CHAPTER 13

Memory Improvement and Learning Efficiency

A User's Guide

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Learning and remembering are ubiquitous human activities. Learning starts almost from the moment a child is born, and evidence now suggests it occurs in the developing fetus. In Western countries, most children are in school settings by the time they are three, with formal instruction already taking place. Indeed, studies now show that children who do not attend pre-K are "behind" when they get to first grade. And this is just the beginning of lifelong learning. Many years of formal schooling ensue—and then functioning in today's world requires constant retraining, regardless of whether you are a plumber, a nurse, an auto mechanic, or an experimental psychologist. For example, an auto mechanic who trained in the late 1970s is likely to be still working today. However, the increased computerization of auto mechanics and the introduction of hybrid and cleaner engines means that repairing today's cars requires knowledge that did not exist in 1979, thus requiring continual re-training. Learning should extend even into retirement. Retired people may retrain to learn how to use cell phones and set up their computer printers. To accomplish all this, people must learn, and to learn efficiently means to learn and accomplish more. In this chapter, some evidence-based methods of improving memory are discussed.

In almost all nations in the world, most children engage in some form of formal education. In most Western countries, many young adults then attend college with the goal of learning new skills and new knowledge. In 2013, approximately 21 million people were enrolled in U.S. higher education institutions (National Center for Education Statistics, 2016). In addition, millions of people every year receive formal on-the-job training; thus, education is a part of business as well. And it does not stop there—consider the five branches of the U.S. military, which train additional tens of thousands every year, from recruits in basic training to enlisted men and women in specialist training to potential officers in the elite military academies. In terms of money, billions of dollars are spent annually to promote learning and remembering in the United States alone (and the United

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States spends less of its gross domestic product on education than many other Western countries do). Thus, making learning more efficient is financially expedient and vital to national security as well.

Consider all the informal learning that goes on every day—in businesses, in homes, and often on our computers, as we are forever connected to the Internet. Many people assert that we now need to know more than ever before in our information age. Think about some of the things you may not have known about a few years ago—as they did not exist—that have nothing to do with formal training or education. These include but are not limited to how to rent movies over the Internet, how to set up your own web page, how to set your new digital watch, and where to find the best bargains in the new mall in your town. If you are a sports fan, you may have learned Stephen Curry's scoring average; if you follow celebrity gossip, you may have just learned on what day Oprah Winfrey was born. Then there are your daily activities: Did you remember to call your mother and tell her about your aunt's visit? Did you remember to tell your boyfriend or girlfriend about the concert tickets you just bought? Our lives are filled with acts of learning and remembering.

Given how much time we all spend learning and remembering, you might expect that at some point, you might get some specific instruction in how to maximize your learning and memory abilities. Unfortunately, such instruction is usually lacking (Roediger & Pyc, 2012). Very seldom do high school age students receive specific instructions in how best to master new material. Even when such instruction is given, it is usually done as an "extra," communicating to the typical high school student that his or her attention is not required. Even some college courses on human memory often skip the topic of memory improvement—you will not find an equivalent chapter in most other textbooks on this topic. There are, however, some excellent new books on the topic. One great book-length treatment of memory improvement is Brown, Roediger, and McDaniel's (2014) book, which you can find in the reference section and in a link at the end of the chapter.

It is the goal of the last chapter of this book to remedy that oversight on the part of our educational system. This chapter is intended as a guide to memory improvement and learning efficiency. It will outline how one can improve the efficiency of one's learning as well as the science behind these assertions. It cannot, however, guarantee improvement. Each individual will need to figure out what works best for him or her and then apply that technique assiduously. However, following some of the principles outlined in this book and emphasized in this chapter will certainly be part of any person's success at improving memory. But before we start, let me reiterate one of the key themes of memory improvement: Memory improvement does not come for free—it requires work and intelligent application.

Thus, hard work is incumbent even on the "memory elite." In this chapter, we will discuss memory performers—these are people with truly fantastic innate memory abilities. Yet, they too must work hard to maximize their memory performance (Foer, 2011). So, yes, there are clearly individual differences in the ability to learn, process information, and remember it later, but even the most intelligent and gifted must work to learn. This chapter will provide some guidelines as to how to make the work you put in give you the most learning for the time spent. In other words, this chapter offers tips as to how to make

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your study time more efficient. It does so by reviewing and summarizing the various mnemonic tips that you have already read in the earlier chapters.

Over the course of the first 12 chapters, 21 mnemonic improvement hints have been offered to help you bolster your ability to learn and remember. All 21 can be found in abbreviated form in Table 13.1 at the end of this chapter. However, by now, you should recognize that 21 hints puts quite a bit of strain on a person's memory to remember. Could you list all 21 hints? It is likely that few readers of this book can, despite the fact that you studied each one before your exams for your memory course. The paradox here is that to use the mnemonic hints, you must be able to remember them. And 21 hints are a lot to retain. In addition, each hint applies under slightly different situations, so you also have to remember which hint is appropriate under which set of circumstances. Proposed here is a way to organize the 21 hints into just four broad principles, which are a lot easier to remember.

The first principle is to **process for meaning**. As you learn new material, focus on what it means. Several of the hints are related to the importance of meaning-based processing in learning. For example, Mnemonic Improvement Hint 4.1 advises you to use elaborative encoding. By relating new information to knowledge we already have, we focus on the meaning of the stimuli. A corollary of this principle is that we need to avoid distraction. When we are distracted, we no longer direct attention to meaning in terms of what we want to learn and remember. When our attention is distracted, it is more difficult to focus on meaning. Think of this in terms of being on a social media site during a class. The comings and goings of your friends on Snapchat engage your attention, and you lose the thread of the professor's lecture, even though the words are still entering your ears. So, one can improve the efficiency of learning by limiting distractions. In practice, this may mean putting one's cell phone away or closing one's Facebook connection.

> **Process for meaning:** As you learn new material, focus on what it means.

The second principle is to engage in **retrieval practice**. Many of the hints promote the generation and retrieval of a particular item as a strong reinforcer of that learning. Think of Mnemonic Improvement Hint 4.2, the generation effect. By generating the item that we need to learn, we strengthen the memory trace much more than by reading the item, leading to a strong boost in long-term retention. Retrieval practice can be interpreted as self-testing, though we benefit from formal testing as well. In the section on retrieval practice, we will also introduce the concept of encoding variability, a method that capitalizes on increasing the number of retrieval cues to improve memory efficiency. More and more research shows just how effective retrieval practice can be for helping us learn more efficiently (Mulligan & Picklesimer, 2016).

> **Retrieval practice:** Generate and practice the items you need to remember from memory rather than simply read or restudy them. Retrieval practice means self-testing.

The third principle is to use **metamemory**. Metamemory refers to our awareness and knowledge of our own memories. By careful and deliberate monitoring of what you have learned and what you still need to know, you can guide your learning

> **Metamemory:** Our knowledge and awareness of our own memory processes.

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in efficient ways. For example, Mnemonic Improvement Hint 1.3 reminds you that memory does not come for free—you have to work at it. This metacognitive knowledge compels you to spend more time engaged in study behaviors. We will also present research that identifies failures of metamemory. Thus, using metamemory to improve learning efficiency is fraught with potential problems. One must understand the advantages and disadvantages of using metamemory in order to improve learning efficiency. But by being aware of metamemory failures, we can compensate for them.

Finally, the fourth principle is that **distributed learning or practice** is superior to massed learning or practice. This means that spreading out your studying over time is superior to cramming. This goes against the folk wisdom that you can always prepare last minute by cramming. With busy schedules, students have a tendency to cram, but this strategy shortchanges them. While cramming is better than nothing, it is a remarkably inefficient way of learning. A little distributed practice goes a long way toward improved memory efficiency. Mnemonic Improvement Hint 1.2 embodies this principle.

Distributed learning or practice: Spacing one's study over time can lead to faster acquisition of information.

Many cognitive psychologists interested in learning efficiency would concur with these four broad principles (see Brown et al., 2014; Roediger & Pyc, 2012; Willingham, 2009). (For a related approach to memory improvement, based on Daniel Willingham's ideas, go to www.sage pub.com/schwartz3e.[1])

Let's examine each of these principles in detail.

1. PROCESS FOR MEANING

Think about the "washing clothes" story introduced in Chapter 5. Bransford and Johnson (1972) asked two groups of participants to read a story. One group had few clues as to what the story was about, whereas the other group knew the title of the story, namely, "Washing Clothes." The participants who knew the title remembered more details from the story than those who did not have the title, even though both groups had the same amount of time to learn the material. Why did the title group do better? Because the group that knew the title was better able to process for meaning. The title provided meaning and therefore structure to the otherwise confusing passage. The title allowed the reader to process the confusing sentences in terms of what they actually meant, because it facilitated tapping existing knowledge bases with which to associate the new material. Thus, the meaning implied in the title led to efficient memory. Both groups had the same amount of study time, but the group that was also better able to process for meaning remembered more from the story.

