

How to Read Effectively

In 2007, speed-reading champion Anne Jones sat down in a London bookstore to read *Harry Potter and the Deathly Hallows*. After forty-seven minutes, she had finished the entire 784-page book. At that rate, Jones was reading at 4,200 words per minute—approximately twenty times faster than the average person. If you could double or triple your reading speed—while still understanding what you read—it would be useful. But is it possible? ✕

How to Actually Read Faster, and Why Speed-Reading Techniques Don't Work ↩

To better understand what you can do to read effectively, it can help to first know a little about the reading process itself.

When you read a word—say, “car”—you first recognize the word. Next, you silently pronounce or “**subvocalize**” it before finally converting it to the idea or concept it represents.¹



To recognize a word, the eye stops to focus on it for around 0.25 seconds. Then the eye jumps to the next word, where it stops and focuses again before jumping to the next word, and so on. These jumps take less than 0.1 seconds.



When you read, your eyes alternate between stopping at a word to focus on it and jumping to the next.

Some speed-reading programs claim to increase your reading speed by reducing these jumps and stops. Such programs will ask you to read three words at a time, or if you're using an app, they'll flash three words at a time, eliminating the need for the eye to jump altogether.



Speed-reading programs often recommend focusing on three words at a time to help reduce the number of jumps. But reducing your eye's motion doesn't speed your brain's processing.



However, research has revealed that your brain is processing the previous word during the jump to the next word.² *The jump is not what slows you down.* What's holding everything up is the mental processing—the recognition of the word, subvocalization, and the conversion to idea or concept.

So if you try to increase your reading speed by cutting back on focus stops and jumps, you're not addressing the real constraint on your reading speed. **If you do want to read faster, you need to speed up the word recognition and conversion to concept.** You can do this by having a good vocabulary, the right background knowledge, and plenty of experience with reading.

Effective Reading Is All About Comprehension

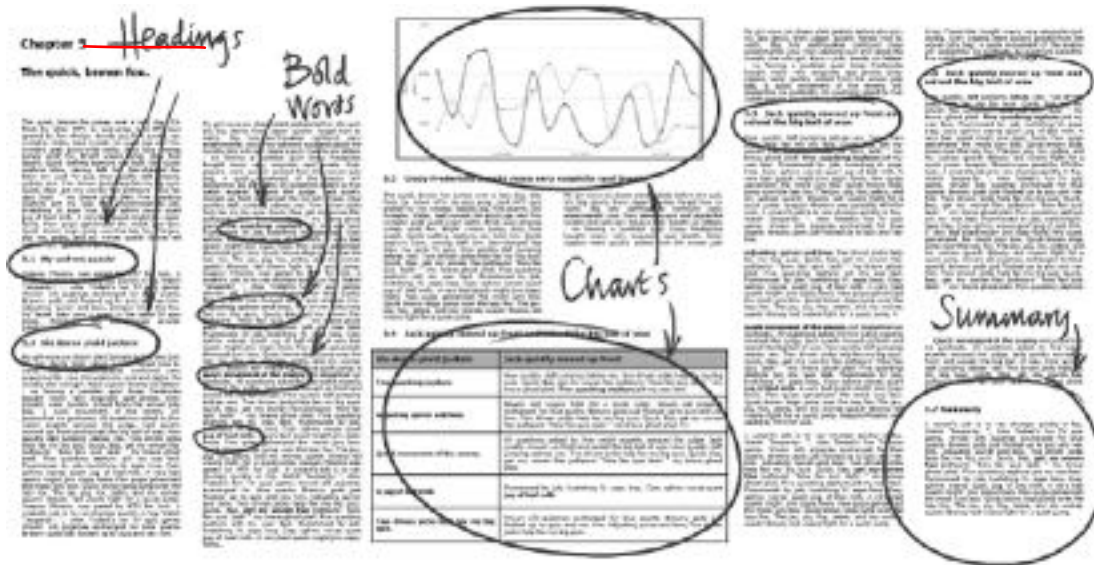
Even though you can increase your reading speed by building your vocabulary and background knowledge, there does seem to be a limit. Research shows that fewer than 1 percent of people can read at speeds faster than four hundred words per minute without loss of comprehension.

