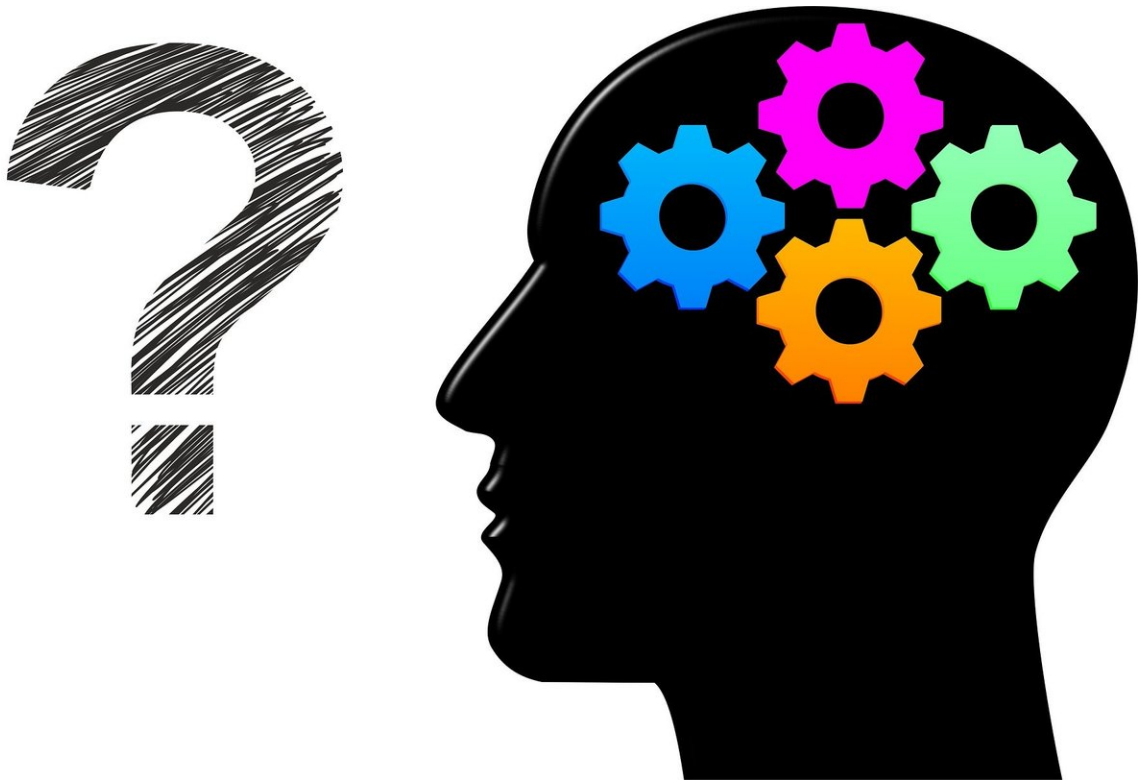
Study investigates the best way to memorize details

March 12 2024



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Recent experiments by psychologists at Temple University and the University of Pittsburgh shed new light on how we learn and how we remember our real-world experiences.

The research, described in *Proceedings of the National Academy of Sciences* (*PNAS*), suggests that varying what we study and spacing out our learning over time can both be helpful for memory—it just depends on what we're trying to remember.

"Lots of prior research has shown that learning and memory benefit from spacing study sessions out," said Benjamin Rottman, an associate professor of psychology and director of the Causal Learning and Decision-Making Lab at Pitt.

"For example, if you cram the night before a test, you might remember the information the next day for the test, but you will probably forget it fairly soon," he added. "In contrast, if you study the material on different days leading up to the test, you will be more likely to recall it for a longer period of time."

But while the "spacing effect" is one of the most replicated findings in psychological research, much of this work has been predicated on the idea that what you are trying to learn—the content of the experience itself—repeats identically each time. Yet that is rarely the case in real life, when some features of our experiences may stay the same, but others are likely to change. For example, imagine repeat trips to your local coffeeshop. While many features may stay the same on each visit, a new barista may be serving you. How does the spacing effect work in light of such variation across experiences?

In two experiments, Temple and Pitt researchers asked participants to repeatedly study pairs of items and scenes that were either identical on each repetition or in which the item stayed the same but the scene changed each time.

One of the experiments asked participants to learn and to test their memory via their smartphones—an unusual approach for learning and

memory research. This enabled researchers to ask participants to learn information pairs at various times of the day across 24 hours, more accurately representing how people actually learn information.

In the second experiment, researchers collected data online in a single session.

Emily Cowan, lead author on the *PNAS* paper and a postdoctoral fellow in Temple's Adaptive Memory Lab, explained, "The combination of these two large-scale experiments allowed us to look at the timing of these 'spacing effects' across both long timescales—for example, hours to days—in Experiment No. 1 versus short timescales—for example, seconds to minutes—in Experiment No. 2.

"With this, we were able to ask how memory is impacted both by what is being learned—whether that is an exact repetition or instead, contains variations or changes—as well as when it is learned over repeated study opportunities.

"In other words, using these two designs, we could examine how having material that more closely resembles our experiences of repetition in the real world—where some aspects stay the same but others differ—impacts memory if you are exposed to that information in quick succession versus over longer intervals… from seconds to minutes, or hours to days."

As in prior experiments, researchers found that spaced learning benefited item memory. But they also found that memory was better for the items that had been paired with different scenes compared with those shown with the same scene each time. For example, if you want to remember a new person's name, repeating the name but associating it with different information about the person can actually be helpful.

"In contrast," Rottman said, "we found that for associative memory—memory for the item and which scene it was paired with—benefited from stability. Spacing only benefited memory for the pairs that were repeated exactly, and only if there were pretty long gaps—hours to days—between study opportunities. For example, if you are trying to remember the new person's name and something about them, like their favorite food, it is more helpful to repeat that same exact name-food pairing multiple times with spacing between each."

The Pitt-Temple experiments represent basic memory research. "Because of how nuanced memory is, it is hard to provide clear advice for things like studying for a test because the sort of material can be so different," Rottman said. "But in theory our findings should be broadly relevant to different sorts of tasks, like remembering someone's name and things about them, studying for a test, and learning new vocabulary in a foreign language.

"At the same time, because all these sorts of tasks have lots of differences, it is hard to make really concrete advice for them. We would need to do follow-up research to provide more concrete guidance for each case."

Cowan continued, "This work demonstrates the benefits of spaced learning on memory are not absolute, instead depending on the variability present in the content across repetitions and the timing between learning opportunities, expanding our current understanding of how the way in which we learn information can impact how it is remembered. Our work suggests that both variability and spacing may present methods to improve our memory for isolated features and associative information, respectively, raising important applications for future research, education, and our everyday lives."

In addition to Cowan and Rottman, study investigators included Vishnu

"Deepu" Murty, principal investigator of Temple's Adaptive Memory Lab, and Yiwen Zhang, a graduate student in cognitive psychology at Pitt.

More information: Emily T. Cowan et al, The effects of mnemonic variability and spacing on memory over multiple timescales, *Proceedings of the National Academy of Sciences* (2024). DOI: 10.1073/pnas.2311077121

Provided by University of Pittsburgh