New study proves the brain has three layers of working memory

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Researchers from Rice University and Georgia Institute of Technology have found support for the theory that the brain has three concentric layers of working memory where it stores readily available items. Memory researchers have long debated whether there are two or three layers and what the capacity and function of each layer is.

In a paper in the March issue of the *Journal of Cognitive Psychology,* researchers found that short-term memory is made up of three areas: a core focusing on one active item, a surrounding area holding at least three more active items, and a wider region containing passive items that have been tagged for later retrieval or "put on the back burner." But more importantly, they found that the core region, called the focus of attention, has three roles -- not two as proposed by previous researchers. First, this core focus directs attention to the correct item, which is affected by predictability of input pattern. Then it retrieves the item and subsequently, when needed, updates it.

The researchers, Chandramallika Basak of Rice University and Paul Verhaeghen of Georgia Tech, used simple memory tasks involving colors and shapes on a computer screen to determine the three distinct layers of memory. They also determined the roles of attention focus by exploring the process of switching items in and out of the focus of attention.

In their previous studies, Basak and Verhaeghen discovered that response time for switching in and out of the core focus is not affected

by the number of items stored when the items are input in a predictable pattern.

In this study of 49 participants across two experiments, the researchers found that when no pattern exists, all participants increased their response time by an average of 240 milliseconds per item as more items are stored. This implies that the area outside the focus has to be searched when there is no pattern, even before the item can be retrieved.

However, as evidenced by the previous studies, when participants were given 10 hours of practice in a memory task with a predictable pattern, all of them could enhance the focus of attention to store four items in the focus core. But this focus does not expand when the memory task has no pattern.

"Predictability can free up resources so a person can effectively multitask," said Basak, assistant professor of psychology at Rice and lead author of the study. "When you do the same sequence over and over again, your memory can be partially automatized so you have the ability to do another task concurrently."

This comes naturally, Basak said. For instance, as you drive the usual route to your regular grocery store, you might also be thinking about what to fix for dinner and making a grocery list. That same secondary task -- the grocery list -- becomes more of a challenge when driving to a different grocery store using an unfamiliar route.

Another facet of the study showed that the third level of memory -- the region containing passive items -- is not only separate from the other two areas of active storage but has a firewall between them. The number of passive items does not influence either response time or accuracy for recalling active items.

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