

Certainty in our choices often a matter of time, study finds

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Credit: Human Brain Project

When faced with making choices, but lack sufficient evidence to guarantee success, our brain uses elapsed time as a proxy for task difficulty to calculate how confident we should be, a team of neuroscientists has found. Their findings, which appear in the journal *Neuron*, help untangle the different factors that contribute to the decision-

making process.

"In our daily lives, we make many decisions," says Roozbeh Kiani, an assistant professor in NYU's Center for Neural Science and one of the study's authors. "Sometimes the [evidence](#) afforded us is strong, enabling us to decide quickly and accurately. Other times, the evidence is lacking; we take longer to decide and tend to be less accurate. Our brain can learn that longer elapsed times are associated with lower accuracy and should mean less [confidence](#).

"Our findings show that our brains use this association to calculate confidence, not just based on the available evidence, but also based on how long it takes to gather the evidence."

"It's an intriguing notion that the brain might convert its data—gathered through the senses—into units of 'degree of belief' by combining evidence and elapsed time," adds co-author Michael Shadlen, MD, a professor of neuroscience at Columbia University, an investigator of the Howard Hughes Medical Institute, and a member of Columbia's Mortimer B. Zuckerman Mind Brain Behavior Institute. "Those same regularities that support the intuition that time might matter also made it challenging to identify time itself as a player and not just a marker for something else, such as accuracy.

"It makes intuitive sense that 'time spent' would serve as a clue about difficulty; proving it in the lab was not easy though. No wonder it took until 2014 to do it!"

It has been established that decisions are usually accompanied by a degree of certainty or confidence, a graded belief that our choices will produce positive outcomes. Confidence plays a critical role in guiding our future behavior in complex environments, especially when decision outcomes are delayed and rapid learning is required.

Less understood, however, is how this certainty is established. Researchers have attributed it to a pair of variables: evidence and decision time. Specifically, if we believe we have sufficient evidence for making a decision, we're more likely to be certain in making a choice. When it comes to time, the quickness of a decision is seen as a reflection of confidence—the more rapidly we make a decision, the more confident we are in making it.

However, it is challenging to separate these two factors as the evidence supporting a specific choice typically affects the time we use to make it.

To address this, the researchers designed an experiment in which the participants were asked to decide on the direction of motion (up or down) in a random-dot motion display—that is, in which direction were the dots headed? Participants answered by making an eye movement to either an up or down horizontal bar, directing their gaze toward one or the other end of the bar to indicate the level of confidence in the decision. The simultaneous expression of choice and confidence ensured that participants were using the same information to guide both aspects of the decision. The researchers controlled the level of difficulty—the noisiness—of the motion and tracked the eye movements to ascertain the choice, amount of time to make the choice, and the confidence in that choice.

Their results showed that, not surprisingly, more evidence boosted the confidence of responses. Moreover, certainty was inversely correlated with reaction times: in other words, the less time it took to make a decision, the more confidence subjects felt about their decisions.

In a second experiment, the researchers dissociated the effect of time and evidence on confidence by manipulating the evidence, so that for a brief period the net evidence was near zero. Subjects increased their decision times to achieve the same level of accuracy as before.

Importantly, however, the reported confidence was lower, indicating that increased decision time can diminish the confidence even in the absence of appreciable changes in accuracy.

"We showed for the first time that the relationship between [decision](#) time and confidence is not fully mediated by evidence—elapsed time plays an independent role," observes Kiani. "In many situations using the elapsed time is advantageous. It offers a computational shortcut and improves the reliability of calculated confidence. However, it also shows that we can dissociate [accuracy](#) and confidence by a manipulation like that used in our experiment."

Provided by New York University

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