Now apply this to the learning one typically does in a college course. In a college course, facts (e.g., "Berlin is the capital of Germany") are usually less crucial than concepts ("Berlin was made the capital after the unification of Germany in 1990 following the fall of the Berlin Wall in 1989. Berlin was also the capital of a united Germany before the end of World War II. What do these facts tell us about German nationalism?"). In our technological, urban Western world, meaning is far more a significant aspect of our world than sensory characteristics. Thus, our teachers generally focus on meaning, and—this is

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critical—we are mostly tested on meaning-based material. Textbook authors do not put some terms in bold and dark lettering like **this** because we want you to remember which words are in boldface. We use boldface, because those words carry important meaning in a particular section and we want to draw your attention to them. Similarly, your diving instructor does not care if you remember whether he or she was wearing a blue wetsuit or a black wetsuit during your practice dive. Rather, the instructor wants you to remember why you need to ascend slowly (avoiding decompression sickness), why you can stay only a few minutes at depths of over 100 feet (buildup of nitrogen in the blood), and why you can remain much longer when diving at 30 feet (less buildup of nitrogen). Thus, in general, processing for meaning works because it conforms to the demands of your teacher, who will generally emphasize meaning.

A review of the mnemonic hints in Table 13.1 will demonstrate how many are related to the principle of "process for meaning." Mnemonic Improvement Hints 4.1 to 4.4, 6.1 to 6.3, 7.1, and 11.1 all make use of process for meaning to one degree or another. Hints 4.1 through 4.4 are all about processing for meaning. Thus, one of the most reliable ways of improving your memory is to focus on levels of processing—specifically, processing for meaning.

Consider the mnemonic improvement hint that advises you to organize what you are learning (4.3). Organization has a long and distinguished history of helping memory (Tulving, 1962). The best way to organize material is in relation to oneself in a strategy known as **subjective organization** (Tulving, 1962). Thus, in studying, you may want to reorganize the information given to you and make up your own organization. For a budding musician, using musical principles to organize biology or history may be helpful. For a musician, written music is a well-learned and meaningful body of knowledge that can be used as an organizing principle for scaffolding new information, such as the bones of the body. Conversely, a doctor attempting to learn the cello as an adult may want to use this process in reverse. The names of the bones may help the doctor as an organizational scheme for remembering musical notation.

> **Subjective organization:** In studying, you may want to reorganize the information given to you and make up your own organization.

Indeed, research shows that when students are forced to organize the material themselves, they remember more than when someone else provides the organization. This is true even when the external organization derives from an expert on the subject matter. In one experimental demonstration, Mannes and Kintsch (1987) gave one group of students well-organized outlines of material on which they would be tested. The outlines, prepared by professionals, provided a logical and coherent manner in which to study for the test. A second group was given a disorganized outline. It contained all of the same facts and did not contain any errors, but there was no logical and coherent sequence to it. There were two interesting outcomes. First, students judged the organized outlines as more helpful and liked them better than the disorganized ones. Second, the first group did better on simple memory tasks, such as recognition, but the second group learned in a deeper, more flexible way that gave them an advantage when they were asked to solve problems and make inferences. Why? Well, the second group of students had to employ

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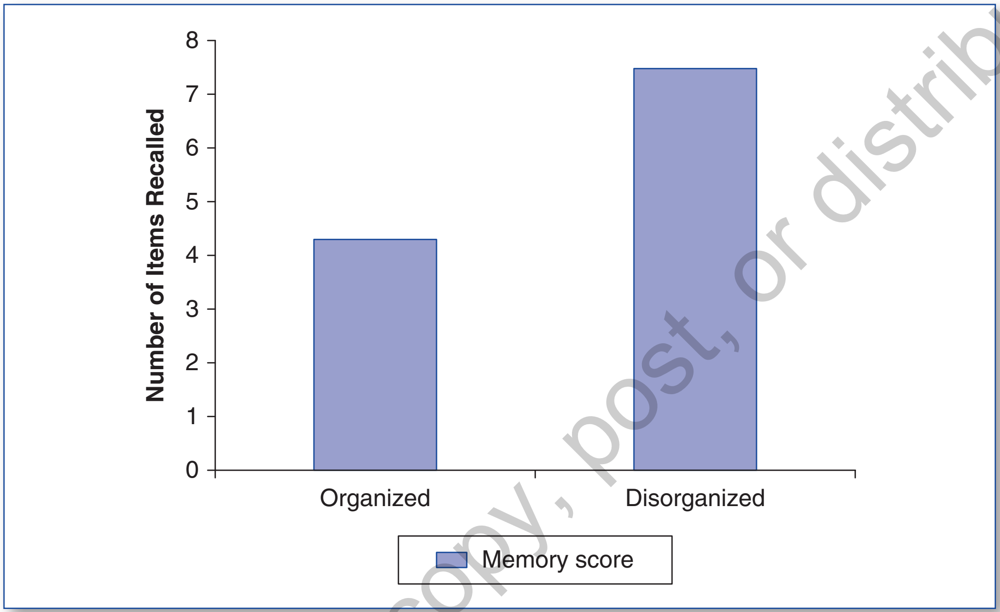
Figure 13.1 Students learned more when the review sheet was disorganized but free of errors. The *Y*-axis represents the number of items recalled.



SOURCE: Based on Christina and Bjork (1991).

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their own personalized organizational strategies to learn the material rather than rely on the already prepared outlines. This forced them into using self-organization and focusing on the meaning of the stimuli in a way not required of the other students. The self-organization that they supplied led to better performance than the logical, professional, but impersonal outline provided by the experimenters. This study demonstrates the need for students to organize material themselves into meaningful patterns (see Christina & Bjork, 1991; see Figure 13.1).

This presents a conundrum for teachers. If a teacher wants students to like him or her and give good evaluations, that teacher should provide them with careful, well-organized notes and outlines. This will make the students feel like they are learning easily. However, if the teacher wants the students to learn more, he or she will give them disorganized outlines that will force them to learn the material themselves. The students will be less satisfied with the teaching but will understand more information from the class.

Technical Mnemonics

A few technical mnemonics take advantage of subjective organization. These mnemonics can often be quite useful in remembering arbitrary lists. By and large, they employ simple

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meaning-based schemes that are useful for the memory of items unrelated to that scheme. **Technical mnemonics** refer to ready-made methods of learning information.

Technical mnemonics: Ready-made methods of learning information, such as acronyms or acrostics.

Acronym: A mnemonic device in which the first letters of each word in a list are formed into an easily remembered word.

Acrostic: A mnemonic in which the first letter of each item in the list is used to form a sentence with an easily remembered visual image or auditory connection that makes the sentence memorable.

Acronyms can be used to help learn lists of information not obviously linked together. Acronyms involve taking the first letter of each word from a list and forming them into easily remembered words. For example, HOMES is a common acronym for remembering the Great Lakes of the United States and Canada (Huron, Ontario, Michigan, Erie, and Superior). FACE represents the musical notes in the open spaces on the musical staff on the treble clef. When the information is needed, all one needs to remember is the acronym, and each letter then serves as a cue to recall the information. *H* cues Huron, *O* cues Ontario, and so on. The famous, if silly, ROY G BIV stands for the colors of the spectrum (red, orange, yellow, green, blue, indigo, violet). Acronyms are easy to generate and helpful for remembering arbitrary information.

Acrostics can also serve as memory aids. Acrostics involve using the first letter of each item in the list to form a sentence with an easily remembered visual image or auditory connection that makes the sentence memorable. When the information needs to be retrieved, it can be unpacked from the acrostic. For example, a famous acrostic is "Every Good Boy Does Fine." The first letter specifies the musical note on the line in the treble clef in musical notation. "Beautiful People Wear Clothes" is an acrostic to remember that Broca's area (*B*) of the brain is involved with the production (*P*) of language and Wernicke's area (*W*) is responsible for comprehension (*C*) of language.

Both of these mnemonics employ organizational principles that may be lacking in the material itself. For example, the naming of the parts of the brain is an historical accident—nor is the logic apparent in the names of the Great Lakes. When we devise our acronym or acrostic, we supply organization that helps us encode that information.

Avoid Distraction to Enhance Meaning and Retention

In our culture, there is constant buzz about the advantages and disadvantages of our technological innovations. Parents lament how much time their kids spend texting, while they themselves spend endless hours talking and driving, a far more dangerous choice. As professors, when we look out at our classes, we seldom see eyes watching us anymore. Students' attention is buried in their laptops, cell phones, and tablets. Our goal here is not to pass judgment on the current status of technology and our culture but to give you an advantage in learning efficiently. And the data here are quite clear: Divided attention prevents processing for meaning, which lowers one's memory efficiency (Hollis & Was, 2016).

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Thus, an easy way to improve your learning is to leave the electronics behind when you attend a lecture and turn off your cell phone when you study. The data on this point will be reviewed here.

