A Practical Guide to Study Skills

Amy Himsel
El Camino College

Like most of you, I had never been taught the best way to study. I am writing this chapter because I want studying to be less confusing and frustrating for you than it was for me, and I want you to know about study techniques that are effective and efficient. So, if you are ready for a change in your study habits, prepare to open your mind to some of the surprising findings from the science of studying. They reveal successful study strategies that will help you improve specific class and overall school performance. You'll discover that the brain has an incredible capacity to change when given the proper exercise—an ability you can apply to any area of your life.

Learning How to Learn

How do we learn? It's a simple question, but the answer is more complicated than you might expect.

Let Go of What You Think You Know

My study plan as a college freshman was straightforward: to memorize as many words as possible from my textbooks and professors' lectures. I was pretty good at this, furiously taking notes in class or as I read the course materials. I spent countless hours repeating the information in an effort to make it sink into my brain, and I earned a reputation for being one of the most studious (okay, obsessive) students in my dorm. So why wasn't I, master memorizer with a will of steel, earning straight As? Like many students, my assumptions about studying were guided more by "common sense" than by scientific reality. Unfortunately, then as now, "common-sense" notions are frequently incorrect (Stanovich, 2010).

It's easy to get tricked into thinking rote methods work because they *feel* so effective in the moment. During my marathon sessions of rote learning, I certainly *felt* like I was doing the right thing. But the proof is in the pudding, and my grades that first year did not match my feeling of mastery. Has this ever happened to you? If so, you are not alone. We are poor judges of how well we have learned something, and we chronically underestimate how much we know about a topic we have studied. Furthermore, the less we know about a topic, the less we realize we *don't* really know it (Kruger & Dunning, 1999). In the quest to become a better and more efficient learner, you must let go of what you think you know about studying and follow methods backed by science.

No matter what your grades were in the past or what your current habits or attitudes are, you can change for the better. Please don't underestimate the brain's potential for change. It is constantly changing due to experience, and you are capable of creating new experiences while you study. As you'll find out, if you learn how the brain works and give it proper attention and exercise, it can change to your benefit.

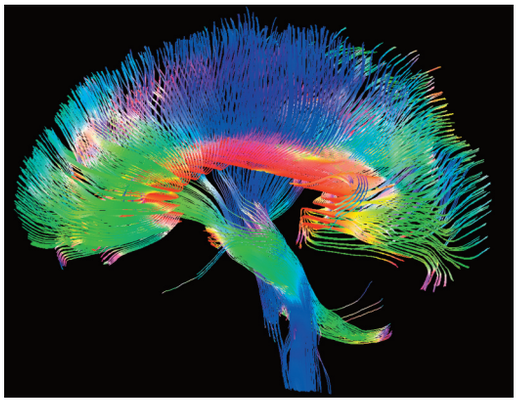
How Your Brain Really Works

Studying is about making memories, but memories are not made in a straightforward manner. We do not "place" information in one spot—like placing an item on a closet shelf, returning later to pick it up, dust it off, and then use it to answer a question on a test. Instead, we make memories when our brain's networks of connections are activated in patterns. Basically, here's what science tells us: Mental exercise creates and strengthens networks of connections in your brain similar to the way lifting weights strengthens your muscles (Medina, 2008). The more you "work" the information (for example, by explaining a concept in your own words), the more neural connections are made or strengthened and the stronger your memory becomes. As a result, you remember more when it's time to take a test.

But here's a surprising fact: Memories—including those formed while you study—are deeply personal, customized to fit your brain and nobody else's in exactly the same way. Why? Because learning is not like painting on a blank canvas. Rather, you start with a backdrop of networks that represent your current knowledge, preferences, and habits.

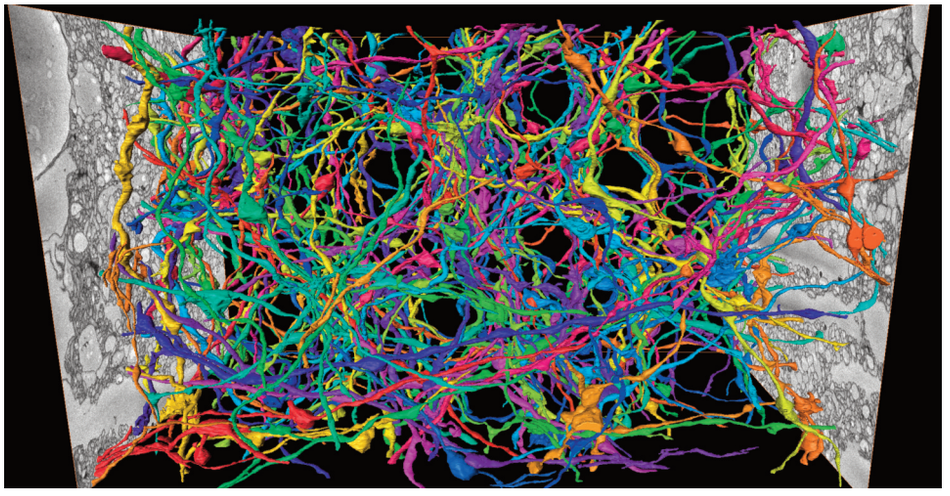
Simply put, you are your connections. You make long-lasting memories by weaving the new information into your unique brain cell connections. No two people will do this in exactly the same way. Likewise, there is no magic formula for studying well. With this in mind, start experimenting with the techniques described in this chapter to find out what works best for your brain. But please don't worry: You don't have to become an expert in neuroscience to learn how best to exercise your brain cell networks. Take a look at Figure 1, and then stay with me to learn the basics of brain change and how to apply that information to your everyday life as a student.

(a)



(a) Tom Barrick, Chris Clark, SGHMS/Photo Researchers

(b)



(b) Image courtesy of Dr. Sebastian Seung: Neural "wiring" reconstructed from the retina V. Jain, J. Murray, S. Turaga, and S. Seung (MIT); K. Briggman, M. Helmstaedter, and W. Denk (MPG)

FIGURE 1 The Connectome These images are models created to represent the incredibly complex and unique networks of connections among brain cells. Nobody's connections are exactly the same as yours. Shown in (a) is a model of neuronal connections across different regions of the brain as a whole. The model in (b) shows a close-up of the complex connections that have formed between individual neurons.

Getting Things into Your Head: Brain-Change Fundamentals

When you study, you start by bringing new information into your brain, a process referred to as encoding. Basically, when you pay attention to information, you encode it. Reading, listening to lectures, taking notes, and reviewing notes are all forms of encoding. But not all forms of encoding are equally helpful. Common study strategies—like rereading the text or notes, or trying to memorize definitions word for word—are rote methods that involve shallow processing, which results in very limited brain change. This kind of encoding produces only the weakest of neural connections, without generating enough raw material from which to later construct an accurate memory.

To study better, move beyond shallow encoding to process information at a deeper level. For example, relate the new information you are trying to learn to something that is already familiar to you. Let's say you need to learn the definition of the term *homeostasis* ("the maintenance of a steady internal state in the body"). That may seem very abstract until you think about your actual experiences with homeostasis—say, a time when you have felt hot and sweaty. That's your body trying to cool itself off, and that's a homeostatic experience. Ever felt dehydrated? That's your body signaling that more liquid is needed. Thinking in this way, you will find that homeostasis now seems far more familiar because you've connected it to knowledge and experiences that are already represented in your networks of brain cells. Even the simple act of putting things into your own words triggers deeper processing because you are converting the material into words that are more familiar to you. (See more about this in Table 1.)

Quality studying also requires practice in getting the learned information out again, a process referred to as *retrieval*. As a student, when I tried to remember the exact words of a definition, I was practicing retrieval—but only in a very shallow form. It is much better exercise for the brain when studying involves deeper methods of retrieval, like restating definitions in your own words (without peeking at your notes first!) or trying to explain the material to someone else.

