Memory: from the laboratory to everyday life

Daniel L. Schacter, PhD

Abstract

One of the key goals of memory research is to develop a basic understanding of the nature and characteristics of memory processes and systems. Another important goal is to develop useful applications of basic research to everyday life. This editorial considers two lines of work that illustrate some of the prospects for applying memory research to everyday life: interpolated quizzing to enhance learning in educational settings, and specificity training to enhance memory and associated functions in individuals who have difficulties remembering details of their past experiences.

Keywords: *memory; memory specificity; episodic simulation; neuroimaging; online learning; interpolated testing; mind wandering*

Author affiliations: Department of Psychology, Harvard University, Cambridge, Massachusetts, USA

Address for correspondence: Daniel L. Schacter, Department of Psychology, Harvard University, Cambridge, MA 02138, USA
(e-mail: dls@wjh.harvard.edu)

The study of memory has progressed rapidly over the past few decades, and as illustrated by the papers in the current issue, it remains a thriving endeavor with many exciting new discoveries and ideas. But memory is not only a target for laboratory study; it is also fundamentally important in many domains of everyday life. This point is nicely illustrated by several articles in this volume addressing memory changes in neurological and psychiatric conditions that can have a profound impact on an individual's ability to function in daily life. Memory research has also been applied extensively in legal settings, where such issues as how to construct effective lineups and how to deal with the inaccuracy of eyewitness testimony are of paramount importance.[1,2] In this editorial, I discuss briefly some recent applications of memory research in educational and clinical settings that show promise for providing meaningful benefits in everyday life.

Enhancing attention and memory in educational settings

During the past several years, a rapidly expanding number of studies have attempted to apply principles and methods of cognitive psychology to educational settings. For example, one basic question concerns whether memory research can be used to increase the effectiveness with which students study for exams. In a recent comprehensive review, Dunlosky and colleagues[3] evaluated the effectiveness of ten different study methods, and characterized each one as being of either high, moderate, or low utility based on available research. Some of the popular methods commonly embraced by students—including rereading, summarizing, and highlighting—received low utility assessments. Only two techniques, both supported by data from numerous laboratory studies, received high utility assessments: distributed study, which involves spreading out study activities so that more time intervenes between repetitions of the to-be-learned information (as opposed to mass study or "cramming"), and practice testing, where students are intermittently given brief quizzes about what they have learned prior to taking a formal test.

The beneficial effects of practice testing for students are based mainly on studies demonstrating that the act of retrieving information can be a highly effective means of strengthening memory for the retrieved information.[4] Recent work in my laboratory has used a variant of the practice testing technique in an attempt to enhance attention and memory during video recorded lectures.[5] Students frequently experience lapses of attention both during classroom[6] and video[7] lectures. For example, when probed during either a classroom or online lecture regarding whether they are attending to the lecture or mind wandering to other topics, students indicated on approximately 40% of probes that they were mind wandering; not surprisingly, the extent of mind wandering was negatively correlated with retention of lecture content.[6-8]

Our study[5] focused on video recorded lectures because they are a key element in online education, which has exploded during recent years, partly as a result of the development of massive open online courses (MOOCs). Consequently, understanding how to enhance learning from video lectures could have important implications for online education. Participants watched a 21-minute video recorded statistics lecture divided into four equal segments. After each lecture segment, all participants did math problems for a minute, after which the tested group received brief quizzes on each lecture segment that took about 2 minutes each; the nontested group continued to work on math problems for an additional 2 minutes and only received a test for the final segment; and the re-study group was shown, but not tested on, the same material as the tested group for each of the segments preceding the final segment. After the final lecture segment, all three groups received a quiz for that segment, and a few minutes later they also received a final test for the entire lecture. At random times during the lecture, participants in all groups were probed about whether they were paying attention to the lecture or mind wandering off to other topics.