For most people on typical reading materials, a comfortable reading speed will be around one hundred to three hundred words per minute. But that's okay, because **effective reading isn't about speed; it's about understanding what you read and remembering it.** You may notice that if you read a lot of highly technical material, your general reading speed even on non-technical material may slow down. That's perfectly normal. Besides, slowing down a little can improve your comprehension.

So how did Anne Jones read the entire Harry Potter book at 4,200 words per minute? It's worth noting that Jones's comprehension was not scientifically measured. Instead, she simply gave a synopsis of the book to reporters. As reading experts argued, she could have done this because she had already read all the earlier Harry Potter books, and she might have had a lot of practice in summarizing books based on bits and pieces of information.³ Could Jones have used the same techniques to carry her as swiftly through a textbook on vector calculus? We doubt it.

Preview the Material

It's much easier to put together a jigsaw puzzle if you've already seen a picture of what the completed puzzle should look like. In the same way, a quick, “big picture” overview of a new chapter can give a useful sense of what's going on before you dive into the details.



Previewing the text means **skimming through the summary and the structure of the book to get a big-picture feel of the text.**

Most textbooks are designed with a specific layout that includes the summary, chapter goals, end-of-chapter questions, bolded headings, pictures, and captions. If your book is like this, before you start reading thoroughly, take a few minutes to skim through. What's the big picture—where's the chapter going?

You may not feel that you're learning much from such a quick review, but the point is just to develop a framework that will help later, as you read through at your usual speed. If you find that you get lost in the details as you read, you can do another preview to remind yourself of the big picture.

Avoid Passive Reading Practices

"Adler and Van Doren's suggestions . . . will make you nostalgic for a slower, more earnest, less trivial time." —ANNE FADIMAN

HOW TO READ A BOOK

THE CLASSIC GUIDE
TO INTELLIGENT READING

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Pigeonhole Principle

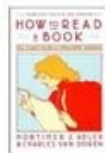


Notes by Sacha Chua, Twitter: @sachac, LivingAnAwesomeLife.com

HOW TO READ A BOOK

MORTIMER J. ADLER & CHARLES VAN DOREN

1972



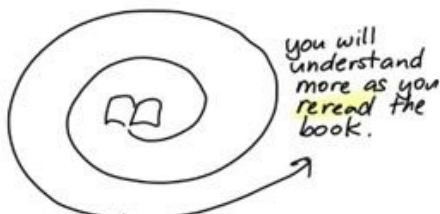
INSPECTIONAL READING

~~systematic skimming~~

Does the book deserve careful reading?
Q Title, table of contents, index, blurb, key chapters, skimmed pages

Superficial reading:

In tackling a book for the first time, read it through without ever stopping to look up or ponder the things you do not understand right away.



you will understand more as you reread the book.
Read at the speed appropriate for the book.

ANALYTICAL READING

Understanding

Notes $\left\{ \begin{array}{l} \text{structural} \\ \text{conceptual} \\ \text{dialectical (discussion between books)} \end{array} \right.$

1. Classify the book.
2. Summarize the book in one sentence or a short paragraph.
3. Show the book's organization/structure.
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Is it true?
So what?

SYNOPTICAL READING

many books & their relationships

$\left\{ \begin{array}{l} \text{Build a bibliography} \\ \text{Inspect books quickly} \\ \text{Analyze selected books} \end{array} \right.$

1. Find the relevant passages (relevant to you) $\left\{ \begin{array}{l} \text{important?} \\ \text{not important?} \end{array} \right.$
2. Reconcile authors' terms.
3. Clarify the key questions in the discussion between books.
4. Define the issues.
5. Analyze the discussion.

Lots of tips on how to read different types of material. (Including philosophy!)

Exercises for different levels of reading!

Let's say you're determined to master a new chapter in your computer forensics textbook. You highlight part of what you're reading—this makes you feel like you're actively engaging with the text. Then you reread the chapter, your eyes skimming more easily over the material, and notice that the information now seems more familiar. Surely, you think, you must be burning the information into your brain.