TABLE 1 Rote Method Makeover

Common rote strategy	New and improved strategy
Reading	• Previewing each section before you read, and writing questions • Using questions to think while you read, and to test yourself after reading
Copying definitions	• Writing definitions in your own words
Memorizing definitions	• Stating definitions in your own words, as though you were trying to explain the terms to someone else
Copying notes	• Elaborating on your notes • Noting connections between your notes and your past knowledge or experience • Making connections between terms and concepts within the material
Rereading the text or your notes	• Processing your notes or the text in different ways • Self-testing with questions you wrote or those provided in the text • Testing yourself to see if you can repeat in your own words the material you have just read
Taking notes focused on the professor's words	• Writing down not only what is on the slide, board, or outline, but also supplementing with your own words • Marking spots of confusion and asking the professor for clarification later
Comparing your notes with a classmate to make sure you "got everything down"	• Discussing your notes with a classmate; explaining to each other the material in your notes • Filling in any gaps with your own words

The mental exercise involved in studying takes time to sink in and stabilize into lasting brain change. This is a process called *memory consolidation,* one that is similar to how your muscles need some rest after exercise in order to develop best. Memories settle into the fabric of the brain gradually, aided by time, sleep, and further mental exercise. Imagine what happens when you spend several hours drilling with rote methods and skimping on sleep in an effort to cram it all in: You actually make the task of learning harder on yourself by shortchanging your brain's memory consolidation process.

How do you apply these fundamentals to studying? What follows are some basic study tips to keep in mind.

Keep Things Challenging

Learning should not feel easy. To be more specific, creating strong, reliable memories—memories that are still there for you on the day of the exam—should not feel easy. Sorry, but that is true. Ignoring this fact is like expecting to housetrain your new puppy on day one. It's funny how this same advice is completely non-controversial when it comes to physical exercise. Who expects to develop impressive biceps by doing curls with only 1-pound weights? Challenging study stimulates deeper brain change, resulting in stronger memories that are more easily retrieved on demand. Scientists call this a "desirable difficulty" because the more you struggle to learn now, the stronger your neural networks become—and the less likely you are to forget the information later (Bjork & Bjork, 2011).

It all makes sense when you spell it out, but it's fascinating how quickly we forget and get tricked by our feelings in the moment. I used to parrot back all kinds of information and definitions in the midst of my marathon rote-method study sessions. It didn't feel difficult, especially after three hours of memorizing. I felt like I was really learning something, which made it all the more disappointing when my test scores showed otherwise. Sound familiar? If so, it's time once again to let go of what you think you know. When studying feels easy in the moment, that's exactly when you should doubt your mastery the most. In contrast, when you feel frustrated and unsure while studying, smile and pat yourself on the back—you are engaging in a vigorous mental workout. Those difficulties are desirable and will pay off big time later.

Space Out Your Study Sessions

I used to study for long stretches of time for each class. I figured the longer I kept at it, the better I would learn the material. Wrong. Contrary to common sense, it's much better exercise for your brain if you space out your study sessions for each class. Consider a weight-lifting analogy: If you wanted to tone up, would you expect your muscles to respond better to one five-hour workout a week than to five one-hour sessions a week? Of course not. Similarly, the brain responds best to short, focused study sessions spaced across several days.

Learning experts recommend you spend two to three hours studying for every hour spent at lectures. That's a lot of time, but it's much less overwhelming if you spread it out across several days. You'll see possible study schedules in the calendars in Figure 2.

Mix Things Up

Exercise your brain connections with some cross-training—that is, by varying the way you encode new information (see Figure 3 on page 6). Of course, it's a great idea to engage in traditional tasks like reading. But monitor your encoding: Are you just focused on memorizing words? If so, you are focused only on *visual encoding.* At that level, processing is shallow. So take another step and encode the information further. For example, the definition of a term will be most memorable if you focus on the meaning *(semantic encoding),* which is aided by putting the definition into your own words. Perhaps also try relating what you read to a body movement or gesture (Cook,

Marisol

2011	Sunday, Jul 17	Monday, Jul 18	Tuesday Jul 19	Wednesday, Jul 20	Thursday Jul 21	Friday, Jul 22	Saturday, Jul 23
11 AM							
						11:00 AM Study Psychology	11:00 AM Study English
Noon						12:00 PM Study Biology	12:00 PM Study Biology
1 PM	1:00 PM Study Chemistry			1:00 PM Study English			1:00 PM Study Chemistry
2 PM					2:00 PM Study Biology		
3 PM			3:00 PM Study English		3:00 PM Study English		
4 PM			4:00 PM Study Psychology		4:00 PM Study Psychology	4:00 PM Study Psychology	
5 PM			5:00 PM Study Chemistry	5:00 PM Study Chemistry		5:00 PM Study English	
6 PM		6:00 PM Study Psychology		6:00 PM Study Psychology		6:00 PM Study Chemistry	
7 PM		7:00 PM Study Chemistry		7:00 PM Study Biology			
8 PM		8:00 PM Study Biology	8:00 PM Study Biology				
9 PM		9:00 PM Study English					
10 PM							

Noah

2011	Sunday, Jul 17	Monday, Jul 18	Tuesday Jul 19	Wednesday, Jul 20	Thursday, Jul 21	Friday, Jul 22	Saturday, Jul 23
11 AM							
						11:00 AM Study Psychology	11:00 AM Study English
Noon						12:00 PM Study Biology	12:00 PM Study Biology
1 PM	1:00 PM Study Chemistry					1:00 PM Study English	1:00 PM Study Chemistry
2 PM	2:00 PM Study Psychology					2:00 PM Study Chemistry	2:00 PM Study Psychology
3 PM	3:00 PM Study Biology						
4 PM	4:00 PM Study English						
5 PM							
6 PM							
7 PM		7:00 PM Study Chemistry	7:00 PM Study Chemistry	7:00 PM Study Chemistry	7:00 PM Study Biology		
8 PM		8:00 PM Study Biology	8:00 PM Study English	8:00 PM Study English	8:00 PM Study English		
9 PM		9:00 PM Study Psychology	9:00 PM Study Biology	9:00 PM Study Psychology	9:00 PM Study Psychology		
10 PM							

FIGURE 2 Two Possible Study Calendars With this customized plan, both Marisol and Noah spend 2 to 3 hours studying for each hour of lecture. They space their studying out across the week in 1-hour blocks per subject—this practice allows rest between subjects for the brain connections they have exercised.

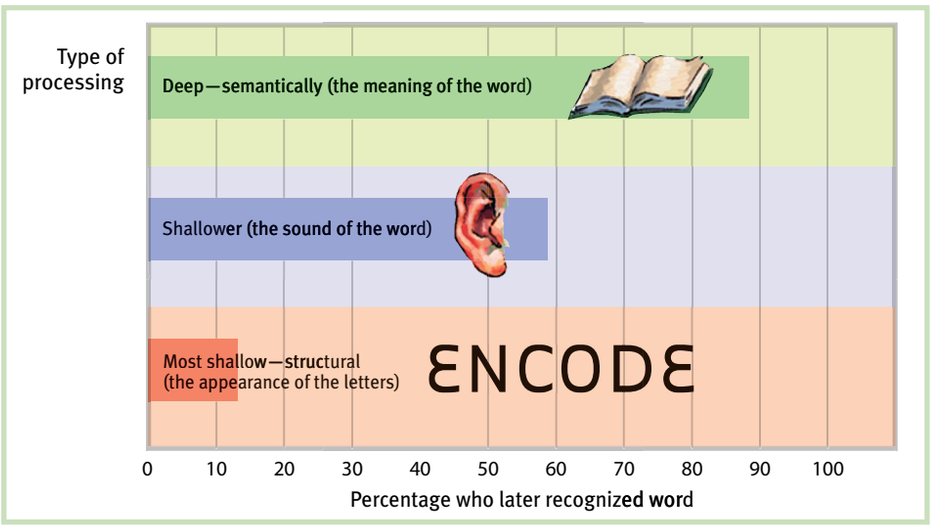


FIGURE 3 Levels of Processing
Processing a word deeply—by its meaning (semantic encoding)—produces better recognition of it at a later time than does shallow processing by attending to its appearance or sound. (From Craik & Tulving, 1975.)

Mitchell, & Goldin-Meadow, 2008). For example, to remember that two variables move in opposite directions in a negative correlation, try moving your arms in different directions as you rehearse the material. You could also try linking the material with a catchy phrase or tune, anything to add an auditory component to the memory. Each encoding experience will present an opportunity to make connections; with more connections formed, more paths will lead to the memory. Remember to never turn down the opportunity to strengthen your memory with more connections!