Participants in the nontested and re-study groups indicated that they were mind wandering in response to about 40% of the probes, but the incidence of mind wandering was cut in half, to about 20%, in the tested group. Moreover, participants in the tested group retained significantly more information from the final segment of the lecture than did participants in the other two groups, and they also retained significantly more information on the final test of the entire lecture than did the other groups. While it is encouraging that interpolated quizzing can dramatically reduce the incidence of mind wandering and increase retention, the results reported must be treated with some caution, both because they were obtained only with a single lecture on a single topic, and also because it is unclear whether the benefits of interpolated quizzing persist across multiple lectures or in actual online (or live) classes. There is reason for optimism, however, because other kinds of practice testing have produced increased learning in classroom settings.[9]

Increasing the specificity of memory

Consider next some recent research concerning a phenomenon that has been associated with a variety of troublesome symptoms in depressed individuals: reduced specificity of autobiographical memories. Several studies have shown that when asked to recall memories of everyday life experiences, depressed individuals tend to provide less specific detail about what happened during those experiences than do nondepressed controls.[10] This reduced specificity has been linked with problems such as excessive rumination and difficulties handling everyday interpersonal situations.[10-12] In light of these findings, a natural question concerns whether it is possible to increase memory specificity in depressed individuals, and whether such increases are associated with improvements in any of the problematic symptoms that had been linked with reduced memory specificity in previous research.

Recent studies[13,14] have addressed this question by demonstrating that several sessions of training that attempts to boost the specificity of memory retrieval in depressed patients (ie, practice with feedback in generating detailed, specific memories) increases the post-training specificity of patients' autobiographical memories, even when controlling for associated improvements in depression. Neshat-Doost et al[13] reported that the gains from specificity training were maintained at a 2-month follow-up, and no improvements were evident in a control group. Raes et al[14] showed that increases in memory specificity after training were associated with improvements in everyday social problem solving and rumination. Although further research needs to be carried out to pinpoint exactly what features of memory specificity training are responsible for the observed improvements, the results to date are encouraging, and highlight how basic knowledge of the memory characteristics of a clinical population can be used to formulate an effective intervention.

Targeting autobiographical memory specificity seems especially useful because a growing number of studies have emphasized that autobiographical or episodic memory is used not just as a basis for remembering past experiences, but also for imagining possible future experiences[15] and related functions such as personal and social problem solving.[16-19] Consistent with these findings, recent research in our lab provides evidence that an induction aimed at increasing memory specificity in young and old adults had beneficial effects on both groups' performance of subsequent tasks that required either remembering past experiences or imagining possible future experiences.[20] Importantly, the effects of the induction were selective in two ways. First, the specificity induction (compared with a control induction) produced increases in the number of episodic details (eg, who, what, where, when) that participants remembered or imagined, but had no effect on the number of remembered or imagined semantic details (eg, general facts, commentary, impressions). Second, the influence of the specificity induction was restricted to memory and imagination tasks; it had no effect on a task that required participants to describe a picture of an everyday scene. These findings suggest that the induction targeted episodic memory in particular, and more generally, that specificity inductions can be used as experimental tools to distinguish among cognitive processes and representations that contribute to memory and related functions.

Concluding comments

The research reviewed in the preceding sections highlights ways in which memory research can be applied to educational and clinical settings. An important next step for this kind of research will be to investigate the neural mechanisms that mediate the observed effects on cognitive processes. How can we characterize the neural changes associated with improved attention and memory as a result of interpolated quizzing during lectures? What kinds of changes in brain activity are associated with the improvements produced by memory specificity training and how can they help to pinpoint the specific processes that are affected? Recent work in the domain of cognitive control has revealed that extensive training on a video game that requires multitasking skills led not only to improved cognitive performance in individuals ranging in age from their 20s to their 70s, but also to associated changes in brain activity that were predictive of cognitive improvements 6 months later.[21] Moreover, the study also yielded evidence that training served to remediate age-related deficits in neural markers of cognitive control. Applying such a cognitive neuroscience approach to the phenomena considered here should enhance our understanding of both theoretical and applied aspects of memory function. ❑