Smith, Isaak, Senette, and Abadie (2011) examined the effects of texting while studying. They divided participants into two groups, one of which was not allowed to use cell phones and a second group that was encouraged to text while studying. The participants studied DRM lists—that is, lists of related items associated with an absent word known as the critical intrusion. After studying the lists, participants were first given a recognition test of items from the list. The results were clear. Recognition performance was much higher in the non-distracted group than in the distracted group. It is worth noting, however, that texting did not increase the likelihood of false memories in this study. However, Otgaar, Peters, and Howe (2012) found that divided attention both lowered correct recall and increased false recall in the DRM paradigm in adults. The bottom line, of course: Texting while studying hurts performance!

These data are consistent with many studies that show that divided attention or distraction can interfere with memory performance across a wide range of memory tests. Brewer, Ball, Knight, Dewitt, and Marsh (2011), for example, found that participants with divided attention showed an impairment on prospective memory tests. This means that when one is distracted, such as by texting or doing other activities, one is less likely to remember the things one needs to do, such as an appointment. Parker, Dagnall, and Munley (2012) showed that divided attention interfered with category-cued recall, a paradigm similar to the kinds of learning one does for a school-related test. It is likely that at least some of the reduced performance seen in divided-attention tasks is because participants are no longer able to direct their attention to the meaning of the to-be-learned material. When they are no longer focusing on meaning, their ability to encode those items is reduced. Thus, a very practical bit of advice is that, when you really want to learn something, avoid being distracted by competing stimuli.

There are also effects of chronic distraction on memory. People who frequently place themselves in situations in which they are multitasking are putting themselves at risk of creating long-lasting problems with memory efficiency. This was recently tested by Uncapher, Thieu, and Wagner (2016). They found that chronic multitaskers performed worse on working-memory tests and long-term memory tests even when they were not multitasking. Thus, even when trying to focus on a single-task, chronic multitaskers looked for distractions, and these distractions lowered their ability to learn and remember.

2. ENGAGE IN RETRIEVAL PRACTICE

The second broad principle in improving memory is to test oneself. Across a large range of situations, self-testing, classroom testing, and other forms of testing lead to strong memory traces and more long-term retention than simply restudying or rereading material. Across many experiments and classroom studies, the advantages of retrieval practice are now well documented. Retrieval practice can help the learning of introductory psychology, foreign language vocabulary, general knowledge facts, visual materials, and

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middle-school science (Carpenter et al., 2016; Rawson & Dunlosky, 2011; Roediger & Pyc, 2012; Trumbo et al., 2016).

Retrieval practice means to learn by testing oneself—that is, making yourself retrieve information. Retrieval practice is currently an important topic of cognitive research, but it is also an easily applied principle of learning and remembering. Research shows that a trial of testing oneself is superior to a trial of restudy (see Kornell & Bjork, 2007). As an example, consider a student who must memorize a lengthy passage from a Shakespeare play. Once the information has been studied to the point at which the student is beginning to memorize the lines but is still shaky with them, he or she can consider two options: (1) Continue to read over the lines or (2) practice saying them, and when he or she makes a mistake, get feedback from a listener. A volume of research demonstrates that retrieval practice or the generation of the lines themselves produces quicker learning than reading them. Likewise, learning a new vocabulary word in French is quicker when you repeatedly test yourself (as in, *monkey*—?) than when you simply read the association (*monkey–le singe*). The act of retrieving creates stronger associations between cues and targets than does simply restudying the items (Carpenter et al., 2016; Karpicke & Roediger, 2008; see Figure 13.2).

Consider a landmark study in this domain. Roediger and Karpicke (2006) focused attention on the advantages of retrieval practice. They asked participants to read short prose passages concerning scientific information. One group of participants simply restudied the items several times. A second group read the same passage but then was asked to recall information about the story on three practice tests. One week later, the participants returned and were retested on the information. The testing group outperformed the restudy group. In fact, the testing group recalled 50% more information than did the restudy group. This study clearly shows how important testing yourself is to acquiring information.

Retrieval practice can either be self-initiated or provided to students by instructors. For example, many teachers will provide practice quizzes for material in the class for which you are reading this book. Though students generally see these quizzes as opportunities to find out how prepared they are, taking the quizzes is also an effective learning tool. Research again shows that taking such practice tests is more effective than restudying (McDaniel, Roediger, & McDermott, 2007). In another study, Campbell and Mayer (2009) tested college students during classes. In one condition, students in an educational psychology class received a PowerPoint presentation that included questions. Another set of PowerPoints included only statements. The students who saw the questions later remembered more from the lecture than those who had only read statements. In yet another study, Trumbo et al. (2016) showed that quiz performance in an introductory psychology course improved for the students who were assigned to a retrieval-practice condition.

The effects of retrieval practice on efficient learning also hold up in light of a number of features that might affect real students. For example, an interesting feature of the testing effect is that even generating a wrong answer leads to better retention of the correct answer, if there is feedback, than simply restudy the item. Huesler and Metcalfe (2012) asked participants to study cue-target word pairs. Some participants reread the items, whereas other students generated the targets. If a participant reported an incorrect target,

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the researchers gave him or her corrective feedback. They found that participants who generated the wrong answer remembered more correct answers later than those who had simply read the answer. This addresses one of the criticisms of self-testing: Some have suggested that it does not work in the real world, because students might retrieve and therefore study the wrong information. However, as long as students have access to the correct answer, generating an incorrect answer is not a problem and indeed, is better than restudying. Metcalfe and Finn (2011) even showed that high-confidence wrong answers, once corrected, lead to good recall of the actual target, provided that the wrong answer was generated. In this experiment, if a participant reported with high confidence that Sydney was the capital of Australia, he or she would later better recall that it is actually Canberra relative to a wrong answer generated with less confidence. Thus, students need not fear generating wrong answers in practice, as doing so produces better learning than does restudying correct answers.

Although retrieval practice can have profound benefits for learning, most people, by and large, are unaware of the huge advantage it affords on learning. People have poor metacognitive knowledge concerning the advantages of retrieval practice. Bjork, Dunlosky, and Kornell (2013) pointed out that even students who self-test to determine their level of preparation are often unaware of the positive consequences of self-testing on learning. Some student may self-test to help determine which items they need to restudy but are not aware that the self-testing actually is studying. Moreover, Jönsson, Hedner, and Olsson (2012) did not find that judgments of learning were higher for retrieval practice items than for studied items. This means that even after self-testing, we do not feel like those items are more well learned than those we just read, even though they are. It is therefore incumbent on memory scientists to spread the word: Retrieval practice helps. Use it (Brown et al., 2014; Roediger & Pyc, 2012)!

Earlier we discussed a paradigm called the **generation effect**, which is consistent with the notion of retrieval practice. In the generation effect, a person generates the to-be-remembered target either by following a rule (e.g., generate a word that rhymes with *head* and starts with a *b*) or by simply reading the association (e.g., *head–bed*). The data show that participants remember the generated associations better than the read associations (Slamecka & Graf, 1978). Again, the act of producing the to-be-remembered item oneself produces cues, which will later be useful in recall.

> **Generation effect:** Memory is better when we generate associations ourselves than when we simply read them.

Thus, a generalization we can make about memory improvement is the following: Test thyself. Repeatedly generating target answers and testing your knowledge base produces the cues that lead to good memory later. This is a pretty easy rule to follow. Most textbooks have test banks that go along with them or review questions at the end of the chapter. The memory-conscious student can employ these educational tools. Ten minutes spent answering the review questions at the end of this chapter will promote better long-term learning of the material than 10 minutes spent rereading various sections. If questions are not provided by your textbook, you can make flashcards—either on regular index cards or the equivalent in computer files—that have a question on one side and the answer

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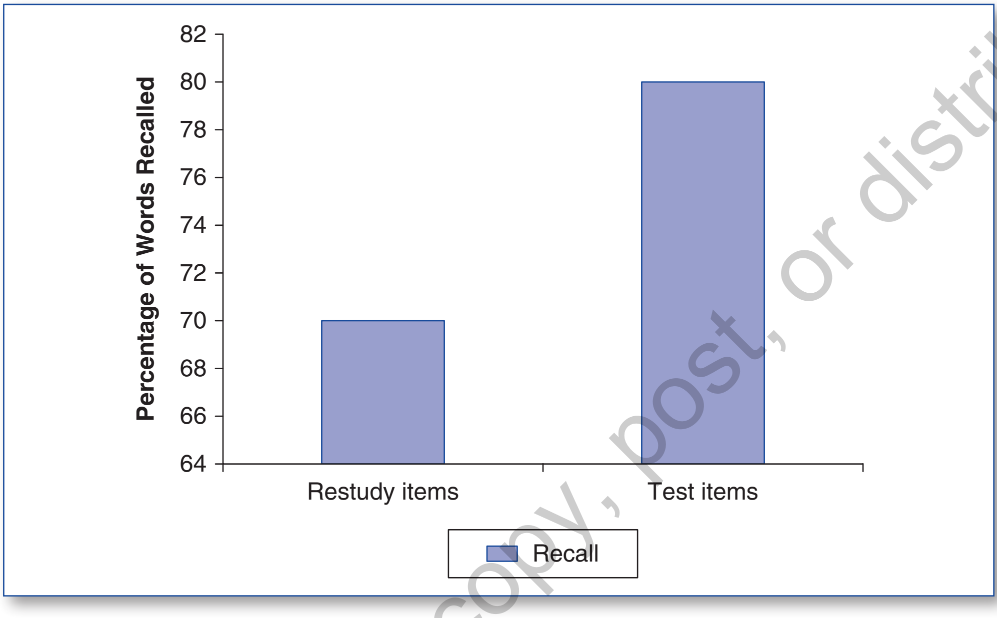
Figure 13.2 The effect of testing relative to restudy on the retention of new material. The *Y*-axis represents the percentage of words recalled.