Test Yourself, Early and Often

If just the mention of the word *test* increases your heart rate, then here's another opportunity to let go of what you think you know: Testing is your friend. Self-testing is one of the best ways to overcome the tendency to overestimate how much you know by providing a reality check of your actual knowledge (Rohrer & Pashler, 2010).

For everyone, self-testing not only reveals current competence but also provides another set of exercises to train the brain. Every time you test yourself, you engage the brain in an attempt to retrieve a memory. This act alone helps strengthen connections among your brain cells. Nevertheless, networks strengthened through study weaken over time. The fact that you once knew something provides no guarantee that you will know it when you are assessed. So test yourself repeatedly to ensure that those memories stay strong.

Combining self-testing with well-spaced study sessions is an even more useful strategy. Spread your self-testing out to create the best opportunity for a strenuous mental workout. When some time has elapsed, even just a day or two, some forgetting will inevitably occur. You would think that's bad, right? It's not. Experts are finding that forgetting helps us learn (Kornell, 2009). Basically, a little forgetting now provides you with a lot of desirable difficulties the next time you study the material. Think of it as one step backward that leads to two steps forward.

SECTION REVIEW

- Rote methods, like rereading the text or memorizing definitions, may *feel* like they work, but they are not very effective for long-term learning.
- The best way to study is to work the to-be-learned information into the unique set of connections that already exist among your brain cells.
- You exercise your brain (and learn best) when you keep study sessions challenging but brief, utilizing a variety of strategies and testing yourself often.

Test Yourself

Hint: Don't look back at the text until you have pulled out of your memory as much information as you can.

- What are rote methods, and why are they less effective than other study methods?
- Why is self-testing such a valuable study skill?

Try It

- Set a timer to go off at regular intervals (perhaps every 15 minutes) while you study. When the buzzer sounds, simply ask yourself: "Does this feel easy?" If so, evaluate your study methods and strive to create more desirable difficulties.
- Give yourself an exam reality check. After you take your next assessment in a class, predict the grade you earned and write it down in your notebook. When the assessment is returned, write your actual grade next to your prediction. Is there a discrepancy? If so, consider why.
- Create your own study calendar for the week ahead. Remember to allow 2 to 3 hours of study for each hour of lecture, and be sure to space out your study sessions for each class.

Crafting Your Mental Workout Plan

Let's get practical and discuss how to translate brain-change knowledge into your everyday life as a student before, during, and after classes.

Exercise Your Brain by Reading Before Class

Reading before class is one of the most overlooked ways to boost your learning in a college course. Think of how a warm-up prepares the body for a workout. Reading the material before class serves a similar function. If you first process this new information and get the neural networks primed, the result will be a much more productive time in class. Why? You will have an easier time figuring out which information is most important. What you hear in class will more easily connect with the networks in your brain because of the mental warm-up. So make the most of your reading by following these tips:

Invite Desirable Difficulties

Get a good workout while you read: If you feel your eyes skimming across the page, or if you reach the bottom and don't remember much (if anything) of what you just read, then you are barely processing the information at all. It happens to the best of us. The important thing is to catch yourself, shake the cobwebs out of your head, and start again with the goal of staying more engaged. Awareness is a step in the right direction. See Table 2 on the next page for specific tips on how to keep your brain active while reading.

Space It Out

If you have a 50-page chapter to read for Monday's class, break it down into smaller chunks (perhaps 15- to 20-page sections), and spread your reading out across a couple of days. Here's another reason to space things out: If you are zipping through a 50-page chapter in one sitting, I doubt that you are engaging desirable difficulties! Pace yourself. Course materials are often organized into sections with headers. Read one or two sections in one sitting, but no more than that. Remember, your brain needs breaks in order for memories to consolidate. Also, this will help you manage your attention better and help reading become more enjoyable.

TABLE 2 Desirable Difficulties While You Read

Here are two specific methods to trigger challenges that help you get the most out of your reading.

SQ3R: The Survey, Question, Read, Rehearse, and Review Strategy
One structured approach to reading for deep processing is SQ3R (Robinson, 1970). Here are the steps:

- Before you read, survey the section to get a general idea of what information you will encounter.
- Next, formulate a question to keep in mind as you read. Your text may already include learning objectives or preview questions that help with this step.
- Now you are ready to read, but you should read with your question in mind, actively considering what the answer might be. Take notes, putting things in your own words as much as you can.
- After you have finished reading a section, take time to rehearse: put the text material in your own words, then ask yourself the question again (but no peeking at the text or your notes until you have answered!).
- The last step is to review what you have learned, paying special attention to the notes in your own words.

3R: The Read-Recite-Review Strategy
The 3R approach (McDaniel, Howard, & Einstein, 2009) is another method to encourage deep processing while reading. You can use this technique repeatedly with your texts or your notes.

- Read a brief section or passage.
- Close your book or cover the text, then recite in your own words anything you can remember about what you have just read.
- Open the book and review the passage to check yourself.

Self-Test While You Read

As you read, think of questions you could ask yourself to test your learning. Write them down somewhere. When you reach the end of the section, use these questions as a self-test quiz. How much did you remember? Take note of the information that you left out, and go back to review that material.

Work the Information in Different Ways

First and foremost, make sure you are focused on the meaning of the words, not memorizing the author's words, which triggers only shallow encoding. How can you do this? Take notes while you read, but don't just copy from a book or screen. Instead, put things into your own words. Consider how this new information fits in with your uniquely wired brain. How does it link to your experiences? Does an image come to mind? If so, draw it. Does a silly thought occur to you? For example, I remember reading about the hippocampus, a brain structure involved with memory, and I immediately thought: "Hippos are similar to elephants, and elephants supposedly have good memories." It stuck. It worked for me, but it might not work for you. Remember, you are your connections, so make what you read stick in a way that makes sense to you!

Go to Class and Train with an Expert

Go to your classes—each and every one of them. These are golden opportunities your brain shouldn't miss. This is a chance to have a mental workout with an expert on the topic. At the very least, a missed class is a lost opportunity to find out what the professor thinks is most important (in other words, what material is most likely to appear on assessments).

Your professor will present the material in at least a slightly different way than it is presented in the readings, so that alone will provide some helpful cross-training to

strengthen your neural networks. But it's ultimately up to you to make class worth your time. Just as simply moving your eyes across the page fails to result in much learning, sitting there and simply writing down whatever is on the board or slides only triggers the most shallow processing. So try the following procedures.

Create a Set of Complete and Personally Meaningful Notes

Notice that I said "create" instead of "take." This is an important distinction. When you "take" notes, you write down the exact words from the board or a slide, and that's it. Some students who are obsessive (as I was) attempt to write down as many words spoken by the professor as possible. In both cases, there is a misconception that the professor's words are magical: If you can just transfer them directly into your brain, you will be in good shape. It's simply not true. Research indicates that students who "create" comprehensive and elaborated notes tend to earn better grades (Peverly et al., 2007).

How do you do this? Of course you should write down the outline, terms, or key examples the professor has provided on the board or slides. And it's wise to jot down additional helpful details your professor may state, as long as you are not attempting to transcribe the words verbatim. What's most important is that you churn the information through your brain so it makes sense to you. You have to work with the information, and transform it in some way so it will become embedded within your neural networks. This strategy can range from simply putting things into your own words to jotting down a related example or a personal experience. It will build bridges that connect the professor's words with your brain.

Try some of these strategies to "create" your own notes:

- *Remind yourself to focus on the meaning, not just the words.* As much as possible, put things into your own words. Make your notes personally meaningful. If note taking seems quick and easy, view this as a warning sign. Keep desirable difficulties in mind.
- *Listen for organizational cues from your professor* (Kiewra, 2002). For example, a statement like "So we have just discussed X, and now I'd like to move to Y" is a clear signal that the lecture is shifting to a new topic. If the instructor tells you "There are four components of Z," use that as a signal to start a numbered list in your notes.
- *Develop a set of abbreviations and symbols*. Save time by abbreviating or using symbols whenever possible. Include those an individual professor uses and invent some of your own (see examples in Table 3). Just make sure the abbreviations and symbols help you make sense of the material.
- *Draw a representation of how concepts relate to each other*. Try venturing outside the standard outline structure. Consider using arrows, for example. Create drawings to represent the information.
- *Check yourself by noting spots where you got lost or confused*. I used to do this by writing a big question mark next to the spot where I got lost. After you mark the spot, shake out the mental cobwebs and then move on to keep up with the pace of the class. Stay after class to discuss the confusing part with the professor or a classmate. Do not wait.
- *As soon as possible after class, review your notes and jot down any additional information that comes to mind.* It's important to do this while the information is still fresh. Better yet, do this with a classmate. You may be able to fill in some blanks for each other. Kiewra (2002) calls this "the reconstruction strategy." But beware of shifting into rote mode! Don't just read and copy verbatim; actually discuss the notes, explain what they mean, and focus on which parts of the meaning either of you may have missed or misunderstood.