REFERENCES

1. Schacter DL, Loftus EF. Memory and law: what can cognitive neuroscience contribute? *Nat Neurosci*. 2013;16:119-123.
2. Semmler C, Brewer N. Eyewitness memory. In: Brown J, Campbell E, eds. *The Cambridge Handbook of Forensic Psychology*. Cambridge, UK: Cambridge University Press; 2010:49-57.
3. Dunlosky J, Rawson KA, Marsh EJ, Nathan MJ, Willingham DT. Improving students' learning with effective learning techniques: promising directions from cognitive and educational psychology. *Psychol Sci Public Interest*. 2013;14:4-58.
4. Karpicke J. Retrieval-based learning: active retrieval promotes meaningful learning. *Curr Dir Psychol Sci*. 2012;21:157-163.
5. Szpunar KK, Kahn NY, Schacter DL. Interpolated memory tests reduce mind wandering and improve learning of online lectures. *Proc Natl Acad Sci U S A*. 2013;110: 6313-6317.
6. Bunce DM, Flens EA, Neiles KY. How long can students pay attention in class? A study of student attention decline using clickers. *J Chem Ed*. 2010;87:1438-1443.
7. Risko EF, Anderson N, Sarwal A, Engelhardt M, Kingstone A. Everyday attention: variation in mind wandering and memory in a lecture. *Appl Cogn Psychol*. 2012;26: 234-242.
8. Szpunar KK, Moulton ST, Schacter DL. Mind wandering and education: from the classroom to online learning. *Front Psychol*. 2013;4:495.
9. McDaniel MA, Agarwal PK, Huelser BJ, McDermott KB, Roediger HL III. Test-enhanced learning in a middle school science classroom: the effects of quiz frequency and placement. *J Educ Psychol*. 2011;103: 399-414.
10. Williams JMG, Barnhofer T, Crane C, et al. Autobiographical memory specificity and emotional disorder. *Psychol Bull*. 2007;133:122-148.
11. Raes F, Hermans D, Williams JMG, et al. Reduced specificity of autobiographical memories: a mediator between rumination and ineffective problem solving in major depression? *J Affect Disord*. 2005;87:331–335.
12. Sutherland K, Bryant RA. Social problem solving and autobiographical memory in posttraumatic stress disorder. *Behav Res Ther*. 2008;46:154–161.
13. Neshat-Doost HT, Dalgleish T, Yule W, et al. Enhancing autobiographical memory specificity through cognitive training: an intervention for depression translated from basic science. *Clin Psychol Sci*. 2012;20:1-9.
14. Raes F, Williams JMG, Hermans D. Reducing cognitive vulnerability to depression: a preliminary investigation of Memory Specificity Training (MEST) in inpatients with depressive symptomatology. *J Behav Ther Exp Psychiatry*. 2009;40:24-38.
15. Schacter DL, Addis DR, Hassabis D, Martin VC, Spreng RN, Szpunar, KK. The future of memory: remembering, imagining, and the brain. *Neuron*. 2012;76:677-694.
16. Gerlach KD, Spreng RN, Gilmore AW, Schacter DL. Solving future problems: default network and executive activity associated with goal-directed mental simulations. *NeuroImage*. 2011;55:1816-1824.
17. Schacter DL. Adaptive constructive processes and the future of memory. *Am Psychol*. 2012;67:603-613.
18. Sheldon S, McAndrews MP, Moscovitch M. Episodic memory processes mediated by the medial temporal lobes contribute to open-ended problem solving. *Neuropsychologia*. 2011;49:2439-2447.
19. Spreng RN, Stevens WD, Chamberlain JP, Gilmore AW, Schacter DL. Default network activity, coupled with the frontoparietal control network, supports goal-directed cognition. *NeuroImage*. 2010;53:303-317.
20. Madore KP, Gaesser B, Schacter DL. Constructive episodic simulation: Dissociable effects of a specificity induction on remembering, imagining, and describing in young and older adults. *J Exp Psychol: Learn Mem Cogn*. In press.
21. Anguera JA, Boccanfuso J, Rintoul J, et al. Video game training enhances cognitive control in older adults. *Nature*. 2013;501:97-101.