

Being Suspicious of the Sense of Ease and Undeterred by the Sense of Difficulty: Looking Back at Schmidt and Bjork (1992)

Perspectives on Psychological Science
2018, Vol. 13(2) 146–148
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sagepub.com/journalsPermissions.nav
DOI: 10.1177/1745691617690642
www.psychologicalscience.org/PPS


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Abstract

Richard Schmidt and I titled our article “New Conceptualizations of Practice: Common Principles in Three Paradigms Suggest New Concepts for Training” to reflect our view that prevailing ideas about how to optimize teaching, learning, and practicing were, in our words, “at best incomplete, and at worst incorrect.” We argued that teachers and trainers were susceptible to being misled by two commonsense assumptions—namely, that procedures that enhance performance during training are the procedures of choice and that the context of training needs to match in detail the posttraining context that is the target of training. A variety of then-recent experimental findings challenged both assumptions and demonstrated, in particular, that procedures posing certain difficulties and appearing to slow the rate of learning often enhanced long-term retention and transfer of to-be-learned skills and knowledge. Given the parallel nature of such findings for both motor and verbal learning, we concluded that principles of considerable generality could be deduced to upgrade teaching and training.

Keywords

education, memory, learning, associative

A year or so prior to the appearance of our 1992 article, Richard Schmidt and I cotaught a graduate seminar that attracted both kinesiology students who had interests in optimizing motor skills and psychology students who had interests in optimizing verbal/conceptual learning. I do not remember the title of the seminar, but our goal was to delve into what research had to say about the key differences between the conditions of training/instruction that might optimize movement learning (Richard Schmidt’s area) versus the conditions of training/instruction that might optimize verbal/conceptual learning (my area). What I do remember clearly from the seminar, even 25 years later, is that Dick and I talked too much and the students too little. The two of us became excited about the similarities, rather than the differences, that emerged when some differences in research methodologies and terminologies were stripped away, which led us to go back and forth, frequently forgetting to involve the students in the discussion.

After the seminar we decided that if some important similarities had not been obvious to us, they were probably not obvious to others as well, and we decided to submit an article to the Association for Psychological Science’s new journal, *Psychological Science*, which its first

editor, William Estes, hoped might serve the field of psychological science in the way the journal *Science* had served scientific research more generally. We did not, of course, predict that *Psychological Science* would become such a success and become so influential in our field, but we thought Estes would be the perfect editor for our article, given his own research—dating back to the 1950s—on optimizing learning, in both human and non-human animals.

The Potential for Teachers and Trainers to Get Fooled

The basic thrust of our article, which we titled “New Conceptualizations of Practice,” was—to quote from the abstract—“that typical training procedures are far from optimal [with respect to] two aspects of posttraining performance: (a) the level of performance in the long term and (b) the capability to transfer that training to related tasks

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and altered contexts” (p. 207). We argued that individuals responsible for training are susceptible to assuming that procedures that enhance performance and speed improvement during training are the procedures of choice with respect to achieving those two goals, but that “a variety of experiments on motor and verbal learning indicate that this assumption is often incorrect.” We stressed that the existence of “parallel findings in the motor and verbal domains suggests that principles of considerable generality can be deduced to upgrade training procedures” (p. 207).

In the article itself we went on to show, in both the motor-skills and verbal-learning domains, how three different manipulations of the conditions of practice that appear to create difficulties for the learner, slowing the apparent rate of learning, can actually enhance long-term retention and transfer. Those three are interleaving, rather than blocking, practice on separate components of to-be-learned tasks; providing intermittent/summarized feedback, rather than continuous/immediate feedback, during practice; and introducing variation in the task to be learned, rather than keeping the task constant and predictable.

Our article was actually strengthened when William Estes raised a potentially problematic issue—namely, whether the overlap between the objective acquisition and test conditions might be the critical variable for learning, not the other dynamics we suggested. More specifically, he asked—in reference to some animal-research findings—whether the conditions of practice that appeared to create difficulties and slow the rate of learning might simply have had more overlap with the delayed final-test conditions, which would then enhance transfer. That very good question actually led us, ultimately, to think that our results were even more important than we had thought because, as we reported in the article, there were a number of experiments in which introducing difficulties enhanced later performance even when the final-test conditions matched the easier of the practice conditions. On the basis of those findings and other considerations, we suggested a refinement of the transfer-appropriate-processing principle (Bransford, Franks, Morris, & Stein, 1979)—namely, that the key consideration is not the superficial overlap of acquisition and final-test conditions, but, instead, the overlap of the processes necessary to perform well on a final test and the processes exercised during the acquisition process. We summarized the point as follows:

Random practice, reduced feedback, and variable practice all degrade performance during practice relative to more “ideal” conditions in acquisition, yet all can be argued to exercise information processing activities that are critical for performance at the test. In other words, these conditions can be considered as effective for learning because they prepare the learner for the processing that will be required at test. (p. 215)

The Potential of Learners Themselves to Be Fooled

Spurred on both by the kind of findings Richard Schmidt and I reported and by a broad review of related findings that Robert Christina and I (Christina & Bjork, 1991) wrote for a National Research Council volume on enhancing human performance, I then became interested in the extent to which learners, themselves, could be fooled by their own performance. That is, might they also be vulnerable to choosing or preferring conditions of learning or practice that produced better performance, or might they somehow realize that such conditions may not enhance learning?

