

## PARROTS, COCKROACHES, OCTOPUSES: ARE THEY CONSCIOUS?

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### YOUNG REVIEWERS:

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Which living organisms are conscious, feeling creatures, and which are more like sophisticated robots that can only respond to stimuli and solve simple problems? There are many different and hotly debated answers to this question. We used biology to come up with a new approach for determining which organisms are conscious. We propose that organisms that can learn in a specific, flexible manner are conscious. Using this criterion, it is likely that consciousness first appeared about 540 million years ago and can now be found in many animal species. If our ideas are accepted, this means that we must change our attitude toward non-human animals and do a better job of protecting them from pain and suffering.

### WHAT IS CONSCIOUSNESS?

Have you ever thought about other organisms and wondered whether are conscious like we humans are? Which organisms have private experiences of pain and pleasure, or fear and joy? This is one of the

## CONSCIOUSNESS

private subjective experiencing. Experienced perceptions, actions and thoughts are goal-directed and are evaluated through feelings such as pleasure and pain. In humans, consciousness also includes the ability to think about thinking

most important questions in biology, as well as one of the most urgent concerns for the way humans live and behave in a world inhabited by diverse kinds of living beings. Philosophers call the private experiences we have, such as the experience of fear, or enjoyment of the blue summer sky, subjective experiences. This means that the experiences are private, produced by our individual minds. No one else can tell how much pain you have with a rotten tooth, for example. Most philosophers believe that subjective experiences are the hallmarks of **consciousness**. Consciousness is not merely the ability to behave in a sophisticated, intelligent manner, because a computer program, which most of us would agree is not conscious, can be clever and defeat a chess master. Rather, consciousness is the seemingly “simple” ability to see a red anemone, smell jasmine, hear sounds such as music, feel the touch of our clothes against our skin, or feel the state of our bodies when they are moving, at rest, excited, or tired. Subjective experiences, which we sometimes call feelings, are a normal part of our actions and thoughts when we are awake and alert.

Scholars debate which living organisms are conscious. Some think that *all* living beings, including bacteria, are conscious. Others propose that only *some* living organisms are conscious. Are plants conscious? Is the fly that lands on your plate a feeling creature? What about the cockroach under the sink? An octopus? Your dog? Your cat? A chimpanzee? Or are humans the only conscious, feeling organisms? This question kept us awake at night and inspired us to conduct many years of research, which resulted in a fat, academic book [1]. During our research and writing, we discussed the origins of consciousness with many people. One encounter left a lasting impression on us...

## ONE PROFESSOR, THREE WOMEN, AND A RABBIT

The three of us—Eva, Simona, and Anna—were invited to a garden party at an Oxford college. We indulged in strawberries and champagne, and our laughter attracted an elderly man with a white shock of hair, who, we later learned, was a famous philosopher. He joined our table and asked us to introduce ourselves (Figure 1).

Eva said, “We are writing a book about the evolution of consciousness in animals. We are trying to understand how and when consciousness first originated and how it evolved.”

“Consciousness in animals!” the philosopher snorted. “What non-sense! Only an entity that is aware of its own mental states can have subjective experiences. Language is probably needed. Non-human animals are not aware of what they see, hear, or feel.”

Anna, a dog-lover, was upset. She asked, “Have you ever had a dog? Or a cat?”

### Figure 1

Scholars and researchers debate which living things are conscious. What might the animals in this drawing be thinking or feeling? (Drawing by Anna Zeligowski).



Figure 1

The philosopher smiled. “Yes, I have a dog, Pythagoras,” he said.

Simona asked, “And is Pythagoras happy to see you when you come back home?”

The philosopher exhaled with exasperation. “Reacting is not feeling. You will agree, I hope, that a headless chicken running around the yard is not conscious of anything. But even if I cannot deny that *dogs* do feel in some sense, rabbits do not.”

We are not telling this story to make fun of this philosopher—this conversation was meaningful to us because it illustrated the difficulty of actually knowing which living beings are conscious, as opposed to merely reacting to their environments without feeling. We can only be entirely certain about our own consciousness and about the consciousness of other human beings who can tell us, with words, about their mental states. Nevertheless, everyone agrees that people who cannot use language, for example babies, have feelings. Clearly, the philosopher knew very little about rabbits and other animals, and he did not think that such biological knowledge was important for his arguments. We disagree! We think that philosophical arguments must be backed up by the best scientific knowledge—in this case, the knowledge of biology.