TABLE 3 Using Abbreviations in Your Notes

Allow your hands to keep up with the pace of class by using abbreviations in your notes. Here are just a few ideas to get you started, but the most important thing is to use symbols that make sense to your brain. What abbreviations could you add for some of the common words or phrases in your classes?

w/o	without
w/n	within
b/c	because
diffs	differences
beh	behavior
♂	male
♀	female
Ψ	psychology
?	ask professor
+	and
→	leads to, causes
≈	is similar to
≠	is not the same as

Train Your Brain for Exams and Other Assessments

Students often ask me how best to prepare for exams. It's a great question, but the problem is that most ask it less than a week before the exam. When should you start preparing for the exam? Today! But that doesn't mean you have to spend hours studying today. A little goes a long way, especially when you revisit the material several times a week. It's like going to the gym a few times a week instead of spending 10 hours there on Saturday to make up for a week of sloth. Here are some suggestions for how to proceed.

Process Your Notes Regularly

Research indicates that you will learn more from processing your notes than you learned while taking them (Kiewra, 2002; Knight & McKelvie, 1986). Rereading is not enough, and neither is copying notes verbatim. Oh, how I wish someone had told me this when I was a student! I wasted loads of time on this particular rote method. Of course, there is nothing wrong with rereading your notes the first time you revisit them. The problem is expecting that you will somehow be able to "write" the contents of your notes directly into your brain (Bjork & Bjork, 2011). This ignores the reality that each of us begins with a brain full of unique connections, where new information sticks best by being woven into the networks that already exist.

Use your notes as a springboard to organize and integrate the course material (see Figure 4). Consider how the different pieces of information connect to one another (*internal connections*), and then think about how the information relates to your prior knowledge and experiences (*external connections*) (Mayer, 1996). This is great exercise for the brain, helping to form and strengthen neural networks that can later consolidate into stronger memories.

- *Make internal links.* There are often numerous ways that the course material could be organized to show internal links, such as terms that can be grouped by some shared characteristic or terms that are notable for how they reveal opposite tendencies. Experiment with different ways to show internal links. You could construct a memory matrix, where you identify categories and appropriately place terms, concepts, or other information. Concept maps are another option; these are diagrams or figures you draw to show relationships among the various aspects of the material (see Figure 5).
- *Make external links.* You can relate the course material to information you currently know by forming mental representations. Depending on the way your mind works, this could come out in many different ways. The links could be visual. For example, I think of neural connections as colorful strands of yarn and of building strong memories as similar to knitting a blanket with that yarn. With further processing (strands/connections), the blanket (memory) becomes more and more resilient.

The links could also be verbal—for instance, analogies. Does a certain concept remind you of something else? If so, write in your notes: "It's like . . ." To understand how brain cells communicate, for example, you could note: "It's like a conversation." You could also imagine methods of linking the material to movements or sounds. Studies indicate that engaging the senses and motor skills when creating a memory yields additional cues that can help embed the new information more deeply into your brain (Glenberg, Brown, & Levin, 2007; Stevanoni & Salmon, 2005). The bottom line: You create stronger memories when you process the new information in a variety of ways.

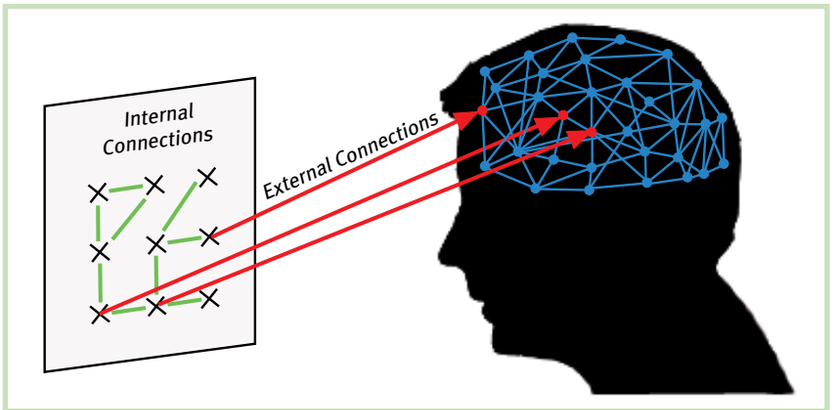


FIGURE 4 Internal and External Links
While making notes, try to connect the new information with things you already know. This is one specific way to weave the material into your uniquely connected brain, as shown in blue. In addition, pay attention to the connections you see between the bits of new information you encounter, as shown in green. Both methods help you process the material deeply. (Illustration after Kiewra, 2002)

- *Simply ask "why"?* Doing so is a very effective and straightforward way to make external links. This method of triggering self-explanation has been shown to improve learning more than does simple summarizing or rereading of notes (Kiewra, 2002). Why does it work? It forces you to think about the meaning of the material instead of focusing on the memorization of words.

(a)

Learning Theories

	Classical Conditioning	Operant Conditioning
main theorist	Pavlov	Skinner
basic idea	anticipation	consequences
specific conditioning terms	unconditional — stimulus, response conditional — stimulus, response	reinforcement — positive, negative punishment — positive, negative

(b)