In short, would learners interpret current performance as a valid measure of learning? The answer was definitely yes: Various subsequent experiments employing meta-cognitive judgments of various kinds demonstrated that participants indeed often interpreted current performance as a valid measure of learning, leading them to both mispredict their later performance on some criterion test and/or choose less effective conditions of instruction or practice over more effective conditions.

Some of the early such findings led me to write an article titled “Memory and Metamemory Considerations in the Training of Human Beings” (R. A. Bjork, 1994), an article in which I introduced the term *desirable difficulties*. Such difficulties include varying the conditions of practice, versus keeping them constant and predictable; using tests, rather than presentations, as learning events; spacing, rather than massing, repeated study opportunities; and introducing “contextual interference” (Battig, 1979) by, for example, interleaving, rather than blocking, the instruction on or practice of the separate components of a given to-be-learned skill, procedure, or concept. They are “difficulties” because they often pose challenges for learners and slow the rate of apparent learning. They are “desirable” because contending with them—successfully—can engage the very encoding and retrieval processes that support long-term retention and transfer, as measured by a later test. As Elizabeth Bjork and I emphasized, though, the word *desirable* is important (E. L. Bjork & Bjork, 2014): If a learner does not have the background knowledge or skills to respond successfully to a given difficulty, it becomes an undesirable difficulty.

Why Did Our Article Have So Much Impact?

For this series of commentaries, the authors were asked by the editor to reflect on a number of issues/questions, including “why you believe the article has had so much impact on the field.” Looking back, I think one reason is quite straightforward: Across the 25 years since the appearance of our article, each of the three “research paradigms” we referred to in our title—that is, interleaving

(rather than blocking) practice, providing intermittent (rather than continuous) feedback, and introducing variation in the task to be learned (rather than keeping the task constant)—became increasingly active research areas and many of the publications in those domains cite the Schmidt and Bjork (1992) article. Research in these three domains represent some of the (relatively rare) instances in which laboratory findings have captured the attention of educators, instructors, and coaches operating in the real world and have led to advances in the teaching and training of a variety of everyday skills.

Other reasons our article has had a substantial impact are more general, including the very reason we thought it was important to submit our article for publication—namely, that we, ourselves, were surprised that there were findings and principles that generalized so well across the motor-skills and verbal-learning domains. Much of the research we summarized had appeared in journals that were contributed to and read by separate audiences. That there were “common principles” meant that our arguments and the findings we summarized were broadly applicable to learning and practicing skills and procedures, to upgrading education, and to optimizing self-regulated learning in multiple domains. In fact, the impact of our article was broader than we anticipated: Investigators and practitioners in other areas saw potential applications of our “common principles” to clinical and medical contexts, to children’s learning, to business environments, and to language training, among other domains.

A final contribution of our article that led to its having an impact is, in my opinion, that we emphasized the critical importance of the distinction between learning and performance, a distinction that traces back to animal-learning and motor-learning research in the 1930s to 1950s (for an “integrative review,” see Soderstrom & Bjork, 2015, in this journal). As emphasized all those years ago, but intermittently forgotten during the intervening years, performance during the acquisition process can be measured, but learning—as measured by performance after a delay and/or in a different context—must be inferred. The 1930s to 1950s research demonstrated that considerable learning could happen during a period when there were no changes in performance. The research we summarized supported that generalization, but also demonstrated that the converse is true as well: Marked improvements in performance during an acquisition phase can be accompanied by little or no learning.

Schema theory, the myth of “muscle memory,” and the legacy of Richard Schmidt

Richard Schmidt, who died on October 1, 2015, left a considerable legacy. His “schema-theory” article in the *Psychological Review* (Schmidt, 1975) is a citation classic, and the textbook he wrote on motor control and

learning, now in its fifth edition (Schmidt & Lee, 2011), is the bible in that field. Within the field of motor-learning research, he was very influential in stressing the importance of the distinction between learning and performance and his motor-schema theory provides a general framework for understanding why the “new conceptualizations” of practice the two of us argued for in 1992 are both so unintuitive and so important. His altogether convincing arguments and evidence that motor skills are represented in a schematic way in the brain help to clarify not only why the notion of “muscle memory,” which leads to the misguided idea that repetitive practice will stamp skills into our muscles, is so wrong, but also why manipulations such as interleaving, variation, and reducing feedback during training can enhance long-term retention and transfer of to-be-learned skills.

Acknowledgments

My thanks to Tim Lee, Elizabeth Bjork, and Robert Christina for valuable suggestions with respect to this article.

Declaration of Conflicting Interests

The author(s) declared that there were no conflicts of interest with respect to the authorship or the publication of this article.

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