But your intuition is deceiving. When you highlight material, for example, you activate the parts of your brain involved in the movement of your hand. That's why you feel you're doing something active. But the “move your hand” part of your brain is not necessarily where the learning links of conceptual understanding are formed. **In other words, highlighting or underlining is passive, at least from the perspective of learning. It is not doing much to create the neural links of learning in your long-term memory.**

Rereading the chapter right after you've first read it can provide a deceptive familiarity. The words become more familiar, but you're not truly grappling with the material—the so-called fluency fallacy. Your neurons aren't being forced to make connections. Along these lines, Carol Davis, an instructor of electrical engineering technology, notes, “Rereading takes away from time you could be actively learning and makes you feel like you've been studying forever without getting anywhere at all.”⁴

If you want to reread, wait at least a day and remember to supplement it with more active learning methods. The exception to this is when the material is particularly dense, with many new and complex concepts. In that case, you may find yourself rereading paragraphs or sections repeatedly before you start understanding what's going on. Ultimately, your first read, followed by sleep time to help with consolidation, can give a sense of the big-picture concepts, while your second read can allow you to focus more on the details.

Practice “Recall Reading”

One of the best ways to read actively is to use a technique we've discussed earlier: *recall*, (retrieval practice) by researchers.⁵ The recall technique allows you to not only remember, but also better understand key ideas. One

study compared rereading to recall and found that students who used recall remembered 25 percent more of the text a week later.⁶ Another study showed that recalling material one time doubled the long-term retention, while repeated recall resulted in a 400 percent improvement in retention when compared to studying one time.⁷

We've alluded to using recall during reading briefly before, but here's a more concrete rundown. Read a page as carefully as you can, trying to pick out the key ideas. Then look away and either tell yourself or write down those key ideas. If that's difficult, reread the text, (yes, it's okay to reread—but this time, try to pay closer attention!) then try again. Another attempt at recall the next day can be even more helpful; this allows you to check whether you've placed the information in long-term memory. (Again, if the material is particularly dense, you may want to reread it the next day prior to attempting recall.)

You can also do this with your notes. Rather than rereading your notes, try to *recall* what's in them. Or write summaries you can refer to later to study for the exam.

Think About the Text

To develop a deep understanding of what you're reading, it's paramount to find a way to actively think about the content and connect it to what you already know. There are many ways you can do this. **Pause to think occasionally, or to summarize what you read in your own words. Use the elaboration technique introduced in chapter 3, or find someone that you can discuss the content with.** Answer questions about the text. If your reading involves technical material, practice with problem sets. These ways of actively thinking about the material will not only improve understanding, but also make you more likely to remember details, since memory and understanding are connected.⁸

An Excellent Strategy for Active Reading: Annotation

Writing down short comments and questions as you read—“annotating”—is an excellent strategy for active reading that also makes it easier to review and refer back to the text.⁹ If you read a document digitally, you can use the commentary/annotation tool provided. If you read on paper, you can make small notes directly in the margins, on Post-it Notes, or on a separate note sheet. This is what you should write down:

- Important ideas, **rephrased** using as few words as possible
- Relationships between concepts
- Your own examples or references
- Information you do not understand or need clarified
- Summaries of key paragraphs
- Potential test questions

The most important part of this strategy is to make sure you're putting the notes in your own words. By processing the information enough to paraphrase, you're gaining a deeper understanding of the material than if you simply rewrite what is in the text.

Make sure you include details as well as big-picture concepts. You need both to gain a deep understanding of the material. But don't just write a vague abstract summary, such as “identifies different types of leaves.” Instead, be concrete: “5 types of leaf edges: entire = smooth; sinuate = curves/waves...”

When you have completed annotating the reading assignment, write a three- to five-sentence summary of the assignment. If you're unable to articulate the key ideas, you should review your annotations and attempt the summary again. If you're still unable to summarize the reading, you should reread the unclear sections and take additional notes on the reading.

How to Handle Excessive or Difficult Texts

Olav once coached “Nina,” a college psychology student who felt overwhelmed by all her readings. Together, the pair piled up all her books and articles and discovered it would take three months of full-time reading

to get through the material. No wonder Nina felt behind on her reading! She therefore categorized her readings into “Need to read” and “Nice to read.” This allowed her to prioritize her studies—and ultimately, to be far more successful.

If you’re studying at a university level and are overwhelmed with text, you can do the same. Ask your instructor, or students who took the course last year, for advice on which readings to consider mandatory, highly recommended, or supplementary. In college, for example, books often cover far more than your course does, so identifying the key chapters or sections within chapters can focus your studies while saving you a lot of time. If it’s still too much, split the reading with other students and exchange summaries.

If you’re doing your reading to try to acquire new skills for a job, the same rules apply. Try to prioritize and at least pick up the main points. Don’t try to assimilate every little detail. Instead, just put in the time you can doing your best at improving your mastery.