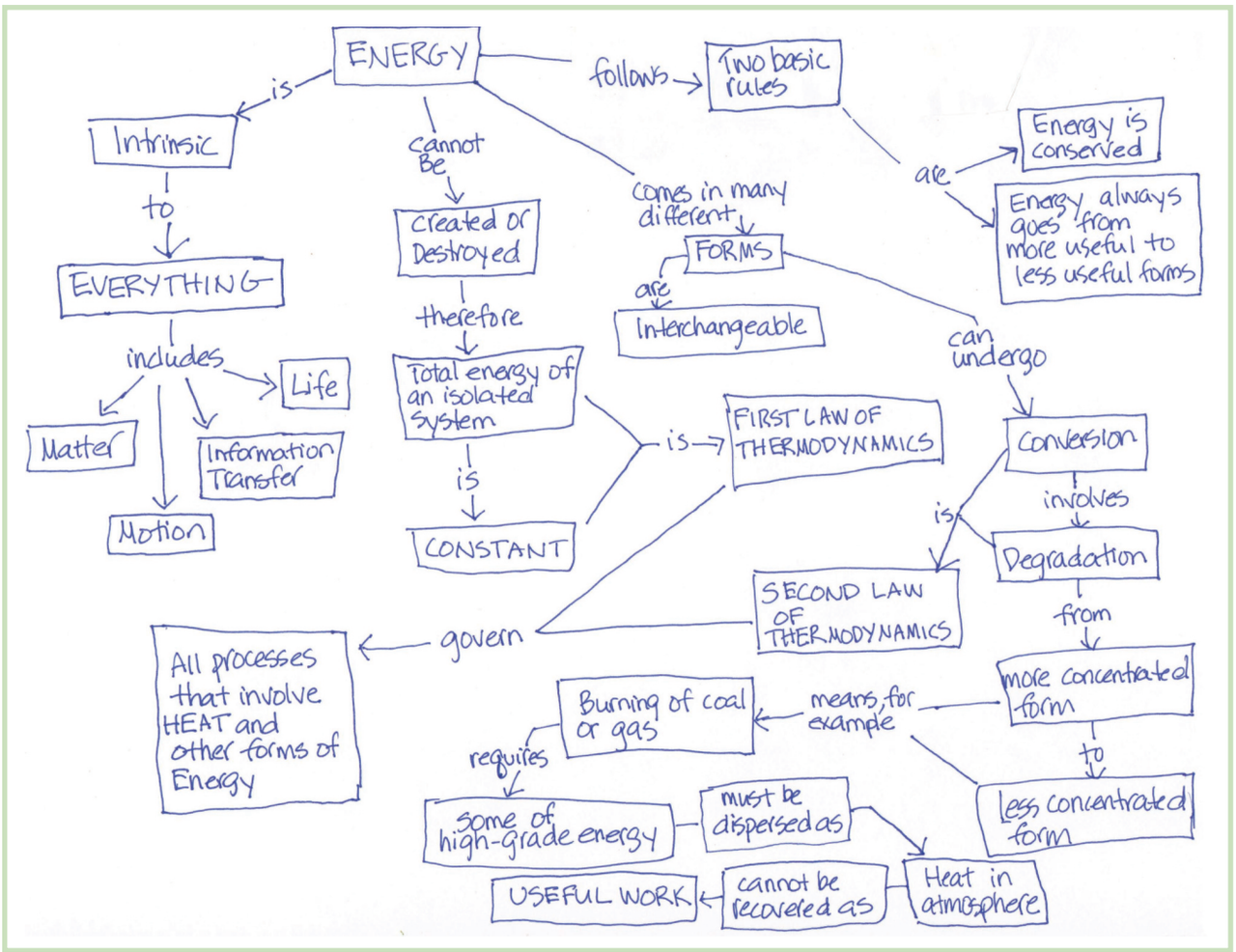


FIGURE 5 Memory Matrixes (a) and Concept Maps (b) **(a)** This memory matrix shows the distinctions a student made between two theories about learning. **(b)** This concept map shows how one student has organized her learning about energy and the natural laws governing it.

Check Your Learning Through Self-Testing—Repeatedly

How did you know that you could ride a bicycle? I remember the exhilarating feeling I had when the training wheels on my bike were removed and I rode down the driveway all on my own. It was scary at first, but eventually I brought the wobbles under control.

How do you know when you have really learned something? Most students rely on how familiar the material seems as they reread it or on how well they do on multiple-choice quizzes or test questions. Think about why that might be the case. Your notes, readings, and multiple-choice questions all contain the verbal equivalent of training wheels: words and organizational features that act as cues for your performance. The trouble is that, unlike training wheels on a bike, we don't realize how much our performance is assisted by these aids. The wheels come off for the exam—questions are in random order, unfamiliar wording is used, you're required to apply what you've learned—and suddenly your confidence is shaken. You feel wobbly. You discover that you really didn't know the material well.

Let's take the training wheels off for a moment, right now. Without looking back on the chapter, answer this question: How are memories formed in the brain?

Now look back to page 2 to check your answer. How much did you remember?

When you self-test like this, you get a more accurate view of how much you understand. This is especially true when you ask open-ended questions, like the one I used above—to answer, you are required to pull all of the information you can from the depths of your own brain. The real challenge is to put the course material away (for a few hours or a day) and then later see what you can still retrieve from the strands of information that were encoded. This strategy tests recall memory—a good countermeasure against that annoying human tendency to overestimate what you know.

There is another excellent reason to self-test: The act of trying to retrieve information helps us embed the information in the brain more deeply, which leads to stronger and more readily accessible memories. Remember, brain cell connections are strengthened by both encoding and retrieval. Making yourself come up with an answer (especially to an open-ended question) is one of the most effective exercises for your memory networks (Bjork & Bjork, 2011).

In short, self-testing is a great workout that will show you what you really do and don't know. Don't be surprised to find that there are some big gaps in your memory. Be happy you found them and can remedy the problem! Also, remember that if it's difficult while you're studying, it's more likely to be easier while you're being tested later. Self-testing creates desirable difficulties that strengthen your memories for long-term retention.

Here are some self-testing options you can try:

- *Use the tools the professor or text author gave you.* Many professors and texts provide lists of objectives, preview questions, or review questions. Just make sure to move beyond multiple-choice questions because, to begin with, they are easier. Focus on open-ended questions, like fill-in-the-blank or essay questions.
- *Make your own tests.* This is a lot easier than you might think. For example, go back to the questions you wrote in your notes while reading. Create flashcards and, on the back of each, write where in your notes the answer can be found. This will remind you not to try to rote-memorize "answers." You can also use the 3R method (look back at Table 2) as a simple and effective way to check your understanding while you study.
- *Mix up the order of questions.* This is a form of brain cross-training. If you always study everything in the same order, the order itself becomes a context cue that fools you into overestimating what you really know. Besides, many professors arrange their exam items in random order.
- *Try out a variety of study locations.* Even without our conscious awareness, cues from the places where we study help us form associations with the new material we are trying to learn (Smith, 2007; Smith & Vela, 2001). If we study in

only one location, we create only one set of context cues to link to the material. Studying in many different locations gives you the chance to form multiple context cues. In other words, trying out different study locations can actually help you form more connections between brain cells relevant to the material. More connections equal stronger memories.

- *Sort items back into their categories*. Shuffle your flashcards and then sort them into piles by chapter or topic. Now you are forced to think about how the items are similar to or different from one another, which is excellent exercise for the mind. Even if this seems too hard, it can trigger deep learning because of the workout it gives your brain (Kornell, in press). Remember, difficulties help you learn!
- *Pretend it is your job to teach someone else this material, someone who really needs the information.* This makes you think about the meaning of the material instead of just focusing on the literal words. Actors often use this method (Noice & Noice, 2006). They are encouraged not to rote-memorize the script but to think of the motivations, goals, and reasons why the person would be saying these things. Even just talking to someone about the material—a classmate, friend, or family member—can serve as a self-test. The concepts that are hard for you to explain are those that need more attention.
- *It is never too early to self-test.* In fact, some research shows that it helps to start testing yourself even *before* you've read the text or attended a lecture on the topic, especially if you follow up by investigating the correct answer afterwards (Richland, Kornell, & Kao, 2009). Aren't you likely to answer incorrectly? Yes, but creating that initial challenge of retrieval for your brain cells prepares you for longer-term retention of the material over time. The answer is less important than the mental exercise the question triggers.
- *Self-test to keep memories strong*. Knowing something now doesn't mean you'll know it at test time. Why? Because your brain has undoubtedly changed, at least a little bit, since you first made that memory. Some students make the mistake of studying only the difficult material, assuming that they already know the easier material. But if brain cell pathways haven't been exercised, even if that material once felt "easy," you may fail to retrieve the information when it matters at a later date (like during an exam!). Remember, the brain responds like a muscle. Imagine that you have finally reached the point where your biceps are perfectly toned. Congratulations! But that doesn't mean you never have to work them again. The same is true of memory.

Remember: Self-test to study; test early and often. Don't wait until it's too late!

SECTION REVIEW

- Warm up your brain by taking a deep-processing approach to reading the assigned material before class.
- View each class as an opportunity to further exercise your brain. Create notes that go beyond the professor's words, and compare your notes with those of classmates afterwards.
- To find out what you have really learned, and to continue the workout of your brain cells, test yourself early and often.

Test Yourself

Hint: Don't look back at the text until you have pulled out of your memory as much information as you can.

- From the perspective of training your brain, what is the purpose of reading the assigned material before class?

- What is the difference between rereading your notes and processing your notes?
- How early and how often should you test yourself while studying?

Try It

- Flip back to a section of this chapter that you found challenging, and use the 3R method (look back at Table 2): Read the section, cover it, then recite anything at all that you remember from the passage. Be patient and give yourself enough time to truly drain the contents of your brain. Finally, uncover the section and review it to check your understanding. Remember, you can use this strategy anytime you read a text or process your notes.
- Ask another student to "reconstruct" lecture notes with you shortly after a class. Discuss the content of your notes to see if either of you missed any information. Resist the urge to simply copy missed information. Instead, explain the material to each other in your own words, focusing on the meaning.
- Examine a set of notes you have recently taken during class. "Re-create" these notes, putting the material in your own words and making internal or external linkages as much as possible. Then devise a plan for how to incorporate more note-creating techniques during the next class.
- Create a "cheat sheet" list of self-testing strategies to keep close at hand as a reminder while you study. During every session of studying on your calendar for the week ahead, strive to incorporate one or two of these strategies at regular intervals.

The Moment of Truth: Exam Day

I am a very anxious test-taker. I dealt with my anxiety by getting to class early on the day of a test and frantically scanning my notes to pack in as many last-minute bits of information as possible. I thought I was improving my chances of success. In reality, I was stressing myself out and making things worse. I was usually sleep-deprived as well, heaping another unnecessary burden on my maxed-out brain (see the feature Help Your Brain Help You: The Importance of Sleep).