SOURCE: Based on Karpicke and Roediger (2008).

on the back. Try answering the question before you check the back. This strategy will allow you to benefit from the generation effect. Making your own flashcards has an additional advantage: Writing down the questions and the answers when you make the cards provides an additional study trial. (For more on the advantages of self-testing and other mnemonic techniques, go to www.sagepub.com/schwartz3e.[2])

Retrieval Cues and Encoding Variability

A related technique that can be used to improve memory efficiency is to create good retrieval cues for oneself. By making a variety of good retrieval cues, one may later have the right hook to retrieve a particular memory or fact. Think about the following familiar situation. You are in your English literature class. You are sitting in front of a blank piece of paper. Your exam essay is to write a short description of the character Horatio in Shakespeare's play *Hamlet* and comment on his influence on the protagonist, so you are trying to remember something about the character of Horatio. But you are drawing a blank. You know you read the play, and you think you got the gist out of it: A man is trying to avenge his father's murder but gets bogged down in uncertainty about whether to believe a ghost. But there were so many funny names that it was hard to keep track of them all.

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Was Horatio one of the friends who betrayed Hamlet to his evil uncle? Or was Horatio Polonius's son? The failure here is not one of learning but one of retrieval. You do not have the correct retrieval cue. If the question had contained information about Horatio's role, such as "Hamlet's friend Horatio, who also witnessed seeing the ghost, influences Hamlet in certain ways," this would have instantly triggered the associations of Hamlet's close friend and his role in the play, and then you would have been able to tackle the essay without any difficulty. Armed with the extra information that functions as a retrieval cue, you would now be able to write a stellar essay.

Cues are bits of information provided by either the external environment or your own imagination. Cues are triggers that help us recall the information that is associated with them. As we discussed in Chapter 4, the right cue can bring back a long-lost memory. You might not have thought of the vacation you took to the woodlands of Minnesota when you were a child for a long time. But when your father or mother says, "Remember when we were staying at the fishing lodge, and you caught a large trout?" this cue then elicits your memory of struggling to land the feisty fish. You may not have known you could remember this event until your parent provided the correct retrieval cue.

Students can also rely on the structuring of retrieval cues in a number of different ways. If we learn in such a way that we know what the relevant retrieval cues will be later, we can perform better by ensuring that those retrieval cues are present at the time of test. This means controlling the encoding environment so that it produces usable cues that will be present at the time of retrieval. **Encoding variability** means that multiple encoding conditions produce good recall, because encoding under a variety of conditions provides lots of different cues, which can then be taken advantage of at the time of retrieval. By chance, it is more likely that one of these conditions will be present at the time of retrieval than if the encoding had taken place under homogeneous conditions. Thus, encoding variability produces good memory (Verkoeijen, Rikers, & Özsoy, 2008).

Encoding variability: The principle that if you study an item of information under several mental and physical conditions, you will be more likely to remember it than if you had studied for the same amount of time or number of trials but under uniform conditions.

The encoding variability principle claims if you study an item of information under several different mental and physical conditions, you will be more likely to remember it than if you had studied for the same amount of time or number of trials but under uniform conditions. So, if you want to remember a particular piece of information (i.e., Julius Caesar lived from 100 BCE to 44 BCE), it is best to study it under a variety of conditions, such as when you are tired and angry, in your dorm room and in the library. Then, when you are asked about the facts of Julius Caesar's life in your history class, you have a number of different cues to remember this information. You may be tired when you take the test, in which cases the cues acquired when you studied when tired will be useful. You may be feeling angry for one reason or another when you take the test, and therefore your "angry" cues will be useful. Consider the scenario when you study only when you are well rested, happy, and in your dorm room. You may establish a series of cues that are associated with each of those states. When you take the exam, you may be tired, unhappy

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about something or other, and in the classroom. Not having studied in different states will leave you with fewer retrieval cues to rely on than if you had studied under more diverse conditions. Therefore, you can use encoding variability to study more efficiently and boost memory performance (Soraci et al., 1999).

Encoding variability ensures that you will have created a range of cues for the information. At the time of test, the **encoding specificity** principle applies—that is, if retrieval conditions match encoding conditions, recall will be maximized. The problem is that you may not always know what the retrieval conditions will be. It may be that the test will take place on a sunny day in which you are a bit tired but feel good about the world. The test may also take place on a rainy day in which you are agitated and angry, because you just had an argument with your boyfriend or girlfriend. If you studied under both sets of conditions—that is, encoding variability—you will be able to make use of the encoding specificity principle at the time of test, as either condition at test was preceded by study in the same condition.

> **Encoding specificity:** Retrieval of information from memory will be maximized when the conditions at retrieval match the conditions at encoding.

Encoding variability can be taken advantage of to improve the efficiency of one's learning. It also can be combined with retrieval practice, which likewise improves the efficiency of one's learning. As with processing for meaning, both encoding variability and retrieval practice require active learning on the part of the student or other learner. One must plan one's study and engage with the material. Indeed, much research is ongoing to understand why retrieval practice is such a powerful learning enhancer (Carpenter et al., 2016). We now turn to the next memory improvement principle, which also emphasizes the advantages of active learning.

SECTION SUMMARY AND QUIZ

This chapter focuses on how each of us can improve our memory by learning and remembering more efficiently. Four major principles have been emphasized: (1) Process for meaning, (2) employ retrieval practice, (3) use metamemory, and (4) make use of distributed practice. Each of these individually can improve learning efficiency, and certainly in combination, they can make your learning and remembering far more efficient. In this chapter, the various mnemonic improvement hints given throughout the book are organized according to these four memory principles. Process for meaning covers a number of topics. First, it implies that elaborative encoding or distinctive encoding lend to more efficient learning. Processing for meaning also means avoiding activities that distract one from using meaning-based strategies. Thus, multitasking and other distractions cause us to not process information meaningfully, leading to less efficient learning. Retrieval practice is an important efficiency tool. A block of time devoted to self-testing (or retrieval practice) leads to better long-term retention than rereading the information. Encoding variability means that, if you study an item of information under several mental and physical conditions, you will be more likely to remember it than if you had studied for the same amount of time or number of trials but under uniform conditions.

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Section Quiz

1. Which of the following is not a principle of memory efficiency?
   a. Process for meaning
   b. Use metamemory
   c. Use distributed learning
   d. Employ visual mnemonics whenever possible
2. In studying, that you may want to reorganize the information given to you and make up your own organization is known as
   a. Self-retrieval
   b. The self-testing effect
   c. Subjective organization
   d. Inferential reorganization
3. Roediger and Karpicke (2006) asked participants to read short prose passages concerning scientific information. One group of participants simply restudied the items several times. A second group read the same passage but then was asked to recall information about the story on three practice tests. They found that
   a. The group that recalled information during study did best on the final test
   b. The group that restudied information during study did best on the final test
   c. Only groups that received encoding variability improved on the task
   d. None of the above are true
4. Which of the following would be considered encoding variability?
   a. Engaging in retrieval practice immediately after first studying information
   b. Using technical mnemonics, such as acronyms, to help learn arbitrary information
   c. Studying the same material when you are in a number of different moods, so that one of those moods will match the one you will be in when you are tested
   d. Rejecting technical mnemonics and avoiding distraction

1. d
2. c
3. a
4. c

3. USE METAMEMORY

The importance of metamemory is generally underestimated in memory improvement programs and books. These books emphasize imagery and other memory tricks and seldom mention the important role of conscious control over the learning environment.

