

MU psychologists demonstrate simplicity of working memory

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A mind is a terrible thing to waste, but humans may have even less to work with than previously thought. University of Missouri researchers found that the average person can keep just three or four things in their “working memory” or conscious mind at one time. This finding may lead to better ways to assess and help people with attention-deficit and focus difficulties, improve classroom performance and enhance test scores.

“Most people believe the human mind is incredibly complex,” said Jeff Rouder, associate professor of psychology in the MU College of Arts and Science. “We were able to use a relatively simple experiment and look at how many objects can be in maintained in the human conscious mind at any one time. We found that every person has the capacity to hold a certain number of objects in his or her mind. Working memory is like the number of memory registers in a computer. Every object takes one register and each individual has a fixed number of registers. Limits in working memory are important because working memory is the mental process of holding information in a short-term, readily accessible, easily manipulated form where it can be combined, rearranged and stored more productively.”

“We know that this kind of memory is really important in daily life,” said co-author Nelson Cowan, psychology professor at Mizzou and an expert in working memory theory. “If a person is trying to do a math problem, there are partial results to keep in mind as that person solves the problem. When people are going to do any tasks in the house—like remembering the location of keys, turning off the stove, combining

ingredients for a cake or recalling a phone number—they use working memory to keep in mind all the different aspects of the tasks.”

Rouder said that to remember a series of items, people will use “chunking,” or grouping, to put together different items. It can be difficult for someone to remember nine random letters. But if that same person is asked to remember nine letters organized in acronyms, IBM-CIA-FBI, for example, the person only has to use three slots in working memory. The difficulty in measuring working memory capacity is assuring that each item presented cannot be grouped together with others to form a larger chunk.

The researchers conducted a simple experiment involving an array of small, scattered, different-colored squares, to test their theory of working memory. The participant saw two, five or eight squares in the array, depending on the trial. The array was then “wiped out” by another display consisting of the same squares, minus the colors. Finally, the participant was shown a single color in one location and was asked to indicate whether the color in that spot had changed from the original array.

“How an individual does this test depends on working memory,” Cowan said. “The results indicating that people have a fixed capacity provide evidence of simplicity in the mind. Many other theorists have suggested that the amount of working memory is circumstance-dependent, depends on a particular test, that there is nothing general we can get out of it, and that it’s complex. We found the mind to be less complex in this case and that should be of great use in the future.”

Working memory is closely related to attention because it requires attention to hold a number of items in mind at once. People with high working memory capacity have more focus. Those with a lower attention span are more easily distracted. This fact may help researchers help

people with attention deficit disorders.

The researchers emphasized that the unique result of their study was that “the data were explained to surprising accuracy by a very simple mental model in which participants either used a register of working memory or, if all registers were full, guessed randomly.”

Rouder and Cowan’s study, “An assessment of fixed-capacity models of visual working memory,” was published this month in the *Proceedings of the National Academy of Sciences*.

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