Humans employ forward and backward prediction strategies adaptively in different situations, research suggests

July 31 2024, by Ingrid Fadelli

Credit: Pixabay.

Humans often predict the outcomes of their decisions and actions, as this helps them to make sense of the world around them and navigate their

present circumstances. Many previous psychology studies suggest that humans primarily make forward predictions, which entail forecasting what future events will follow a present event.

Researchers at the Hebrew University of Jerusalem and Yale University recently explored the possibility that, in some situations, humans might instead sometimes deploy backward prediction strategies, which consist in predicting what present events are likely to precede various future events.

Their findings, published in *Nature Human Behaviour*, suggest that forward and backward prediction are used adaptively, based on the setting one is in.

"Our paper was motivated by confronting a core assumption pervading computational modeling literature on planning that didn't square with our intuition about planning from everyday experience," Dr. Paul B. Sharp, co-author of the paper and incoming Assistant Professor at Bar-Ilan University (formerly Yale postdoctoral associate), told Medical Xpress.

"Specifically, most models assume that we only predict from current events to future goals. Everyday experience tells us we plan backward: we imagine inhabiting a destination in the future and work our way back toward our current state in the environment."

Building on this intuition, Dr. Sharp and senior author Eran Eldar set out to develop a computational model that would implement backward prediction, and explain various decision-making processes, including those underpinning complex planning.

The researchers then carried out a series of experiments, which involved adaptations of tasks that are commonly used by cognitive psychologists to study human planning and decision-making.

"These tasks, typically called one- or two-step decision tasks, involve participants learning via experience how actions taken at certain images transition to new images," Dr. Sharp explained.

"Put simply, participants take an action and see which images come after it. They can then predict which images are most likely to follow a given image, or if they predict backward, which past images are likely to precede a current image."

The researchers recruited a total of 1,299 participants and asked them to complete a series of decision-making tasks. These participants completed various experimental trials, during which they gradually learned patterns underlying the sequences of images they were presented with.

"After many trials of learning, participants are told which images, if reached, will give them a large reward," Dr. Sharp said. "They then used the predictions they formed to try to reach that state with reward in a decision phase that comes after the learning phase."

When they analyzed the data they collected, Dr. Sharp and Eldar found that their study participants employed backward and forward prediction strategies in an adaptive way, following a key principle. Specifically, people appeared to deploy whichever prediction strategy was more 'computationally frugal' (i.e., resource-effective) for the decision-making task they were completing.

"We now plan to explore other unanswered questions regarding how subjects first learn backward and forward predictions, and how these are used at decision time to plan," Dr. Sharp said. "For example, do we infer which form of prediction is more frugal during learning, and is that informed by an inference about environmental structure? Or do we learn both forms of prediction, and simply infer during decision-making that

one is more efficient?"

The recent paper by this team of researchers appears to contradict the long-standing assumption that most people predominantly employ forward prediction strategies during decision-making. In the future, it could pave the way for additional psychology studies testing this hypothesis, as well as computer science-based efforts aimed at artificially replicating backward prediction.

"For example, work in AI has shown that backward planning that's used offline (i.e., not during planning, but during rest) to improve decision making is more accurate according to a different principle than the one we pursued," Dr. Sharp added.

"Coming up with a unified model to explain both sets of findings in an empirical study with human participants (the AI work was just a simulation study without any real participants) would advance our understanding of when backward prediction is useful."

More information: Paul B. Sharp et al, Humans adaptively deploy forward and backward prediction, *Nature Human Behaviour* (2024). DOI: 10.1038/s41562-024-01930-8