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However, cognitive psychology is showing an increasing understanding of the role that metamemory plays in ordinary learning and remembering and the role it plays in memory improvement (Kornell & Finn, 2016; Schwartz & Efklides, 2012). *Metamemory* means our awareness and knowledge of our own memories. This awareness ("I know this material really well") and knowledge ("I am good at remembering names," or "I know very little about dog shows") can be used to structure our learning and remembering. For example, when asked to recall the mailing address of your third cousin twice removed, you may know immediately that you do not know this bit of information. This awareness can spur a number of responses. You can look up the address on the Internet or call another cousin to get it. But your awareness of your lack of knowledge allows you to make a decision. A student studying vocabulary can quickly assess whether he or she has learned all of the items. On the basis of this assessment, he or she can then decide either to continue studying or to get a good night's rest. Metamemory can play a role in memory improvement both at the time of encoding and at the time of retrieval.

The message of this section is the following. Studies show that metamemory is good at distinguishing difficult items from easy ones. Thus, we can use our metamemory judgments to determine which items need to be studied more and which items need to be studied a bit less. However, our metamemory tends to be overconfident so that we overestimate the likelihood that we will remember and underestimate the likelihood that we will forget. This may lead us to not study enough. So, although we may use our judgments of learning to determine which items to study, we should not rely on them to determine how long or in what manner to study (Kornell & Finn, 2016; Schwartz & Efklides, 2012).

Judgments of Learning as Mnemonic Improvement Tools

Judgments of learning are made during study and concern the likelihood of remembering an item later. As discussed in Chapter 9, judgments of learning are both accurate at predicting future performance and useful as a guide to which items to restudy. Consider the use of judgments of learning in encoding. While studying, you can assess how well you have learned particular items. For example, while studying for a Spanish vocabulary test, you can make judgments of learning on English Spanish word pairs (e.g., *railroad–el ferrocarril*). Making judgments of learning can offer a number of distinct memory advantages. First, if you use the delayed judgment of learning effect (that is, wait a few minutes after studying the item and then cue yourself with only the cue word, in this case, the English word), you can make more accurate judgments of learning as well as benefit from the retrieval practice (Jönsson et al., 2012). Second, making judgments of learning provides you with feedback as to what you have learned and what you have not. Having made judgments of learning for the various items, you are now in a position to decide what you need to restudy. You probably do not need to study further those items to which you gave high judgments of learning. However, those items that you gave lower judgments of learning need more time and more study trials (Kornell et al., 2011).

> **Judgments of learning:** Judgments during study of whether the item has been learned already.

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How does this improve memory? The act of making a judgment of learning itself appears not to improve memory more than the equivalent amount of time spent studying the item, although this has been the subject to debate within the field (see Dunlosky & Metcalfe, 2009; Jönsson et al., 2012). Instead, judgments of learning can be used to improve memory by allowing us to direct our time, energy, and effort toward those items for which we need the most study. Consider if you studied all the items a second time for an equal amount of time each. You would essentially be wasting study time on the easy items that you have already mastered and might not study the more difficult items enough. Instead, by making judgments of learning and knowing which are easier and more difficult items, you can concentrate your study on the items you need to learn. Thus, in the same amount of time, you can learn more information by not focusing on items you already know.

The output of judgments of learning can also inform our learning in a second manner. It can allow us to adaptively control our study behavior, depending on our goals and our circumstances. For one class, for example, you may be aiming for an *A* because you really want to do well in that class. In another class, you may be satisfied to just get by, perhaps because it is a general requirement and not part of your major, perhaps because it is just plain difficult, and perhaps because it is less interesting. Thus, the goal of one class is perfection, but for the other class, it is just to master enough to pass the course. You can use judgments of learning to adjust to these different goals. In the class where you want the *A*, you must study even the most difficult items, but in the other class, you might just study the easier items and perhaps a few difficult items to earn a *C*. Interestingly, this approach to study has now been formalized into a model of memory study called the **region of proximal learning**, developed by Janet Metcalfe and her colleagues (see Metcalfe & Kornell, 2005; Xu & Metcalfe, 2016). (For more on this topic, go to www.sagepub.com/schwartz3e.[3])

> **Region of proximal learning:** A theory of metamemory that advances that an adaptive learning strategy is to study those items that have not yet been learned but are not too difficult—those at the leading edge of difficulty.

According to this theory, we maximize our learning by studying at the leading edge of difficulty. We maximize our learning by studying the easiest of the items we have not mastered yet. We do not need to restudy the items we have learned already—this would be an inefficient use of our time. Also, we do not exactly know how much time we will have to prepare or how much time we would need to master the highest-difficulty items, so we might sacrifice too much time if we focus on the most difficult items first. So we study the least difficult of the ones we have not yet mastered. Figure 13.3 shows this triage of study material. But then we should direct our attention to those items that we think we can master in the shortest amount of time and retain for the longest. We can only do so by focusing on the judgments of learning we have made about these items.

We seldom know exactly how much time we need to study or how much time we have to study. You do not know ahead of time that you will have to drive to the airport to pick up your cousin or that a friend will need to speak to you after a bad breakup with a boyfriend or girlfriend. Thus, at times, our ability to learn or prepare for a test will be cut off before we are satisfied. If our study time turns out to be limited, and we cannot study all

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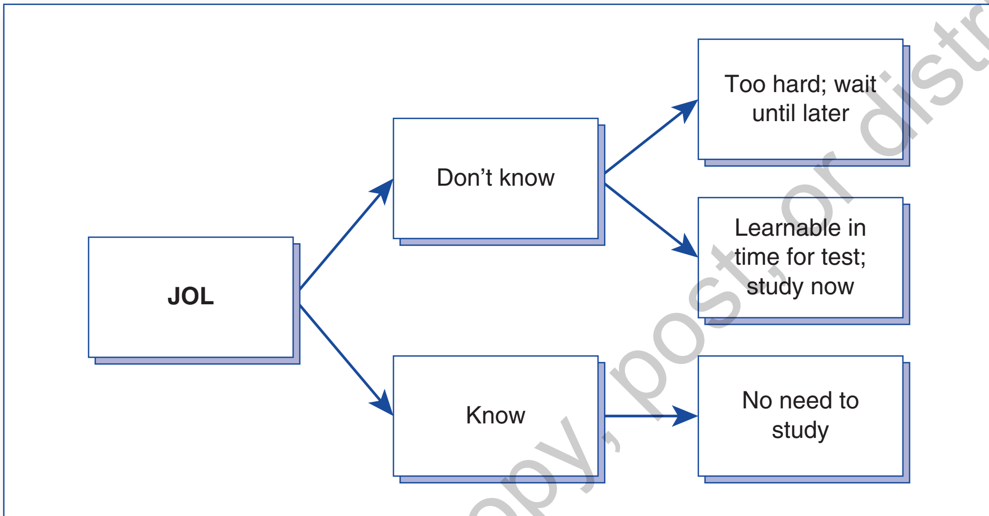
Figure 13.3 The region of proximal learning stipulates that the most efficient manner of studying is to study the easiest items we have not yet learned. This is illustrated by the relation of judgments of learning (JOLs) to study time decisions in this figure.



the items, we are better off learning as many items as possible in the time that we have. Thus, by focusing on the easiest of the not-yet-mastered items, we will learn more of these items than if we had started with the most difficult of the not-yet-mastered items and then progressed to easier items. If it turns out we have enough time to focus on the most difficult items, then we can do so, but these items are attempted only once all other items have been learned.

Thus, judgments of learning can be used as a screen to determine the difficulty of items, given that easy items require less study than difficult items. Moderately difficult items ought to be studied before the most extremely difficult items. Depending on how much total study time you have, you can master more and more of the difficult items. The efficient way to study is to always study the easiest item not yet learned so as to master the most amount of the material if your study time is suddenly curtailed.

Stability Bias

One of the original authors of the region of proximal learning model, Nate Kornell, has more recently described a phenomenon that limits the usefulness of the proximal-learning model. He and his colleagues called the phenomenon **stability bias** (Kornell, 2011). Stability bias is an inherent flaw in how metacognition works. Stability bias leads to poor judgments and poor decision-making. Thus, being aware of stability bias may allow you to

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account for it or overcome it. Stability bias means that we tend to underestimate the advantages of further study and underestimate future forgetting based on what we can retrieve now. Thus, stability bias has two components: We discount the advantages of future studying, and we discount the likelihood that we will forget what we remember now. Thus, if I have now learned that Canberra is the capital of Australia, I will underestimate the likelihood that I will forget that fact later and underestimate the helpfulness of future study. This has important implications for the usefulness of judgments of learning as study tools.

Stability bias: Underestimating future forgetting and overestimating future remembering based on what we can retrieve now.

To test the idea of stability bias, Kornell and Bjork (2009) conducted 12 experiments. Participants were instructed to study some paired associates one time and other paired associates four times, and then they took a cued-recall test. Not surprisingly, recall increased across the learning trials, with more trials leading to better recall performance. But judgments of learning did not track this; judgments of learning given on individual paired associates did not increase across the learning sessions. This means that participants were, by and large, unaware of the strengthening of each memory trace that came from further study, though, of course, they knew that, in general, continued study means more learning. They just did not apply that understanding to individual items. If students do not see the advantage of further study on individual items, they may choose not to study, even though continued study would improve performance. This tendency leads to the proverbial complaint among students that they studied really hard but did not do well on the test. This experience may be, in part, fueled by the failure to anticipate the benefits of continued study. “Studying hard” does not mean studying enough.

