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A blind spot in motor learning

Practicing different skills in separate, concentrated blocks triggers people to be overconfident about how well they've learned motor skills, according to new research.

"The implications of the new findings are universal. In many situations, the way that we think is the best way to learn is not, in fact, the ideal way."

-- Bennett Schwartz Florida International University

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Among surgeons and carpenters, athletes and algebra students, it is a truism that practice makes perfect. But research has also shown that how such practice is structured makes an important impact on how well people retain what they have learned.

According to a new study, however, that is a principle that most laypeople fail to recognize.

The study, published in the July issue of APA's *Journal of Experimental Psychology: Learning, Memory and Cognition* (Vol. 27, No. 4), confirms--as earlier research on both verbal and motor learning has indicated--that practicing several different skills in separate, concentrated blocks leads to better performance during practice than does interleaving the practice trials on those separate skills. But in the longterm, interleaved practice leads to better learning than does blocked practice.

However, the research indicates, the temporary boost that blocked practice provides prompts people to overestimate how well they have learned the skills they practiced.

"People are often poor assessors of what they have learned," concludes the study's first author, cognitive psychologist Dominic A. Simon, PhD, a postdoctoral fellow in the department of kinesiology at McMaster University in Hamilton, Ontario. "They often base their expectations of future performance on their performance now."

If people are making judgments about whether they're prepared to do something, they might make a decision that would be wrong, explains Simon. In some circumstances, that's not too bad, he says, but in others--say, in trying to tie off a suture during surgery--the consequences can be serious.

The fact that blocked practice leads to better short-term performance but poorer long-term learning "has great potential to fool teachers, trainers and instructors, as well as students and trainees themselves," adds co-author Robert A. Bjork, PhD, of the University of California, Los Angeles.

"It's natural to think that when we're making progress, we're learning, and when we're struggling and making errors, we're not learning as well," he says. "So people who are responsible for training can often be pushed toward training conditions that are far from optimal."

Blocked v. random practice

For decades, psychologists have known that on both verbal learning and motor tasks, practice trials that are distributed across time or interleaved with other tasks, rather than massed together, yield better long-term retention. However, especially in motor learning, few studies have examined how accurate people are at judging their own learning.

To test how people's learning squares with their sense of how well they have learned--that is, their "metacognitions"--Simon and Bjork assigned 48 participants to practice typing three different five-key sequences on the number pad of a computer keyboard. Participants were instructed that they should try to complete each of the three sequences as closely as possible to a specified goal movement time, which was different for each sequence.

Half the participants were assigned to a "blocked practice" condition, in which they practiced the three key sequences, each in a separate block, until they had correctly

completed each sequence 30 times. The remaining participants were assigned to a "random practice" condition, in which the three patterns were randomly interleaved. In both conditions, participants received feedback about their performance accuracy and speed after each trial.

Periodically during this practice phase of the experiment, participants were asked to indicate how well they thought they had learned the key sequences by predicting how well they would perform the same sequences on a retention test the next day. When they returned the next day, they first took a paper-and-pencil test of how well they remembered the three keystroke sequences and their associated goal movement times. Then, they predicted how well they would perform on each of the patterns. Finally, participants took a retention test, performing each of the key sequences six times--half in a blocked order, and half in a random order.

As the researchers expected, during the practice phase of the experiment, participants in the blocked practice condition performed better than did those in the random practice condition, especially early on during practice.

Of greatest interest to Simon and Bjork, however, were participants' predictions about their own learning, or their metacognitions. The team found that, both during the practice phase and immediately before taking the retention test the next day, participants in the blocked practice condition expected to perform better on the retention test--reflecting better learning of the motor sequences--than did participants in the random practice condition.

In fact, however, such optimism was unfounded. One day after the practice session, participants in the blocked practice condition performed substantially worse than did those in the random practice condition, on both the paper-and-pencil test of their recall of the motor sequences and the timed performance test. In contrast, participants in the random practice condition were quite accurate in predicting how well they would retain what they had learned.

It remains uncertain exactly why blocked

practice leads to greater immediate gains but lesser long-term learning than does random practice. One idea is that random practice requires people to repeatedly "reload" the motor program corresponding to each task, which aids the later retrieval of that program. Another idea is that random practice requires that the several skills be differentiated in terms of their similarities and differences, resulting in a mental conceptualization that supports retention of those skills. In contrast, explains Bjork, blocked practice encourages people to make trial-by-trial adjustments, which enhance current performance but do not induce retrieval processes and conceptual categorization of the types that enhance learning.

"The problem," says Bjork, "is that if people confuse the current sense of ease with learning, they'll tend to prefer training conditions where things are kept constant and predictable--conditions that act as crutches to prop up performance without fostering learning."

Call for a training overhaul

Now that metacognitive weakness in motor learning has been demonstrated in the laboratory, it will be important to extend the finding to more real-world tasks and over a period longer than one day, remarks Florida International University cognitive psychologist Bennett Schwartz, PhD. But even this initial finding, he says, helps to underscore what is wrong with education and training across a vast range of areas.

"The implications of the new findings are universal," he argues. "In many situations, the way that we think is the best way to learn is not, in fact, the ideal way."

Simon agrees, "These are everyday issues for a lot of different training situations, whether you're a surgeon, a basketball player, a fighter pilot or a carpenter."

Experimental psychologist Harry P. Bahrick, PhD, of Ohio Wesleyan University, argues that the findings have especially important implications for the nation's educational system.

"Most schools are interested in high test scores and in reaching them in an efficient way," he says.

But, he says, Simon and Bjork's research highlights that "the value of knowledge depends on its longevity. If it goes in one ear and out the other, you've wasted your time--and our schools don't pay any attention to that at all."

What this study does better than any other, he says, is to show why we stay with these counterproductive educational and training practices. "It's because our expectation is counterfactual."

This article is part of the Monitor's "Science Watch" series, which reports news from APA's journals.

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