The First Thing to Do Is to Manage Your Stress

Of course you are nervous: You feel motivated to do your best yet worried about the uncertainty inherent in testing. (What questions will be on the test? Will I know the answers?) The stress is even greater with past experiences of disappointment related to testing. Stress makes us feel threatened, and the body responds by increasing heart rate, generating sweat, and pumping stress hormones through the bloodstream. Unfortunately, those worries steal valuable brain energy and make it difficult for you to function at top capacity. Instead of worrying about your stress response, take action. Here are some ways to manage test-day stress:

Breathe Deeply to Reduce Your Stress Response

This advice is simple but absolutely true. You may not be able to prevent the stress reaction, but you can have an impact on how long it lasts and how intense it becomes. Your body is simply unable to sustain that intense fight-or-flight reaction forever. And you can hasten its decline by taking charge of the things you can control, like the rate of your breathing.

HELP YOUR BRAIN HELP YOU

The Importance of Sleep

Take care of yourself. This advice is obvious when it comes to physical health; for example, no runner in her right mind would suggest staying up all night before a marathon. Yet, like me, I bet many of you have treated your brain poorly in pursuit of better grades. Pressed for time, we assume we must skimp on sleep to learn the material. Let go of what you think you know, and let sleep improve your memory!

No, I'm not talking about sleeping with your book beneath your pillow. Getting a good night's sleep helps the brain form and keep memories. How? A well-rested brain is better at encoding (Walker, 2008). In other words, if you're chronically sleep deprived, your brain has a harder time processing new information. You make learning harder on yourself.

Sleep also helps us strengthen and maintain the networks of memories we have recently formed. While you sleep, the brain reactivates the memories you worked on during the day, a form of mental exercise that knits those memories more deeply into your network of connections (Rasch & Born, 2008). Even a short period of daytime sleep can trigger the consolidation process that helps stabilize new memories in the brain (Mednick, Cai, Kanady, & Drummond, 2008).

Why not just power through sleepiness with caffeine? That was my "solution." I thought that Diet Coke and coffee made up for the hours of sleep I regularly skipped. Nope. In fact, research suggests that a nap may benefit your brain more than a double-shot latte. One study found that a 60- to 90-minute nap boosted memory significantly more than a 200- to 300-mg dose of caffeine (Mednick et al., 2008). Sure, caffeine makes you feel more alert, but a nap actually helps you *strengthen* the memories you've studied so hard to create.

I'm sure it's obvious why all-nighters before an exam are an absolutely terrible idea: You harm your brain's natural ability to cement memories at the very time it's most critical that your brain be working at top capacity! But even skipping a couple of hours of sleep is enough to decrease your brain's potential. Of all the advice in this chapter, this is the piece I most desperately wish I had known back when I was in college. I could have studied less and slept more? That's right! And I probably would have earned the same, or even better, grades. It's too late for me, but not for you: Get plenty of sleep and help your brain help you learn!

Have a Stress-Reduction Plan for the Moments Before the Test Is Passed Out

Figure out what helps reduce your stress response, and take action. Are you a social person who relaxes by talking to others? If so, engage in conversation with another student. Or do you need to focus inward in order to calm yourself down? Does music help you relax? Recent research suggests that highly test-anxious students relax and perform better when they write out their test-related worries for 10 minutes before the exam (Ramirez & Beilock, 2011). Try some of these suggestions, and find out what works best for you.

Identify Factors That Influence Your Ability to Stay Focused During the Exam, and Ask About Possible Accommodations

For minor requests, ask your professor. For example, if you are easily distracted by noise, ask your professor if you can use earplugs (not earbuds) during the exam. If it is noisy in the hallway, ask if the professor could close the door. If you think you may have a disability that warrants more significant accommodations, make an appointment with the disabilities services department on campus well in advance of any exams. Typically, professors are unable to make significant accommodations without this kind of expertise involved.

Be Strategic in Completing the Exam

Try some of these tips to give your brain the best chance to perform.

Start by Skimming

Skim the exam from start to finish before starting to answer questions. Why? On a practical level, skimming lets you take stock of what is coming. It reminds you of how many items are on the exam. It allows you to check whether the exam is

printed on both sides of the page, so you don't accidentally fail to answer any of the questions. But skimming is also an overlooked strategy for warming up your brain. As you quickly read each question, you are exposing yourself to a treasure-trove of cues that will spark activation of your neural networks. This may not happen immediately, and you may not be fully aware of it happening. But, when it helps, you will be happy you gave it a chance!

Write on the Exam (if permitted)

Your brain is very busy while you are taking an exam, so anything you can do to ease the cognitive strain can make a big difference. Circle important words (e.g., *not*, *all*, *except for*). Cross out answers you know are incorrect. Jot down notes, charts, figures—anything that comes to mind that could help you answer the question.

If You Are Uncertain, Mark the Question, Move On, and Return to It Later

As you work on other questions, the cues you encounter may begin to jostle connections and activate a pathway to the answer. When I was taking the statistics portion of my comprehensive exams in graduate school, I kept going back to the same question again and again. I just didn't know the answer. But eventually, after working on other parts of the test, the answer just popped into my head like a gift from the universe. I can't tell you how it happened, but obviously my work on the test shook up my neural networks and spread the activation to enough spots that allowed me to construct the memory. Sometimes you have to give your brain time to activate the proper networks. Remember, each memory may consist of thousands of connections, and any of these could serve as a lifeline to the information you need.

A Special Tip for Multiple-Choice Questions: Cover the Answer Choices, and Read Only the Stem of the Question First

Basically, treat a multiple-choice question like an open-ended question first, and try to recall the answer. Think of it as a strategy to warm up the relevant neural networks. Next, uncover the answer choices and make a decision. Why do this? Sometimes it's easy to overanalyze the answer choices, which can lead to confusion. Answer choices often contain a variety of cues that can lead you down the wrong neural pathways. Focus on the stem first, trigger those associations, and then consider the answer choices.

Don't Assume Your First Hunch Is Always Correct

Many of us have received the well-intentioned but misguided advice to trust our instincts and not change our initial answers. Let go of what you think you know! To the contrary, research indicates that students more often change from an incorrect to a correct answer than vice versa (Lilienfeld, Lynn, Ruscio, & Beyerstein, 2010). If you really don't know the answer, randomly making changes is not going to help improve your score. But if you are struck by compelling reasons that suggest your initial answer is incorrect, trust your reasoning.

A Special Tip for Essay Questions: Brainstorm and Outline First

You probably get more nervous about essay questions than multiple-choice ones, but don't let this fear freeze your brain. In the margins or on the back (if writing on the exam is permissible), sketch out any ideas that come to mind in response to the essay question. Try to organize these thoughts into some structure. This helps activate the relevant brain cell networks, basically warming up the brain. If the answer isn't coming to you, move on to other questions and come back to it later. Some-

times the act of answering other questions will remind you of other bits of relevant information. As that happens, write those ideas alongside the others. When you are ready to answer the essay question, make sure you provide the information that is requested. For example, compare/contrast questions require you not only to define concepts but also to show how they are similar to and different from one another. Application questions require that you not only provide definitions but also show how terms or concepts relate to a given example.

Don't Rush Through the Exam Just to "Get It Over With"

We all look forward to unpleasant experiences coming to an end. My dentist is a terrific person, but dental work is unpleasant, and I want appointments to be over as quickly as possible. It's only natural that you would feel the same way about exams. However, unlike being at the dentist, you decide how quickly to work on a test; within the overall testing-time framework, you decide when the ordeal is over. The anticipation is enticing: You look forward to the feeling of relief.

In my class, I often hear audible sighs as students walk out the door after taking a test. This desire for relief can lead you to work faster than you should, increasing your odds of misreading questions or making other careless mistakes. So take all the time you are given to show all of what you know on an exam.

SECTION REVIEW

- Manage your pre-exam stress so you can devote more of your brain's resources to demonstrating your mastery.
- Be strategic in completing the exam: Skim to get an overview, make notes to aid your memory, and allow the experience of taking the exam to activate the connections you made while studying.
- Do not rush. Take the time you are given to show what you really know!

Test Yourself

Hint: Don't look back at the text until you have pulled out of your memory as much information as you can.