Stability bias also means that we underestimate forgetting—that is, we do not anticipate how much information we will forget over time. For example, Koriat, Bjork, Sheffer, and Bar (2004) examined people’s abilities to anticipate forgetting. Two groups of participants studied paired associates and then made judgments of learning. One group’s judgments of learning were directed at a test to be taken in 10 minutes, whereas the other group’s judgments of learning were directed at a test to be taken one week later. Despite the difference in the anticipated retention interval, the judgments of learning were identical. At test, those in the one-week retention interval group recalled fewer items than those in the 10-minute retention interval group. The judgments of learning did not predict the certainty of forgetting, especially over longer retention intervals. In sum, stability bias demonstrates both a failure to appreciate the value of continued study and a failure to anticipate forgetting. To counter the effects of stability bias and overconfidence, learners should continue to study learned items by engaging in retrieval practice, in addition to attacking unlearned items.

To summarize, judgments of learning are useful in distinguishing between easy items and difficult items (Schwartz & Efklides, 2012). This is helpful, as it allows us to make control decisions about what to study. Given different time constraints, we might want to focus more on easy items or difficult items. The region of proximal learning model suggests that we study the easiest items not yet mastered. This will maximize our learning by allowing the most learning to take place per unit of time. However, the stability bias

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suggests that our judgments of learning are overconfident. We discount forgetting and also underestimate the advantages of overlearning. Thus, an efficient learner will also restudy items that he thinks are already learned to avoid the pitfall of stability bias. So the take-home message here is that judgments of learning can be successfully used to distinguish between easy and difficult items, but that we need to study even after we feel like we have learned the material.

These aspects of metamemory involve the continuous monitoring of one's own knowledge and the continuous use of this monitoring to make informed decisions about learning and memory. This approach to memory improvement is called **self-regulated learning**. Research shows that self-regulated learning is superior to learning in which others, even experts, decide which items a person should study (Kornell & Bjork, 2008). This is because only each individual can know which items are distinctive (and therefore easy) or confusing for that individual. We now turn to the next broad principle that drives memory improvement.

Self-regulated learning: The continuous monitoring of one's own knowledge and the continuous use of this monitoring to make informed decisions about learning and memory.

4. DISTRIBUTE YOUR PRACTICE

Distributed practice means that long-term retention is enhanced when we spread out our study over time as compared to studying all at once. This particular principle applies across many learning domains, not just studying for exams or mastering a new language. Distributed practice is superior to massed practice in learning new skills, varying from playing a musical instrument, typing, sewing, playing basketball, and even driving a tank. However, this section will focus on the advantages of distributed practice for encoding information, such as school-related learning, into long-term memory (Paik & Ritter, 2016; Roediger & Pyc, 2012).

Distributed practice: Spacing study out over time.

Avoid Cramming: Massed Versus Distributed Practice

Every college student has found herself in this situation. It is the night before the big test, and you have not yet even started reading the textbook chapters that will be covered on the exam. Because of other commitments, you have also missed several class sessions. So you are essentially starting to prepare for this exam from scratch! Students call this "cramming." It is a staple of college life, yet it is a remarkably inefficient manner of learning. The memory improvement tip offered here is to avoid cramming.

The technical term for cramming is *massed practice*. **Massed practice** means that all study occurs in one block of time. Now, massed practice has its place. It should not be completely rejected. In fact, massed practice can be employed with

Massed practice: Studying entirely in one block of time.

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some success right before an exam (or performance). The practice immediately before the exam will leave studied information highly accessible, and this may help on test performance. Think of the time you quickly glanced over your notes just before a professor started handing out exams. You may have noticed something in your notes that turned up on the exam. The disadvantage of massing is that, although it may render a few items highly accessible, it does little for availability. Because a student cramming for an exam is focused on a short-term issue—passing the test—the long-term goal of learning tends to be forgotten. Thus, students often fall into a pattern of cramming because it gets them through their tests, but then they remember little of the course once it is over. If you have not studied, you have no choice and must mass your study before the test. However, you can learn more effectively and do as well on the test by distributing your study. The point here for students is that cramming is remarkably inefficient. You can learn more—and do better on your tests—in less time if you used distributed practice.

Massed practice promotes little long-term retention of the practiced material. Cramming may result in enough learning to get you a passing grade on the test, but you will have to restudy it all over again to prepare for the cumulative final, almost as if the material was brand-new. More important in the long run is that you will not remember the information later—in the real world—when it might come in handy. A useful rule is that massed practice promotes accessibility—a good thing if the material is already well learned and you are about to be tested on it. But distributed practice promotes availability—a good thing if you want the information to be in your memory when you may need it later. In this sense, distributed practice is more efficient; it creates more total learning than does massed practice in less time.

Distributed practice means that practice is spread out over time. In this way, distributed practice is based on the **spacing effect**; two trials produce better retention if they are separated by more time than if they are closer together. For the college student, distributed practice means that you might spend 30 minutes every morning reading your textbook and perhaps 15 minutes reviewing the major concepts. If you do this, you may need only a short study session the night prior to the exam, because you will have already mastered the material. The short study session accomplishes the same goal as cramming would; it renders the material accessible for the test situation. Thus, you will do better on the test than the crammers and remember the information years from now. In addition, when your friends are busy cramming and feeling really stressed, you can go out for dinner with other friends, get a good night's sleep, be relaxed the next day, and still do better than your cramming friends on the exam—and then go to the beach or to a party while your crammer friends are sleeping off the all-nighter. The only negative side effect of distributing your practice? Your friends will be jealous! (For more on the differences between massed and distributed practice, go to www.sagepub.com/schwartz3e.[4])

> **Spacing effect:** More learning occurs when two study trials on the same information are spread out over time than when they occur successively.

Ample research supports this assertion (except the part about jealous friends and partying at the beach). In one study that employed methods very much akin to the learning students must do for school, Kornell (2009) asked participants to study difficult, GRE-type

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words and their more common synonyms (e.g., *effulgent–brilliant*). Each word definition was presented on a computerized version of a flashcard. The "flashcards" had the difficult word on one side, and if you pressed a key, you could see the "back" of the flashcard, which had the definition or more common word. Kornell used this paradigm to compare learning under massed or distributed practice.

Kornell's (2009) participants were divided into two groups. One group learned by massing first, the other group by distributing practice first. In both the massed and the spaced conditions, participants studied each definition four times throughout the course of study. However, in the distributed condition, the group studied one big stack of flashcards, thereby maximizing spacing. A particular word definition was not restudied until all of the other definitions had already been studied. In the massed condition, the group studied four small stacks of flashcards and was tested after each one. Thus, there was much less time between two successive study sessions of the same word definition. The total number of items was the same for the big stack of flashcards and the four smaller ones. Therefore, the difference was the amount of spacing between successive studying of a particular definition.

Kornell (2009) found that the distributed items led to better cued recall than did the massed items. And the distributed condition produced about 50% more items recalled. This is a huge effect! Imagine it: Just by employing this one memory improvement technique, you can improve your memory ability by 50%! And it is remarkably consistent across individuals. The advantage of distribution over massing was present in over 90% of the students tested. Thus, the effects of distributed practice are strong and consistent across individuals. Regardless of whether we use old-fashioned index cards or computer programs to help us learn efficiently, the spacing effect is important. Kornell's study is one of a long line of studies that demonstrates just how much better distributed practice is than massed practice. What makes Kornell's study particularly compelling is that it deals directly with materials that many students must master—if they want to be accepted into graduate school—and it deals with the manner in which many students do study.

In another study, Landauer and Bjork (1978) attempted to maximize the advantages of both massed and distributed practice by using both in a study paradigm. They devised what they called optimum rehearsal patterns. In their study, Landauer and Bjork compared standard spaced practice to something they called **expanded retrieval practice**. Expanded retrieval practice means that you initially space your study of a particular item very close together to maximize learning and the advantages of retrieval practice, but then your subsequent trials get further and further apart. Thus, you might study *book–le livre,* then study the same item again. Then, you might intersperse three other French English word pairs before you study *book–le livre* again. Next, you might intersperse eight more French English word pairs before you study *book–le livre* again. In this way, you continually remind yourself of the items and keep the pairs easily accessible but don't waste study time by short spacing.

Expanded retrieval practice: Initially spacing study of a particular item very close together to maximize learning and the advantages of retrieval practice but then spacing subsequent trials further and further apart.

The expanded retrieval practice takes advantage of the effects of cramming—that is, that studied items become easily accessible in the early phases of study—and then it takes

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advantage of distributed practice through the expanding spacing, which allows for restudy and permanent storage in an efficient way. This phenomenon is also one of a select few in memory science that has inspired a limerick:

You can get a great deal from rehearsal
If it just has the proper dispersal
You would just be an ass
To do it en masse
Your remembering would turn out much worsal.

