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The Smart Way to Study

UC San Diego Researchers Report on How to Improve Long-Term Learning

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Combine the aphorisms that "practice makes perfect" and "timing is everything" into one and you might get something resembling findings published in this month's issue of *Psychological Science.* Proper spacing of lessons, the researchers report, can dramatically enhance learning. And larger gaps between study sessions result in better recall of facts.

Conversely: Cramming - whether it's math for a midterm or a foreign language in anticipation of a trip abroad - is not effective in the long haul.

Led by Hal Pashler and John Wixted, professors of psychology at UC San Diego, the study has implications for education.

In light of the study, the coauthors write, "it appears no longer premature for psychologists to offer some rough practical guidelines to those who wish to use study time in the most efficient way possible to promote long-term retention."

More than 1,000 subjects participated in three sessions. In the first session, they were taught a set of such obscure but true facts as Norway is the European nation that consumes the most spicy Mexican food and Rudyard Kipling invented snow golf. The second session was a review of the same facts. The time between the sessions ranged from several minutes to several months. Study time was held constant in all the conditions. After some further delay, up to about one year, subjects were then tested.

Not surprisingly, when the interval between the second session and the test was increased, memory got worse - reflecting the familiar curve of forgetting. The interesting finding, however, was that increasing the time between the study sessions reduced the rate of forgetting. This reduction in forgetting was very large - sometimes increasing the likelihood that information would be recalled in the final session by 50 percent.

"The finding that greater spacing between study sessions can enhance later memory was expected, given prior research going back over a century. The results of our study revealed a number of new facts that were not known, however," said Pashler, who heads the Attention and Perception Lab at UCSD. "First, the study used much longer time intervals than in prior research, and it turned out that effects were larger than those seen in earlier studies using much shorter time periods. Second, the results showed that there is an optimal value for the delay between the initial study and the final test, and that this optimal delay varies with the final retention interval: the longer the final retention interval, the longer the optimum delay between study and review."

The results suggest, Pashler said, the optimal amount of time over which learning should take place depends upon how long the information needs to be retained: "If you want to remember information for just a week, it is probably best if study sessions are spaced out over a day or two. On the other hand, if you want to remember information for a year, it is best for learning to be spaced out over about a month."

Extrapolating from the results, he added, "it seems plausible that whenever the goal is for someone to remember information over a lifetime, it is probably best for them to be re-exposed to it over a number of years."

"The results imply," said Pashler, "that instruction that packs a lot of learning into a short period is likely to be extremely inefficient, at least for remembering factual information."

In a general way, Pashler said, the results also support the use of software designed to provide spaced review, such as the open-source Mnemosyne Project.

Coauthors of the paper are Nicholas Cepeda of York University and UC San Diego, Doug Rohrer of the University of South Florida, and Edward Vul of UC San Diego and MIT.

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