Whatever you’re reading, if you’re struggling with difficult explanations, see if you can find simpler ones. Ask a friend or tutor to explain the material to you. Watch a YouTube video. Or take a break to allow the diffuse mode to kick in.

★ ★ ★

At the end of the learning road, there’s usually a test. In the next chapter we’ll see how to finish off strongly when all your learning is assessed and graded.

KEY TAKEAWAYS

FROM THE CHAPTER

- **Trying to read more quickly is not the way to read more effectively.** If you try to increase your reading speed beyond what feels natural, your comprehension will suffer.

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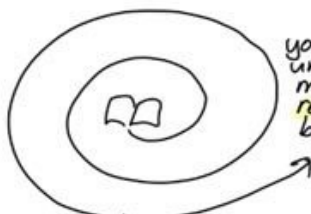
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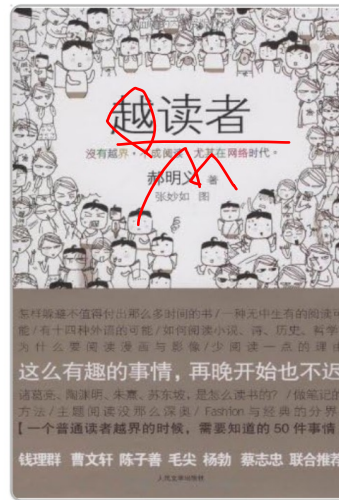
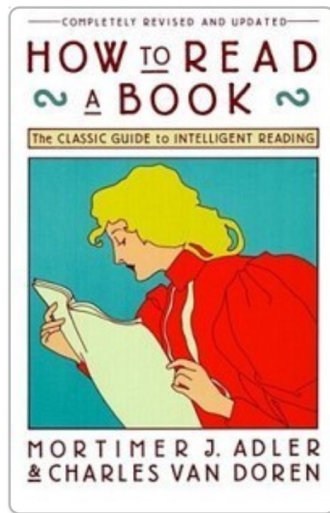
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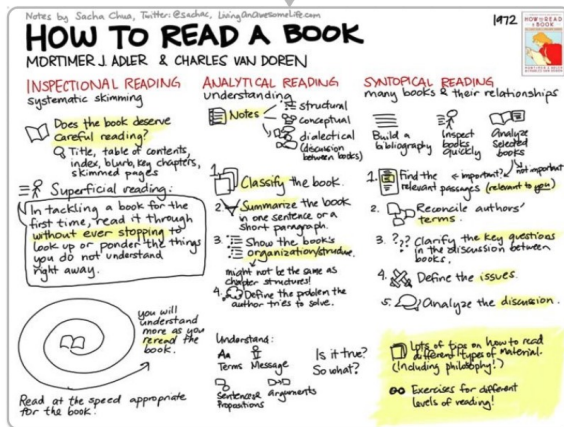
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Too hard?

Where to?



Obsidian

- **Preview the text before reading it in detail.** Seeing the big picture allows you to make sense of and remember the details.
- **Avoid passive rereading.**
- **Practice active recall.** As you read, periodically look away and see if you can recall the key point of a page. This will help cement these key ideas in mind as well as build your understanding.
- **Find ways to think about the text—it improves comprehension.** You can take small time-outs while reading, answer questions about the text, summarize it in your own words, or discuss it with others.

How to Win Big on Tests

When Barb studied electrical engineering, she once did every possible practice problem she could to prepare for a tough circuits test. It would have been difficult to be more prepared than she was—in fact, before the test, some of the class's top students had come to her so she could explain a few of the more difficult concepts.

Yet Barb flunked the test, getting all ten questions wrong, while almost everyone else in the class did well. She thought, “They must be quicker on tests—or just plain smarter than me.”

But she was wrong. It was just that there was *one* little test-taking trick she didn't know.

The Importance of Test-Taking Skills and Knowledge

We tend to think that to earn a high grade, all we need to do is learn the material well. But unfortunately, that's no guarantee. **To do well on tests, we also need to be good at taking tests. That involves having knowledge about the upcoming test, and the ability to use smart test-taking strategies.**

Barb learned the importance of this after she failed the circuits test. It turned out that the professor had wanted students to make a special assumption* on the test. But he hadn't mentioned this assumption while

teaching the class, it wasn't in the assigned chapters of the book, and it wasn't in the test instructions. However, without making this assumption, you couldn't get a single question right.