—Bjork (1988, p. 399)

A caveat to the advantages of distributed practice (spacing effect) over massed practice is that people prefer to mass their practice. Indeed, in Kornell's (2009) study, even though 90% of people did better when using distributed practice, 72% *thought* that they did better when massing their practice. Logan, Castel, Haber, and Viehman (2012) showed that judgments of learning were not affected by massing or spacing, even though spacing led to much better recall. This metamemory error can be persuasive. In another study, Baddeley and Longman (1978) also showed that distributed practice produced better learning, in this case, in a program to teach employees to type on typewriters quickly and accurately. However, the employees who learned via a massed program rated their learning experience as more positive than those who had learned via distributed practice. Thus, it is important for those who want to maximize their memory efficiency to keep distributed practice in mind when they begin learning, because it is both counterintuitive and less pleasant than massed practice.

What is common to all of these studies, regardless of the stimuli, specifics of the experiment, or time course of the spacing is that distributed practice leads to better recall performance than does massed practice. For the person who wants to maximize his or her learning efficiency, this is valuable information, especially given how much distributed practice goes against our natural grain. Like all the other memory efficiency themes in this chapter, using distributed practice requires an active learner who is willing to plan and use his or her intelligence. The reward in learning efficiency, however, can be quite large.

SECTION SUMMARY AND QUIZ

Four major principles have been emphasized: (1) process for meaning, (2) employ retrieval practice, (3) use metamemory, and (4) make use of distributed practice. Each of these individually can improve learning efficiency, and certainly in combination, they can make your learning and remembering far more efficient. In this section, we focus on the use of metamemory and the use of distributed practice. Judgments of learning can be useful in helping us guide our study. However, they should be used to determine which items are easy and which items are difficult. They should not be used to determine how long or in what manner to study. This is because of the stability bias-—which causes us to underestimate the advantages of future learning and discount the likelihood of forgetting. Distributed

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practice means that long-term retention is enhanced when we spread out our study over time as compared to studying all at once. Many studies have shown that distributed practice is superior to mass practice. Thus, even though students prefer massed study, if they wish to improve their learning efficiency, they should switch to distributed practice.

Section Quiz

1. The theory of metamemory that advances that an adaptive learning strategy is to study those items that have not yet been learned but are not too difficult—those at the leading edge of difficulty is known as the
   a. Judgment of learning theory
   b. Region of proximal learning
   c. Strategic agenda theory
   d. The labor-in-vain effect
2. Cameron has been studying for an exam. After considerable study, he attempts to evaluate his learning. Because he does not think he is benefiting from continuing to study and is confident he knows all the items that he will be tested on, he stops studying. What issue of memory efficiency should Cameron be concerned about?
   a. Stability bias
   b. The Kornell effect
   c. The region of proximal learning
   d. People's preference for massed practice
3. Kornell (2009) asked participants to study difficult, GRE-type words and their more common synonyms (e.g., *effulgent–brilliant*). He found that
   a. More than 90% of students did better with massed practice
   b. More students preferred distributed practice to massed practice
   c. Students learned about the same using massed and distributed practice
   d. All of the above are false
4. Two trials produce better retention if they are separated by more time than if they are closer together is known as
   a. Massed practice
   b. The judgment-of-learning effect
   c. Stability bias
   d. The spacing effect

1. b
2. a
3. d
4. d

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MYTHS AND METHODS TO AVOID

A few widely practiced mnemonic techniques and memory improvement strategies are not based on good science and in some cases, may work against good memory performance. These will be described briefly, because it is as important to avoid the bad techniques as it is to embrace good techniques in many endeavors, memory included.

First, there is no such thing as a memory drug—at least, not as of yet. If you go to your local health food store, you may see ginkgo biloba advertised as a memory-enhancing herbal supplement. However, there is no scientific evidence that ginkgo biloba actually boosts memory (Canter & Ernst, 2007). Though harmless, perhaps, it will not give your memory the boost that the advertisements on the bottles claim. Beck et al. (2016) found that, while harmless, ginkgo biloba did not improve memory or cognitive functioning in elderly adults. Many students rely on caffeine to help them study. Caffeine does allow one to remain alert for longer, but there is no evidence that it helps memory abilities. In fact, if anything, people who have caffeine in their bloodstreams are less efficient learners than those who do not have caffeine in their blood (Mednick et al., 2008). So drink your cappuccino if you like it, but do not expect it to help you remember material when you take the exam. (For more on this topic, go to www.sagepub.com/schwartz3e.[5])

Second, there is no science behind the claim that you can learn new information by subliminal methods or by playing tapes while you sleep (Druckman & Bjork, 1991). Subliminal learning means receiving information below the threshold of consciousness. Although such subliminal presentation can affect some behaviors (e.g., implicit memory), it does not seem to promote the learning and remembering of explicit information, such as the knowledge we acquire in college courses. Furthermore, there is no research to support the claim that playing tapes while sleeping will have any positive impact on later learning or remembering (Willingham, 2009).

A Note About Imagery-Based Mnemonics

You will note that imagery-based mnemonics have been largely left out of this chapter. Indeed, the principle upon which they are based—namely, that use of perceptual imagery can boost memory—runs counter to the first principle reviewed in this chapter (process for meaning). Don't let this confuse you. Memory is complex, and the more techniques we use, the more efficient memory can become. Therefore, processing for meaning and using imagery-based mnemonics will be superior to using either strategy by itself. In some cases, imagery techniques, such as the method of loci, will help you do this. Imagery-based mnemonics can be quite useful in remembering lists of arbitrary items, names, and especially new language vocabulary (see Verhaeghen & Marcoen, 1996).

Thus, by careful and intelligent use of these memory principles, it is possible to improve your memory. Repetition and distributed practice are important to the learning process—so we'll repeat them again: (1) Process for meaning, (2) engage in retrieval practice, (3) use metamemory wisely, and (4) distribute your practice.

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MNEMONISTS

For the overwhelming majority of us, even when we follow all the recommendations in this chapter, memory will still be hard work and take time. However, through a combination of innate ability and practice, some people have extraordinary memory. By and large, these people use memory techniques similar to the ones described in this chapter, but they often heavily rely on imagery, particularly variants of the method of loci, and remember new information much more quickly than do the rest of us (Foer, 2011). In this section, we will consider some of these famous **mnemonists** and how they remember or remembered so well.

Mnemonists: People with extraordinary memory. One becomes a mnemonist through a combination of innate ability and practice.

S

The famous Russian psychologist A. R. Luria wrote a book about his study of a young Russian man named Solomon Sherashevsky (Luria, 1968/1987). Luria referred to his subject by his initial, S, but since Mr. Sherashevsky was also a public memory performer, there is no need for anonymity. Sherashevsky was born into an educated Jewish Russian family, growing up learning Hebrew and Yiddish as well as Russian. He would later use his multilingual abilities to help him remember large lists when giving demonstrations of his memory.

As Luria described the development of this mnemonist, Mr. Sherashevsky was working as a reporter for a newspaper in Soviet-era Moscow when his editor noticed that, despite the fact that Sherashevsky never took notes, he seemed to remember everything: his assignment, the assignments of other reporters, indeed everything the editor said. On the urging of his editor, Sherashevsky visited the neuropsychologist Luria, who then began probing his memory in a collaboration that lasted years. In one study, Luria showed that he could give Sherashevsky a list of 70 items just one time and Sherashevsky could repeat the list *in any order!*

One thing that became clear to Luria was that Sherashevsky's great memory was in part dependent on his unusual sensory characteristics. Sherashevsky had a condition called **synesthesia**. Synesthesia means that sensory qualities from one sense (e.g., vision) are perceived as being sensory qualities in another sense (e.g., sound), in addition to the actual modality that they are perceived in (Brogaard, Marlow, & Rice, 2016). Synesthesia does not involve hallucinations; people with it know where the perceptions are coming from in the environment and behave normally in most circumstances. However, they have interesting perceptual responses. Many people with synesthesia, for example, see words as having colors. Thus, the word *image* may be purple, but the word *book* may be bright red. They know that the word *image* may be printed in any particular color, and they perceive that, too. But when they read the word *image,* a sensation of "purpleness" appears. Most people with this condition

Synesthesia: Sensory qualities from one sense (e.g., vision) are perceived as being sensory qualities in another sense (e.g., sound) in addition to the actual modality that they are perceived in.

