Sequential dependencies in perceptual decisions

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In most psychological experiments, observers respond to multiple trials that are presented in a sequence. In perceptual psychology, it is common to assume that these responses are independent of responses on previous trials, as well as of stimuli presented on previous trials. There are, however, multiple reasons to question the ubiquitous assumption of “independent trials” – for example, responses in cognitive experiments depend on previous stimuli and responses, and it is unclear why perceptual tasks should be unaffected by such serial dependencies. This observation raises two central questions: First, how strong are trial by trial dependencies in psychophysical experiments? Second, what are statistical methods that would allow us to detect these dependencies, and to deal with them appropriately?

Here, we present a model that allows for quantification of such trial by trial dependencies and apply it to psychophysical data-sets from perceptual decision tasks. Using multiple data-sets from one auditory and two visual experiments as well as simulated data, we show that our model successfully detects trial by trial dependencies if they are present and allows for a statistical assessment of the significance of these dependencies. Although the strength and direction of trial by trial dependencies varied considerably between observers, significant trial by trial dependencies were observed in 6 out of 7 observers. For those observers, model fits improved considerably if trial by trial history was incorporated into the model. The trial by trial dependencies we observed could be well captured by linear superposition of effects form multiple previous responses and stimuli.

We conclude that previous trials and responses influence responses in perceptual tasks, too.