- What impact does stress have on your brain?
- How can skimming the exam influence your memory?
- What should you do if you are having second thoughts about an answer you chose?

Try It

- Reflect on your typical pre-exam experience. What changes could you make to improve your brain's ability to do its best for you? Identify at least one strategy you could incorporate when you take your next exam.
- Evaluate the strategies you typically follow while taking exams, and plan out the changes you could make to improve your performance on the next one.
- The next time you take an exam, introduce a "mindful moment" whenever you feel overwhelmed. Try the S.T.O.P. method (Stahl & Goldstein, 2010): *Stop* (simply take a brief moment to pause). *Take* a deep breath. Without passing judgment, *Observe* what's going on in your mind and body (Is your heart rate elevated? Are anxious thoughts interfering with your reasoning?). Finally, *Proceed* (check the time, note how many more items you have to complete, and decide which test-taking strategies to use next). Remind yourself of this strategy by writing "STOP" at the top of your exam.

Actually Doing It

Consider this question: What are the observable behaviors that successful students engage in consistently? At this point, you should have all kinds of answers. That's the easy part. But consider a trickier question: Once successful, how do you prevent yourself from slipping back into old, ineffective patterns of study behavior, like cramming, depriving yourself of sleep, and rote memorizing? Unfortunately, "saying" is much easier than "doing." But take heart: Any pattern of behavior or thinking you engage in that is detrimental to your learning is still just a habit. Habits reflect well-worn pathways in the neural networks of the brain, like a map of our current default settings. Habits are not eliminated overnight, but they can be changed through awareness, persistence, and motivation (see the feature Help Your Brain Help You: The Trouble with Multitasking to learn about a common habit that makes learning more difficult).

Developing Habits of Self-Regulation and Self-Control

Changing habits requires plenty of self-regulation, something that is challenging for most of us. If you've ever known what you needed to do but had trouble actually doing it, you know what this is like. We need to exercise self-control, putting off something very interesting right now in order to do something else that is less interesting but will pay off big time later. Luckily, we can build self-control over time; it's another mental muscle that responds to training (Muraven, 2010). The benefits extend well beyond studying, too; our strengthened self-control helps us modify any habit or learn any new skill—from quitting smoking to learning a new job.

HELP YOUR BRAIN HELP YOU

The Trouble with Multitasking

Are you easily bored? I am. I get bored while I'm cleaning or doing laundry, so I often listen to a podcast or audiobook. It makes the time pass more quickly. As long as one of the tasks is virtually mindless (like folding laundry), multitasking can work just fine. But when you try to do two cognitively complex tasks at once—like studying while texting or IMing—the brain protests. Why? The brain cannot simultaneously engage in two tasks requiring complex cognition. Instead, it shifts back and forth between tasks. When you study, you exercise one set of networks in the brain. When you read and answer a text message, you switch to a completely different network. All of this switching puts a lot of stress on your brain. It's like requiring one conductor to switch back and forth between two different orchestras performing different pieces. Your brain is designed to do its best work when focused on one task (Rubenstein, Myer, & Evans, 2001). When you try to multitask while studying, you activate a less flexible and more basic area of the brain capable of only the most shallow processing (Foerde, Knowlton, & Poldrack, 2006).

You may feel like multitasking is necessary in order to keep you from feeling so bored. Maybe it seems like you're able to study longer while watching TV, using Facebook, or talking to friends. If this is the case, I need you to let go of what you think you know. Yes, time may seem to pass more quickly, but you are making things much harder on your brain by providing it with a very weak form of exercise. By eliminating distractions, you make your studying more efficient and effective. In short, multitasking wastes time; performing one task at a time saves time.

What if you are a chronic multitasker? Can you train your brain to switch between tasks without any declines in brain performance? The scientific evidence suggests the answer is no: Practice does not make perfect. In fact, those who multitask most often tend to show the steepest declines in their cognitive performance while multitasking (Ophir, Nass, & Wagner, 2009)!

If you are easily bored while studying, evaluate your study habits. Spending several hours memorizing definitions or rereading notes? That's boring. Instead of pulling out your cell phone or turning on the TV, use the strategies discussed in this chapter. Remember, studying that feels challenging now pays off the most later, and it also happens to be much less boring than memorizing flashcards. So try something different. Spend shorter periods of time on each subject, and alternate between subjects. Make a concept map. Create some open-ended questions and test yourself. Pretend you are teaching the material to someone else. Focus on having a high-quality mental workout, and your urge to multitask won't be so strong.

Procrastination is one of the biggest self-control challenges we face. It feels good in the moment because we have avoided an aversive task. In regard to studying, students procrastinate for many reasons. Some are afraid of failure, and some believe they do their best work under the pressure of the last minute. Whatever the reason, procrastination gives us an escape from an unpleasant feeling. But it always catches up with us in the end. One study found that students who procrastinated reported more health problems near the end of the term, perhaps because of the stress of all of that cramming. On top of that, their grades suffered as well (Tice & Baumeister, 1997). Here are some strategies you can use to strengthen your self-control.

Start with a Short Burst

If you are having trouble getting started with a task, make it very easy at first. Work on the dreaded task for only 10 minutes, and then take a 2-minute break to do something more interesting. Go back for another 10-minute work session, and then take another 2-minute break. Repeat as necessary! I do this to kick-start my grading, which at first leaves me feeling overwhelmed. But when I think about only spending 10 minutes on grading, it's no longer a big deal. What usually happens next is that the simple act of getting started breaks the spell of procrastination. I find that after a few 10-minute bursts, I can work longer.

Make Sure You Are Spacing Out Your Studying

Remember, it's better for your brain if your study sessions are short and frequent. This helps with procrastination as well, because a 1-hour study session seems far less dreadful than a 5-hour marathon.

Capitalize on Your Strengths and Interests

Fuse something that provides immediate rewards with something that advances you toward your long-term goal (Steel, 2007). For example, if you are a very social person who loves meeting new people, form a study group early in the semester and start meeting regularly. If you love nature, incorporate a short session of reading into your next hike. In other words, find ways to link studying with some of the things you love.

Make Small Changes in Your Environment to Stay Focused on Your Goals

People striving to meet health-related goals do this by eliminating unhealthy foods from their pantry at home. You can do something similar to advance your academic goals. Reduce distractions by turning off any indicators of new texts or e-mails. Better yet, put your cell phone in a different room. Is the Internet a constant temptation? Temporarily disable your online access. Do you have trouble staying focused in class? Sit where you are not able to see the clock, or put your watch or cell phone away so you can't see the time. Why? The more we check the time, the more slowly time seems to pass (Sackett, Meyvis, Nelson, Converse, & Sackett, 2010). Try sitting in the front row, where the professor is more likely to notice your behavior. That way, you're less likely to feel tempted to give into your urge to text, sleep, or daydream.

Act "As If"

Have you ever felt your attitude needed an adjustment? Try changing your behavior first. Do you think this is the most boring class in the world? Act "as if" you are interested: Get to class early, sit near the front, listen intently with an expression of interest, and create great notes. Quite literally, play the role of "interested student." Do this to boost your studying outside class (if necessary) as well. Obviously, this

will feel very strange at first, but research indicates that our attitudes often shift to line up with our behaviors (Festinger, 1957). This may not become your favorite class, but acting "as if" is likely to help improve your attitude and motivation. As a result, you have more energy to apply effective study strategies!

SECTION REVIEW

- Habits are behaviors learned over time. As such, habits can be unlearned through persistence and patience.
- Self-control and self-regulation habits are central to long-term, effective studying.
- You should focus on making small changes first.

Test Yourself

Hint: Don't look back at the text until you have pulled out of your memory as much information as you can.

- How is practicing self-control like engaging a muscle?
- Why can it be beneficial to your studying to act "as if" you are more interested and motivated than you sometimes really feel?

Try It

- Think back to a time when you successfully changed a habit. How did you do it? Adapt elements of that experience to change your least effective study habits.
- If you tend to put things off, choose one procrastination-reduction method to apply in the week ahead.
- Identify the biggest distractions you face while studying, and make changes to your environment to minimize these distractions the next time you study.

If At First You Don't Succeed . . .