### A “MARKER” OF CONSCIOUSNESS

Some scientists have tackled the question of whether animals other than humans have subjective experiences. In a 2012 document called

the Cambridge Declaration on Consciousness, a group of brain scientists and psychologists declared that humans, other mammals, and birds have brain structures, brain activities, and behaviors so similar to those of humans that it is very likely that they all have subjective experiences [2]. The more similar an animal's brain and its patterns of brain activity are to those seen in humans, the greater the likelihood that the animal is conscious. But what about animals that have very different brain organization, like fish, cockroaches, and octopuses? They are so different from humans that it is extremely difficult to compare their brains to the human brain.

To determine whether animals that are very different from humans are conscious, it is important to first understand the fundamental characteristics of consciousness. This is complicated, because it is possible that not *all* consciousness looks exactly like the consciousness with which we are familiar. Scientists who study the nature of life face a similar problem: how can they recognize forms of life that may be different from those with which we are familiar on our planet? For example, can we determine whether there is, or has ever been, life on a planet like Mars? Scientists are now collecting chemical samples from the planet to answer this question, but what if the living things on Mars use different chemistry than that used by living things on Earth? Even if the chemistry is different, if we find alien forms on Mars that have some of the same properties that characterize life as we know it (such as metabolism, growth and repair, the ability to maintain a stable internal environment, and a way to pass information on to the next generation), we shall conclude that there is a high likelihood that these entities are alive. Moreover, if we can find one ability that requires *all* the characteristics of life that we know of, we would have a good **marker** for life. Scientists suggest that a system like DNA, which allows new generations of organisms to adapt to variations in their environments, is a strong marker of life.

#### MARKER

A capacity that enables an observer to infer that all the hallmarks of a mode of being, such as life or consciousness, are in place.

We used a similar approach [3, 4]. To find out what scientists believe to be the most important properties of consciousness, we studied the literature on consciousness and came up with a list of abilities that most consciousness researchers would agree to be essential parts of consciousness. One of these is the ability to understand both wholes and parts, for example to not only recognize an apple as a unique object, but also to see it as something red, round, and fragrant. Another characteristic of consciousness is the ability for flexibly evaluate perceptions and actions as rewarding or punishing. For example, an item of food that we liked in the past can be perceived as disgusting if it is associated with illness. A third characteristic is the ability to distinguish between the effects of a stimulus that is the result of our own activities and the effects of an identical stimulus that is independent of our own activities (Think of the effect of being tickled by another person and tickling oneself). There are other necessary characteristics of consciousness that we will not discuss here, but the

## Figure 2

Examples of conscious animals with the capacity for open-ended learning. **(A)** An octopus learned to hide in a coconut shell. **(B)** Bees learn from experienced bees how to reach food. **(C)** An African Gray parrot can communicate using symbols like letters and even learned to spell words! (Drawings by Anna Zeligowski).