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consider it an advantage, and many of them use it to become successful artists (see Ward, 2008). (For more on synesthesia, go to www.sagepub.com/schwartz3e.[6])

Sherashevsky employed his synesthesia to remember just about everything throughout his life. He could remember a single list memorized for Luria a year later without any loss of details. He claimed to be able to remember events from very early in his infancy, well before the offset of childhood amnesia in most people. Sherashevsky parlayed his memory abilities into a career, as he toured Russia showing off his memory abilities. But Luria claimed there was also a price to pay: Because of his vivid synesthesia and attention to sensory details, Sherashevsky would often become confused about the meaning of even the simplest stories. Sherashevsky was an intelligent man who could eventually figure out the meanings, but it was difficult for him at times, because the sensory characteristics would always overwhelm the meaning intended by the storyteller. Thus, a particular metaphor by an author would elicit a synesthesiac reaction from him, which was often counter to the intended meaning of the metaphor. He also picked up on the slightest errors in text—such as when a blue coat is later referred to as "navy." The change in color would completely throw off his imagery of the story. Such conflicts were confusing to Sherashevsky.

Most of the empirical work done by Luria concentrated on Sherashevsky's extraordinary ability to encode meaningless information on the very first trial, such as his ability to hear and then recall a long list of numbers. Luria did express interest in Sherashevsky's seeming inability to forget information from autobiographical memory. However, Luria did not extend his research into this domain. Recently, there have been a number of cases of people reported with superior autobiographical memory, including people who claim to be able to remember everything they have done on every day of their life. In one case, Parker, Cahill, and McGaugh (2006) studied a woman who reported "total recall"; she claimed to remember every event from her life. Parker et al. could find no events that their mnemonist participant could not remember from her life, who claimed to have exerted no effort in encoding the events of her life; in fact, there were events that she wished that she could forget, but she simply could not. However, documented cases of such superior autobiographical memory are rare indeed. (For more on the case investigated by Parker et al., go to www.sagepub .com/schwartz3e.[7])

Many other mnemonists have been studied by experimental psychologists. Some seem similar to Sherashevsky in that they have synesthesia (Yaro & Ward, 2007), or their exceptional abilities are unique to numbers (Takahashi, Shimizu, Saito, & Tomoyori, 2006; Thompson, Cowan, & Frieman, 1993). It is worth pointing out the title of one of the most recent scientific reports on a mnemonist—namely, "One Percent Ability and Ninety-nine Percent Perspiration" (Takahashi et al., 2006), which suggests that even individuals who claim to have great memory, demonstrate great memory, and may work as professional mnemonists need to put a great deal of work into it. This is described in detail in the book by Joshua Foer, which describes his journey from being ordinary journalist to the U.S. memory champion (Foer, 2011).

Exceptional memory has actually become a competitive sport. Every two years, at the Memory Olympics, participants compete in remembering names, remembering digits, and many other memory-dependent games. Maguire, Valentine, Wilding, and Kapur (2003) were able to study some of these competitors using fMRI. Relative to control participants,

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the "Olympians" showed more activity in areas of the right prefrontal cortex, which are associated with spatial memory and navigation. This is consistent with the report by more than 90% of the memory experts that they use the method of loci to aid their memory. (For more on memory competitions, go to www.sagepub.com/schwartz3e.[8])

SUMMARY

This chapter focuses on how each of us can improve our memory by learning and remembering more efficiently. Four major principles have been emphasized: (1) process for meaning, (2) employ retrieval practice, (3) use metamemory, and (4) make use of distributed practice. Each of these individually can improve learning efficiency, and certainly in combination, they can make your learning and remembering far more efficient. In this chapter, the various mnemonic improvement hints given throughout the book are organized according to these four memory principles. Moreover, it is possible to contrast normal memory and how to make it efficient with the exceptional memory seen in rare individuals. For the most part, these individuals combine a natural gift for or interest in memory with the same principles that improve normal memory. The author personally wishes each and every reader the best of luck in applying these cognitive principles to your own learning and remembering.

Table 13.1 Twenty-Two Mnemonic Tips

- Mnemonic Improvement Tip 1.1: **Overlearn:** Study past the point where you have mastered the material. Promotes long-term retention.
- Mnemonic Improvement Tip 1.2: **Use the spacing effect or distributed practice.** Space your study over time—don't study all at once. Promotes long-term retention.
- Mnemonic Improvement Tip 1.3: **Learning takes work.** There is no magic bullet for memory. Good memory requires hard work. Requires strategic planning.
- Mnemonic Improvement Tip 1.4: **External cues can help.** Structure your environment to help you remember. Promotes prospective memory and memory for ordinary objects.
- Mnemonic Improvement Tip 3.1: **Use chunking.** Group information in working memory. Promotes good short-term retention.
- Mnemonic Improvement Tip 3.2: **Practice working memory tasks.** Train your working memory, perhaps by practicing digit span tasks. Promotes good short-term retention.
- Mnemonic Improvement Tip 4.1: **Deep processing.** Use elaborative encoding. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 4.2: **Leverage the generation effect.** Produce your own associations and practice recalling the items you need to remember. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 4.3: **Organize the information.** Apply meaningful categories to to-be-learned material. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 4.4: **Use distinctiveness to advantage.** Focus on a distinctive aspect of to-be-learned information. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 4.5: **Use retrieval cues.** Create powerful retrieval cues that are strongly associated to the information. Ensures access to learned information.

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- Mnemonic Improvement Tip 4.6: **Leverage the encoding specificity principle.** Match your learning environment, internal and external, to the expected testing environment. Ensures access to learned information.
- Mnemonic Improvement Tip 6.1: **Use the method of loci.** Use a well-learned landscape to encode new items. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 6.2: **Use the keyword technique.** Make visual images that link to-be-learned items. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 6.3: **Use the pegword technique.** Use both visual and auditory imagery to learn new items. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 7.1: **Keep a memory diary.** Record events from your life every day. Promotes good retention of autobiographical events.
- Mnemonic Improvement Tip 8.1: **The cognitive interview.** Use the three principles of cognitive interviewing (context reinstatement, different temporal patterns, different spatial patterns) when retrieving eyewitness events. Allows for maximum retrieval of event detail.
- Mnemonic Improvement Tip 8.2: **Close your eyes.** Allows you to recall more details from episodic memories without a cost in false memories.
- Mnemonic Improvement Tip 9.1: **Make judgments of learning.** Assess what you know and don't know. Use this self-knowledge as a guide to what to study. Promotes rapid encoding of new information.
- Mnemonic Improvement Tip 9.2: **Work within your region of proximal learning.** Study easy or difficult items based on time constraints and learning goals. Maximizes study efficiency.
- Mnemonic Improvement Tip 11.1: **Engage in memory conversations.** Have frequent discussions with young children (and other adults) about past events. Promotes good retention and recall of autobiographical events.

KEY TERMS

acronym
acrostic
distributed learning or practice
encoding specificity
encoding variability
expanded retrieval practice
generation effect
judgments of learning
massed practice
metamemory
mnemonists
process for meaning
region of proximal learning
retrieval practice
self-regulated learning
spacing effect
stability bias
subjective organization
synesthesia
technical mnemonics

REVIEW QUESTIONS

1. What are the four broad principles of memory improvement?
2. Why is distraction considered an example of divided attention? What is the effect of divided attention on encoding?
3. What is subjective organization? What evidence exists that subjective organization is superior to other forms of organization?

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4. What is encoding variability? How can it be employed to improve memory?
5. What is retrieval practice? How can it be employed to improve memory?
6. How can students use judgments of learning to improve the efficiency of their study? What are the potential drawbacks of relying on judgments of learning?
7. When is massed practice helpful? Why is distributed practice generally a better study strategy?
8. Kornell (2009) conducted a study to examine the differences between massed and distributed practice. What was his methodology, and what did he demonstrate?
9. What is the difference between distributed practice and expanding rehearsal? When might expanding rehearsal be superior to distributed practice?
10. What is a mnemonist? How do the memories of mnemonists differ from those of normal individuals?

ONLINE RESOURCES

1. For a related approach to memory improvement, go to Daniel Willingham's website at http://www.danielwillingham.com.
2. For more on the advantages of self-testing and other mnemonic techniques, go to http://bps-research-digest.blogspot.com/2008/02/how-to-study.html.
3. For more on the region of proximal learning, go to http://www.columbia.edu/cu/psychology/metcalfe/Research.html.
4. For more on the differences between massed and distributed practice, go to http://www.psychologicalscience.org/index.php/publications/observer/2011/april-11/how-should-students-study-tips-advice-and-pitfalls.html.
5. It is likely that memory-enhancing drugs are not far off in the future. For more on this topic, go to http://www.newyorker.com/reporting/2009/04/27/090427fa_fact_talbot. Also see http://www.scientificamerican.com/article.cfm?id=the-quest-for-a-smart-pil.
6. For more on synesthesia, go to http://www.syn.sussex.ac.uk.
7. For more on the case investigated by Parker et al., go to http://www.universityofcalifornia.edu/news/article/7952/.
8. To learn more about the USA memory championships, go to http://www.usamemorychampionships.com.

Go to **www.sagepub.com/schwartz3e** for additional exercises and study resources. Select **Chapter 13, Memory Improvement: A User's Guide** for chapter-specific resources.

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