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Study measures bias in how we learn and make decisions

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Credit: Human Brain Project

Thinking about drawing to an inside straight or playing another longshot? Just remember that while human decision-making is biased by potential rewards, what we know about individual cues that help us to make those decisions is biased toward failure, a Dartmouth College study finds.

The study appears in the journal *Nature Communications*.

"The type of bias we measured is relevant for learning in situations where rewarding outcomes are rare, for example during gambling," says lead author Alireza Soltani, an assistant professor of psychological and brain sciences. "It would be interesting to study this behavior in pathological gamblers since certain cues are learned to be way more predictive than they are."

The researchers studied how humans learn evidence from different sources of information using reward feedback—probabilistic learning and inference—when these sources are presented simultaneously and don't fully predict the outcome. The researchers also studied how we combine different sources of information to make a final decision. The results show that our ability for such learning and inference is both limited and biased because we inherently cannot separate information about cues from the overall probability of possible outcomes. More specifically, we show contradictory biases when we perform probabilistic decision-making, or the analysis of several possible outcomes using the knowledge of prior events to predict future ones. In other words, although our choice is biased toward the more rewarding or more probable outcome, our inference about the individual cues used to make those decisions are biased toward the less probable or less rewarding outcome.

The researchers related these contradictory biases to learning at the level of the brain's synapses and how learning is modulated by expectation of reward and by attention, or what cues we are attending to at the time of decision-making. The results show that inference does not follow any standard model, where evidence (about each cue) and prior (the probability of either outcome) are combined optimally. Instead, it seems that what we learn about each cue is always contaminated by prior.

"Probabilistic learning and inference is something we do in daily life - for example, you try to guess what caused a stomach ache after eating many food items," Soltani says. "But we are never presented with one cue alone. There are always many cues or we take many actions before we see an outcome. The feedback we get is often binary—success/failure, reward/no-reward—and then we have to connect them and learn about what predicts a rewarding outcome. While it seems that we are good at this task—otherwise we could not function or learn in the complex world we live in—humans show systematic biases in their inference. But in this study, we quantified such biases and showed that they emerge from how we learn and are not reasoning errors as they have been assumed or due to memory shortage."

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