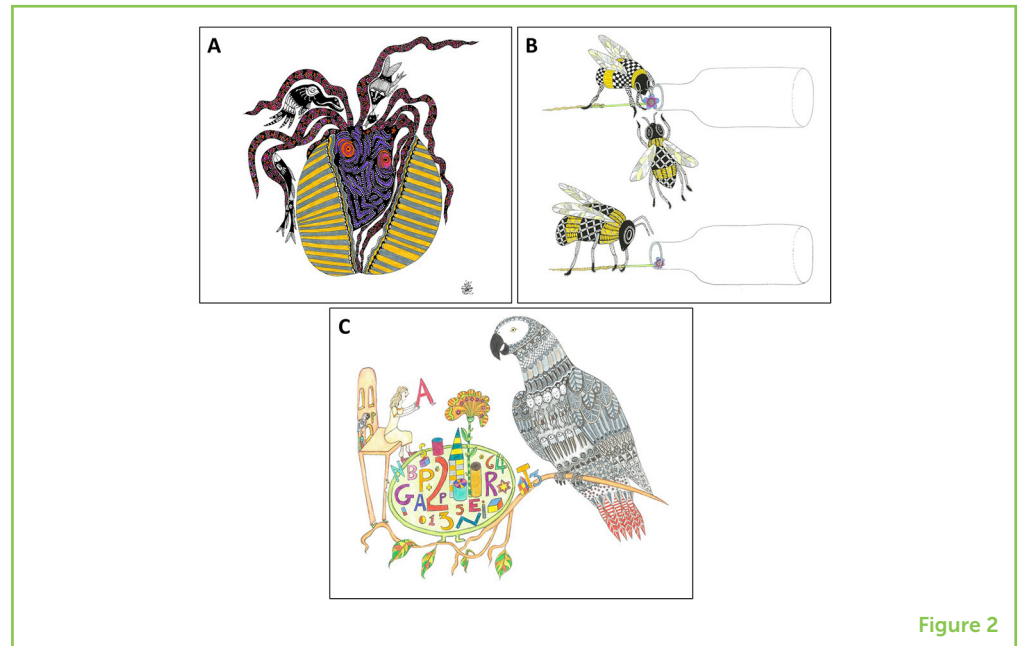


Figure 2

important take-away is that most scholars agree that if a living being manifests all these capacities, chances are it is a conscious being.

Next, we studied our list and looked for a single ability—a marker—that would suggest the presence of *all* the characteristics of consciousness. We discovered that the most suitable marker is **open-ended learning**. This is learning that enables an animal to tell patterns apart from each other (like color or smell patterns in flowers), to learn that two things are related to each other, even when there is a time gap between them (like the presence of smoke indicating that there is a fire), to learn that an action can be rewarding or punishing, depending on the changing conditions of life, and the ability to learn complex actions and the relationships between them (like those required for dancing, finding hidden food, or building a tool). An organism that shows open-ended learning must be a conscious organism because such learning requires all these hallmarks of consciousness.

## WHICH ANIMALS ARE CONSCIOUS?

Using open-ended learning as our consciousness marker, we then asked which animals exhibit this capacity and are thus likely to be conscious organisms. We found that all vertebrates (mammals, birds, reptiles, amphibians, and fish), some mollusks (octopuses, for example), and some arthropods (crabs, cockroaches, flies, and bees) are likely to be conscious creatures (Figure 2). The brains of all these animals, which are very different from each other in their structures, can nevertheless do similar things, because the principles of their brain-organization are similar. Although the actual implementation is different, all these animals have complex memory

## OPEN-ENDED LEARNING

Enables discrimination among differently organized sensory and action patterns, flexible evaluation of actions and sensory stimuli and the ability to learn on the basis of past learning. We consider this type of learning as an evolutionary marker of consciousness.

processes, flexible evaluation systems, and can integrate information from many sources.

How long ago did consciousness evolve? The fossil record shows that vertebrates and arthropods first appeared 540 million years ago, during a period called the Cambrian explosion. During this period, many new species evolved and most of the animals on Earth today first appeared. When we examined the fossil brains of the arthropods and vertebrates from the Cambrian Era, we saw that these organisms had the brain organization that supports open-ended learning. Consciousness emerged in mollusks 250 million years later. It seems that consciousness appeared three separate times over the course of evolution.

### WHAT ARE THE MORAL IMPLICATIONS?

If we are correct and many living organisms are conscious, what does this mean, morally? How should we be treating animals? If many kinds of animals are conscious, it means that they are not as different from us as we may have thought. If animals can suffer from pain the same way that humans do, then we believe that humans have the duty to minimize the suffering of other creatures as much as possible. If animals are conscious, then maybe we should do more than just protect them from injury and care for their basic needs like food, water, and shelter; we should also care for their social and emotional needs. For example, if a horse is conscious, then isolating it in a stable is no less cruel than putting a human being in a prison cell! Horses, like humans, are social animals and their need for the company of other horses is as important as our need for the company of other people. Taking care of the emotional needs of animals means that we might have to change the ways that we use animals for food and other consumer products. Realizing that other animals are conscious beings will help us understand that we are part of a rich natural world. Humans are not the masters of the planet, but instead we are part of a web of life and of consciousness that we need to maintain and to respect [5].

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### YITZHAK NAVON SCHOOL OF SCIENCES AND ART, AGES: 10–11

The Yitzhak Navon school is a developing educational institution that was established 5 years ago in a new developing neighborhood. The class that refereed the paper is heterogeneous, including different levels and varieties of linguistic, scientific, and general abilities and levels. Most students in the class, mostly girls, are curious and have high motivation to study.



## AUTHORS

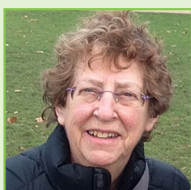
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