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Switching it up: How memory deals with a change in plans

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You're about to leave work at the end of the day when your cell phone rings: it's your spouse, asking that you pick up a gallon of milk on the way home. Before you head out the door, though, your spouse calls again and asks you to stop by the hardware store too. Based on your knowledge of the area and rush-hour traffic, you decide to get the milk first and the toilet plunger second. But whoops! The phone rings again. This time, it's your boss, asking you to work late. That means another change of plans.

Adjusting our behavior to such changing circumstances enables us to achieve our goals. But how, exactly, do our brains switch so elegantly and quickly from one well-entrenched plan to a newer one in reaction to a sudden change in circumstances? In the milk-hardware-boss example, do we simply remember a list of streets and turns, or do we remember a more abstract set of "rules" governing the web of relationships between the items we want to buy, our driving route and our relationships with spouse and employer?

The answer is "both," according to researchers at The Johns Hopkins University, who have learned that two different areas of the brain are responsible for the way human beings handle complex sets of "if-then" rules. The researchers, led by Susan Courtney, associate professor of psychological and brain sciences at the Zanvyl Krieger School of Arts and Sciences, learned that rules that people must actively remember (in other words, which are not part of their everyday habits) are controlled primarily through the prefrontal cortex, which is in the very front of the brain, beneath the forehead.

"This discovery may eventually lead to enhanced understanding of psychiatric diseases such as schizophrenia, obsessive-compulsive disorder and attention deficit disorder, all conditions in which a person's ability to remember and change such rules is impaired," said Courtney, lead author of a paper in a recent issue of *Neuron*.

Courtney and her team used mental math tasks (a good working example of "if-then" rules) and functional magnetic resonance imaging to investigate which areas of the brain are used for different functions. Before beginning the study, participants memorized the numbers 47 and 53 and the operations (rules) "add" and "subtract". Only one of these two numbers and one of those two operations were relevant to any given trial. For example, participants would begin by remembering either 47 or 53 and the instructions to either "add" or "subtract." They then would be given a second number, which they would add to or subtract from the first until instructed to make a change. That change could involve keeping the add or subtract "rule" and switching the number, keeping the number and switching the rule, or switching both the beginning number and the "rule."

Courtney said that if we hold both rule and number in our memory in the same way, then there would be no difference in the pattern of activity when people were asked to switch up the rules compared to when they changed numbers, because both rules and numbers would be in the same place in memory.

But that's not what they found.

Instead, they discovered that the prefrontal cortex became more active when participants had to switch rules, and a different part of the brain – the parietal cortex, which is near the back of the head – became more active when the participants were asked to switch numbers.

"This indicates that different parts of our brains store different kinds of memories and information," Courtney said. That, she said, "provides clues about how the human brain accomplishes complex, goal-directed behaviors that require remembering and changing abstract rules, an ability that is disrupted in many mental illnesses."

Source: Johns Hopkins University