.001. This may be because, for some consumers, green consumption is a higher level of consumption, and green consumption can satisfy part of their vanity psychology. Moreover, today's society advocates green consumption. When consumers who value "mianzi" more and think green consumption can win the "respect" of others, they will prefer green consumption.

In model III, consumers' perceived cost has a significant negative moderating effect on the path of environmental affection toward green consumption, while face culture has a weak regulating effect on the path of environmental affection toward green consumption. Therefore, H5 and H7 are confirmed. According to the moderating effect coefficient, we have drawn **Figure 3**.

It can be seen from Figure III that for groups with high perceived costs, the impact of environmental affection on green consumption is weaker than those with low perceived costs. The premium of green consumption and the inconvenience of purchasing are major obstacles for consumers to implement green consumption behavior. It can be seen from Figure IV that for groups with high face culture, enhancing their perception of environmental issues can effectively increase their probability of green consumption. Face culture has a certain role in promoting green consumption.

It is worth noting that the impact of policy incentives on green consumption is not significant, and they neither exert a main effect nor a moderating effect, which is contrary to our hypothesis. Therefore, H6 is rejected. It may be because the current green promotion policies are more oriented toward the production side and less incentive policies toward the consumer side, resulting in consumers not feeling significant about the policy incentives.

## DISCUSSION

In order to explore the formation mechanism and internal driving force of Chinese consumers' green consumption, clarify the impact of consumers' pro-environmental awareness components on green consumption, and assess the moderating effects of consumers' perceived cost, government policy incentives, and face culture, this article conducted a series of empirical analyses based on the survey data of 839 consumers in Jiangsu and Anhui provinces.

The results of the study show that pro-environmental awareness is the basis for green consumption. If the individual lacks pro-environmental awareness, it is difficult to adopt green consumption. Among the three components of pro-environmental awareness, that is, environmental knowledge, environmental affection, and environmental responsibility, all have a significant impact on green consumption behavior. The results are consistent with the research of Maloney et al. (1975), Hines et al. (1987), Fransson and Gärling (1999), Newton et al. (2015), Ritter et al. (2015), Liobikien et al. (2016), and Sheng et al. (2018). However, in Wang's (2013) study of Chinese residents' resource-saving awareness

and resource-saving behavior, there is a significant positive interaction effect between knowledge and affection. In this study, the two components of environmental affection and environmental responsibility have positive interactions that promote each other. This shows that, although resource-saving behavior and green consumption behavior are both pro-environmental behaviors, there are certain differences in their influencing factors and paths.

In addition, groups with pro-environmental awareness are not necessarily choosing green consumption, and the transformation from awareness to behavior is also affected by many factors. Consumers' perceived cost is an important deterrent to consumers' green consumption. This is consistent with the findings of Wang et al. (2015). A consumer who supports green consumption may also be price sensitive. When there is an economic price to pay for green consumption, this willingness is significantly reduced. Due to the externality of the benefits of green consumption, when measuring the cost and value of green consumption, consumers pay more attention to their own efforts and ignore the benefits to the ecology, thereby reducing the willingness to green consumption. This is also in line with the behavioral characteristics of a "rational economic man."

Cheng and Chen, 2020 research proves that, for Chinese rural residents, face culture plays a vital role in the transformation of non-environmental-friendly behaviors into environmental-friendly behaviors. This research also proves that face culture plays an important role in promoting green consumption for Chinese consumers. When consumers think that green consumption is a higher level of consumption, green consumption can satisfy their psychological motivation to gain respect and demonstrate their personal qualities, economic conditions, and social status.

However, in this study, the government's policy incentives show that there is no significant direct impact and moderating effect on consumers' green consumption behavior. This is inconsistent with the research results of Iyer and Kashyap (2007). We need to note that Iyer and Kashyap (2007) studied the residents' garbage recycling behavior, while this article studies the residents' green consumption behavior. Although garbage recycling behavior and green consumption behavior are both pro-environmental behaviors, there are still certain differences in the extent to which policy incentives affect them. It also may be due to the fact that current Chinese policies are more oriented toward green production, and the people on the consumption side do not have deep feelings about policy incentives.

These findings are important because they can guide us to better promote green consumption. In order to increase residents' knowledge of environmental protection, strengthen their environmental concerns, and enhance their sense of environmental responsibility, it is necessary for the entire society to create a good atmosphere for environmental protection. In the long run, environmental protection education should be integrated into family education, pre-school education, primary education, secondary education, higher education, and other education systems. The knowledge of environmental protection should be popularized from

an early age to establish the correct values of humans and nature. In the short term, the government can use various media channels (TV, radio, new media, community propaganda, etc.), with the help of publicity advertisements, environmental protection manuals, behavior guides, knowledge popularization, and other forms of communication, to discuss various environmental issues, strengthen public perception of environmental issues, and stimulate public environmental responsibility.

Considering consumers' concerns about the high cost of green products, green product companies can weaken consumers' attention to prices through product differentiation and brand positioning. Fundamentally, it is also necessary to accelerate scientific research and development for reducing the cost of green consumption.

Face culture is a cultural phenomenon unique to China. Taking advantage of this, the government can guide the public to give positive feedback on green consumption behavior. For example, the government can strongly praise and positively comment on green consumption behavior. Enterprises can focus on promoting the important role of green consumption in enhancing consumers' personal image and quality of life, for encouraging the public to adopt green consumption practices.

## CONCLUSION

This research proves that pro-environmental awareness is an important basis for green consumption, and environmental knowledge, environmental affection, and environmental responsibility effectively promote consumers' green consumption behavior. In particular, the study proves that there is a positive interaction between environmental affection and environmental responsibility. Environmental emotion and environmental responsibility act as an amplifier for each other. This is a contribution of this study. Because most of the existing literature tends to ignore the interaction of various components of pro-environmental awareness, to a certain extent, the conclusion of this study makes up for this defect.

This research also proves that perceived costs will hinder consumers from making green consumption, which is consistent with previous research results. However, this study also found that policy incentives have no significant impact on consumers' green consumption behavior, which is inconsistent with previous research results. One of the reasons given in this article is that different types of pro-environmental behaviors have different influence factors and influence paths. This also enlightens us that, in future research, we can finely divide environmental

behavior into different types, examining and comparing the influencing factors and paths of different types of pro-environmental behaviors.

Finally, the study proves that face culture plays an important role in the green consumption behavior of Chinese consumers. Under the long-term and profound cultural influence, the individual's self-concept, cognition, affection, and motivation have been subtly affected. Most Chinese people will consciously identify and follow the Chinese cultural value system, norm system, and belief system. But face culture is only a part of Chinese culture, and only studying face culture has certain limitations. Future research can be extended to different characteristics of Chinese culture and study the effect of different Chinese cultural characteristics on the green consumption behavior of Chinese consumers.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## ETHICS STATEMENT

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

## AUTHOR CONTRIBUTIONS

MS and JW contributed to the development of the theme and writing the manuscript. Both authors contributed to the article and approved the submitted version.

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