Effective habits for studying and self-regulation come from the same place: the well-trained brain. Imagine your brain cells lifting weights, getting stronger and building more connections every day. It will take time to figure out which strategies work best for you, so be prepared to experiment. Remember, your brain is wired uniquely; the strategies that work best for you may be different from those that work best for others. You may also find that different classes require different strategies, so prepare to modify your approach accordingly.

Allow yourself to be human. You will probably lapse back into ineffective strategies or habits occasionally. What matters most is what you do next. Take a lesson from a recent study on procrastination (Wohl, Pychyl, & Bennet, 2010). Students who forgave themselves for procrastinating before Exam 1 were much less likely to procrastinate before Exam 2. Self-forgiveness prevented them from spiraling into apathy, like a dieter who slips up with one cookie and decides he might as well eat the whole box. The self-forgivers acknowledged their slip-up and took the next opportunity to get back on track again. So with these findings in mind, keep persisting!

Whether your future plans include academics or not, I hope the practical advice offered in this chapter will help you make long-lasting changes in the way you approach any type of learning experience.

References

Bjork, E., & Bjork, R. (2011). Making things hard on yourself, but in a good way: Creating desirable difficulties to enhance learning. In M. A. Gernsbacher, R. W. Pew, L. W. Hough, & J. R. Pomerantz (Eds.), *Psychology and the real world: Essays illustrating fundamental contributions to society* (pp. 56–64). New York: Worth Publishers.

Cook, S. W., Mitchell, Z., & Goldin-Meadow, S. (2008). Gesturing makes learning last. *Cognition*, *106* (2), 1047–1058. doi:10.1016/j.cognition.2007.04.010

Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General, 104*, 268-294.

Festinger, L. (1957). *A theory of cognitive dissonance.* Evanston, IL: Row, Peterson.

Foerde, K., Knowlton, B. J., & Poldrack, R. A. (2006). Modulation of competing memory systems by distraction. *Proceedings of the National Academy of Sciences*, *103*(31), 11778–11783. doi:10.1073/pnas.0602659103

Glenberg, A., Brown, M., & Levin, J. (2007). Enhancing comprehension in small reading groups using a manipulation strategy. *Contemporary Educational Psychology*, *32*(3), 389–399. doi:10.1016/j.cedpsych.2006.03.001

Karpicke, J. D., & Blunt, J. R. (2011). Retrieval practice produces more learning than elaborative studying with concept mapping. *Science, 331*(6018), 772–775. doi:10.1126/science.1199327

Kiewra, K. A. (2002). How classroom teachers can help students learn and teach them how to learn. *Theory into Practice*, *41*(2), 71–80.

Knight, L. J., & McKelvie, S. J. (1986). Effects of attendance, note-taking, and review on memory for a lecture: Encoding vs. external storage functions of notes. *Canadian Journal of Behavioural Science/Revue canadienne des sciences du comportement*, *18*(1), 52–61. doi:10.1037/h0079957

Kornell, N. (in press). Discrimination learning: Training methods. In H. Pashler (Ed.), *Encyclopedia of the mind.* Thousand Oaks: Sage Reference.

Kornell, N. (2009). Optimising learning using flashcards: Spacing is more effective than cramming. *Applied Cognitive Psychology*, *23*(9), 1297–1317. doi:10.1002/acp.1537

Kruger, J., & Dunning, D. (1999). Unskilled and unaware of it: How difficulties in recognizing one's own incompetence lead to inflated self-assessments. *Journal of Personality and Social Psychology*, *77*(6), 1121–1134. doi:10.1037/0022-3514.77.6.1121

Lilienfeld, S. O., Lynn, S. J., Ruscio, J., & Beyerstein, B. L. (2010). *50 great myths of popular psychology: Shattering widespread misconceptions about human behavior*. Malden, MA: Wiley-Blackwell.

Mayer, R. E. (1996). Learning strategies for making sense out of expository text: The SOI model for guiding three cognitive processes in knowledge construction. *Educational Psychology Review*, *8*(4), 357–371. doi:10.1007/BF01463939

McDaniel, M. A., Howard, D. C., & Einstein, G. O. (2009). The Read-Recite-Review study strategy: Effective and portable. *Psychological Science*, *20*(4), 516–522. doi:10.1111/j.1467-9280.2009.02325.x

Medina, J. (2008). *Brain rules: 12 principles for surviving and thriving at work, home, and school*. Seattle, WA: Pear Press.

Mednick, S., Cai, D., Kanady, J., & Drummond, S. (2008). Comparing the benefits of caffeine, naps and placebo on verbal, motor and perceptual memory. *Behavioural Brain Research*, *193*(1), 79–86. doi:10.1016/j.bbr.2008.04.028

Muraven, M. (2010). Practicing self-control lowers the risk of smoking lapse. *Psychology of Addictive Behaviors*, *24*(3), 446–452. doi:10.1037/a0018545

Noice, H., & Noice, T. (2006). What studies of actors and acting can tell us about memory and cognitive functioning. *Current Directions in Psychological Science*, *15*(1), 14–18.

Ophir, E., Nass, C., & Wagner, A. D. (2009). From the cover: Cognitive control in media multitaskers. *Proceedings of the National Academy of Sciences*, *106*(37), 15583–15587. doi:10.1073/pnas.0903620106

Peverly, S. T., Ramaswamy, V., Brown, C., Sumowski, J., Alidoost, M., & Garner, J. (2007). What predicts skill in lecture note taking? *Journal of Educational Psychology*, *99*(1), 167–180. doi:10.1037/0022-0663.99.1.167

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science*, *331*(6014), 211–213. doi:10.1126/science.1199427

Rasch, B., & Born, J. (2008). Reactivation and consolidation of memory during sleep. *Current Directions in Psychological Science*, *17*(3), 188–192.

Richland, L. E., Kornell, N., & Kao, L. S. (2009). The pretesting effect: Do unsuccessful retrieval attempts enhance learning? *Journal of Experimental Psychology: Applied*, *15*(3), 243–257. doi:10.1037/a0016496

Robinson, F. P. (1970). *Effective study*. New York: HarperCollins.

Rohrer, D., & Pashler, H. (2010). Recent research on human learning challenges conventional instructional strategies. *Educational Researcher*, *39*(5), 406–412. doi:10.3102/0013189X10374770

Rubinstein, J. S., Meyer, D. E., & Evans, J. E. (2001). Executive control of cognitive processes in task switching. *Journal of Experimental Psychology: Human Perception and Performance*, *27*(4), 763–797. doi:10.1037//0096-1523.27.4.763

Sackett, A. M., Meyvis, T., Nelson, L. D., Converse, B. A., & Sackett, A. L. (2010). You're having fun when time flies: The hedonic consequences of subjective time progression. *Psychological Science*, *21*(1), 111–117. doi:10.1177/0956797609354832

Smith, S. M. (2007). Context and human memory. In H. L. Roediger, Y. Dudai, & S. M. Fitzpatrick (Eds.), *Science of memory: Concepts* (pp. 111–114). Oxford: Oxford University Press.

Smith, S. M., & Vela, E. (2001). Environmental context dependent memory: A review and meta analysis. *Psychonomic Bulletin and Review, 8,* 203–220.

Stahl, B., & Goldstein, E. (2010). *A mindfulness-based stress reduction workbook*. Oakland, CA: New Harbinger Publications.

Stanovich, K. (2010). *How to think straight about psychology* (9th ed.). Boston: Allyn & Bacon.

Stanovich, K. E. (2010). *Rationality and the reflective mind.* New York: Oxford University Press.

Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin*, *133*(1), 65–94. doi:10.1037/0033-2909.133.1.65

Stevanoni, E., & Salmon, K. (2005). Giving memory a hand: Instructing children to gesture enhances their event recall. *Journal of Nonverbal Behavior*, *29*(4), 217–233. doi:10.1007/s10919-005-7721-y

Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological Science*, *8*(6), 454–458. doi:10.1111/j.1467-9280.1997.tb00460.x

Walker, M. P. (2008). Sleep-dependent memory processing. *Harvard Review of Psychiatry*, *16*(5), 287–298. doi:10.1080/10673220802432517

Wohl, M. J., Pychyl, T. A., & Bennett, S. H. (2010). I forgive myself, now I can study: How self-forgiveness for procrastinating can reduce future procrastination. *Personality and Individual Differences*, *48*(7), 803–808. doi:10.1016/j.paid.2010.01.029