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How the Brain Learns to Value the Road Not Taken

~ Study that asked people to pick paintings reveals bias in how memories of past decisions influence future decisions. ~

NEW YORK — Like many of us, Natalie Biderman spends a lot of time thinking about her choices. She deliberates about big decisions, such as which university to attend, and small ones, such as what to order at a restaurant.

Now, this graduate student has discovered a bias that affects the choices we make. Her new experiments, published 30 July 2021 in *Nature Communications*, explore how people decide between two things. She found that our opinion about an option we don't pick can be powerfully – even irrationally – influenced by how things turn out for the option we do pick. This extends beyond regret over a bad decision; decisions with good outcomes also affect how we think about the road not taken.

"The very act of deliberation creates a link, in our mind, between the options we are considering, such that we later estimate the value of an unchosen option in opposition to the chosen option," said Biderman of Columbia's Zuckerman Institute and Department of Psychology, first author on the new paper. "If the fish you order at a restaurant tastes good, for example, the salad you decided against might become even less desirable the next time you order – even though it's a perfectly delicious salad."

The work suggests that our memories make lasting connections that affect our choices, perhaps without us even realizing it. Understanding this bias could help us to make better choices in our professional and personal lives.

"Our memories create a rich web of associations that allow us to extract more information from our experiences but sometimes this can also lead us astray," said Daphna Shohamy, PhD, a principal investigator at Columbia's Zuckerman Institute and last author on the paper. "Understanding these associations gives us insight into how our memories of our past serve our future."

An Artful Experiment

Studies of decision-making often focus on reinforcement learning. In this framework, the brain keeps a mental tally of how desirable different things are. Making choices

and learning from the results causes the list in our head to be updated with new values, hopefully helping us get better at picking good things over bad.

But this view does not capture the full complexity of human experience, said Biderman. To dive deeper, she asked study participants to pretend to be art auctioneers. Shown two paintings – a bowl of fruit and a boat on a river, for instance – people had to pick one to sell.

“We chose art because we wanted people to make choices about objects that were memorable and meaningful, but whose real-world value was ambiguous,” said Biderman.

After making a choice, participants were then told the value of the piece they picked. The fruit painting might net $150 or be worth nothing. Importantly, the value of the other piece, the one passed over, was not revealed.

“Previous studies often told people the value of things they don’t choose to see how that informs their decisions,” said Kavli Professor of Brain Science Dr. Shohamy, who is also codirector of Columbia’s Kavli Institute for Brain Science. “By withholding that information, we were able to test whether the act of making a decision creates an association between the choices presented.”

After repeating this process a few times, Biderman changed things up. She then showed people pairs of paintings they had passed over: that boat on the river, say, and a portrait of a man in a hat. When asked to pick one of these options, people should have made random decisions, since no knowledge of what these paintings were worth had been provided.

Instead, the researchers found a pattern: a preference for paintings that had originally been paired with pieces that did not do well. The poor performance of the chosen option seemed to increase the value of the option not chosen. Similarly, paintings whose partner had done well were devalued and picked less often.

Remembrance of Things Painted

The scientists also found that the better people remembered the original pairing, the stronger this bias became. This is in line with previous work from the Shohamy lab, which has highlighted the role of memory in decision-making. The hippocampus, a brain region important for memory, may play a greater role in our choices than previously recognized.

“We expect the hippocampus to be connected to the associations we are seeing in the new study,” said Dr. Shohamy.

Questions remain. Would someone with a damaged hippocampus have a bias when making decisions? Do the associations noted in today’s paper go the other way: Does learning about the road we didn’t take change our opinion of the one we did?

But as she continues her work, Biderman is already looking at her everyday decisions in a new way by keeping in mind the influence of her past experiences.

“Now that I know about this bias, I notice it constantly,” said Biderman. “I like to think that this awareness will help me to make better decisions.”

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This paper is titled “Memory and Decision Making Interact to Shape the Value of Unchosen Options.”

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