

The title

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Abstract

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words “**here we show**” or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline.

Keywords: keywords

Word count: X

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Imagine that you are driving down a highway going sixty miles per hour. All of the sudden traffic slows down and you see two police cars pass by. “I guess there was an accident”, you think to yourself as you anticipate a longer commute than expected. You later pass the cars involved, and also arrive twenty minutes late to work. Why did you predict that a car crash had occurred? Why did you predict that you would have a longer commute time? These types of questions are asked by researchers when studying contingency judgements. A contingency judgement can be defined as one’s perception of whether a particular stimulus predicts a particular outcome. The purpose of studying human contingency judgements is to be able to gain a better understanding of the way that people learn about the causal relationships between events (Beckers, 2011).

In order to study this further, we created a model using RStudio. Our model attempts to create a simulated version of memory. Specifically, it focuses on evaluating the percentage of information remembered after cues and outcomes are first presented. The model is first presented a set amount of cues and outcomes, and its “memory” is then checked by “asking” the model to predict whether an outcome will occur given that a cue was presented or not.

Our model is based on the MINERVA 2 framework. MINERVA is founded on the idea that each experience leaves an individual memory trace (Hintzman, 1986). In other words, repeated exposure to the same information creates multiple copies rather than strengthening the same memory. This is called multiple-trace theory. While this theory is assumed for the purposes of this study, many other models attempt to explain how contingency judgments are formed.

Our experiment is based on a research study performed by Crump et al. (2007). While this study involved presenting humans with a contingency task, our computer model attempts to replicate the findings of the study, and expand upon it. The findings of the

original study explain that people are generally normative. In other words, people generally act in an expected way when making contingency judgements, and this is referred to as the ΔP rule (Allan, 1993). For instance, if someone changes the brightness of their phone screen and it becomes brighter, a person will likely be able to tell that an increase occurred rather than a decrease, or no change. This would be expected, or normative, behavior. By the same token, human beings are not robots, and each person has their own biases. These biases result in a departure from expectations during research. This phenomenon is explained by the outcome density effect. This states that when more outcomes occur, they lead participants to more strongly predict that there is a contingency occurring in order to create the outcomes, even if there is not necessarily a true contingency between events. For instance, if someone is shown a circle followed by a square 95% of the time, they are more likely to predict that the circle indicates that a square will be presented later, even if the order was randomly generated and no connection between the two cues was intended.

What psychological mechanisms are involved in making contingency judgements? Several theories can be used to explain the way in which contingency judgements work. One of these is called rule-based theory. This theory looks at people or even animals as intuitive statisticians who extract contingency information by applying formulas (Allan, 1993). In other words, animals and humans act as “calculators” unwittingly. Another theory is associative theory, which looks at contingency learning as a result of Pavlovian associations formed between all previously presented events (Allan, 1993). This is based on the Rescorla-Wagner model of learning, which explains that learning diminishes as the conditioned stimulus becomes more familiar. This makes the case that contingencies are learned through the repeated presentation of stimuli. For instance, in Crump et al. (2007), when a red circle is presented after a blue square, participants learn to associate the circle with the square and form a judgement that the circle is contingent upon the prior presentation of the square. Signal detection theory deals with measuring one’s ability to differentiate between actual information and random patterns that distract from it. Based

on this theory, contingency judgements are formed based on how well one is able to separate noise (random pairings) from actual contingencies.

Several factors may influence whether or not one is able to make an accurate contingency judgement. First, there is a minimum amount of change necessary for one to tell whether something is different from before. For instance, if someone only changes the brightness on their phone by 1% would one be able to notice? There is also a minimum amount of stimulation required in order for someone to be aware that something is happening. Further, noise interference also plays a role. This is anything that distracts the participant in some way while they are trying to focus on the contingency task. Other thoughts, sounds, or objects in sight can create noise in one's memory.

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

Material

Procedure

Data analysis

We used R (Version 4.0.2; R Core Team, 2020) and the R-package *papaja* (Version 0.1.0.9997; Aust & Barth, 2020) for all our analyses.

Results

Discussion

References

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