IF YOU HAVE A FACE-TO-FACE CLASS, ASK QUESTIONS

Those who ask their instructor questions get extra information, and those who don't, won't. But don't ask questions like "What will be on the test?" which many instructors find annoying. Instead, show evidence that you've already worked on whatever you're asking about. For example, you might ask, "I was reviewing my notes and the slides—I'm expecting these types of problems and prioritizing these topics for my studying ... Does that seem to fit with what you would suggest?"

So why did the other students do so well and not Barb? **It turned out that many of the other students had access to the prof's old tests.** They knew roughly what the professor was going to be covering—and that the special assumption would probably be on the test. After discovering what the other students were up to, Barb started interacting more with her fellow students to make sure she had access to the same test information.

So before you start preparing for a test, do your best to find out what it will look like. Not the exact questions (we're not advocating that you cheat!), but what type of questions you'll get, how they'll be evaluated and graded, and any expectations and assumptions. There are several ways to familiarize yourself with an upcoming test, such as reviewing information you have about the test, clarifying things you're uncertain about, and discussing the upcoming test with others. But perhaps the most important is to practice with old tests from that instructor, if at all possible.

The Importance of Practicing with Old Tests

Test-taking is invaluable for learning. One hour of test-taking, for example, will teach you far more than one hour of studying.¹ And taking practice tests are valuable too—in fact, **research shows that the best way to prepare for a test is by practicing with problems and questions that are similar to those of the upcoming test.**² It's easiest to do this by working with old test questions. Of course, problems from other sources can be

nearly as helpful—although they may not include the exact type of questions you’re likely to get on the test.

But remember: practice problems won’t help if you just look at the answers. This just loads the information into working memory, where it can easily fall out. You need to work practice problems yourself, even if you think you already understand them. This working out *yourself* of practice problems is what takes you to the “pro learning” level.

Where do you find old tests? When it comes to licensing and professional exams, there are often old versions of the test available, either in books or online. For college and online classes, a search for the name of your class/unit, a key term you know will be covered, and practice/quiz/test/example/questions can also unearth surprisingly helpful materials. You could also refer to comprehensive websites like Course Hero for practice questions. Just be careful that you’re not breaking any rules by accessing and using prior materials.

If you can’t find old practice questions, come up with some questions yourself that you think are likely to appear on the test. If you’re taking a course with stated learning objectives, try rewriting them as exam questions. This can work especially well for psychology, history, and other largely nonquantitative courses.

You may have realized that taking practice tests is important for another reason—as with other types of practice, it helps develop the long-term memory links of your procedural system. Remember, having links in both your declarative and procedural systems gives you a much broader and richer understanding of the materials. You will also be able to react more quickly and intuitively when you’re facing the real test.

Plan Your Time

When Olav received the exam schedule for his first semester as a graduate student at Oxford, he felt certain that he would fail all his exams. At his undergraduate school in Norway, lectures would normally end one to two months before the final exams, leaving students with plenty of time to prepare. As Olav looked down at his first exam schedule in Oxford, he realized he had only one week to study for five exams. What should he do?

Olav took comfort in the fact that he wasn't the only one with little time to prepare. (And if it *was* too little time to prepare, he was pretty sure the university wouldn't fail an entire batch of nearly three hundred students.) Next, he set up a *plan*, so that he could get the most out of whatever time he had left.

A plan doesn't create more time, but it does allow you to spend your time wisely. A plan will also reduce stress, since you don't have to worry about what to do. All you have to do is follow the plan.

OVERALL STUDY PLAN

W	Mon	Tue	Wed	Thu	Fri	Sat	Sun
21	History Math	History Spanish	Math Spanish	Math History	Spanish History	Day off	Day off
22	Spanish Math	History Math	History Spanish	Math Spanish	Math Spanish	Math Spanish	Day off
23	Math Math	Math Math	Math Exam	Spanish Spanish	Spanish Exam	History History	History History
24	History Exam						

If you have multiple tests coming up, start by finding out how much time you have to prepare for each test. Look at the number of days available for preparation and divide them among the exams. Next, use a calendar to plan which days you'll prepare for the different exams. Try to prepare for at least two exams on any given day to build spacing into your study. The only exception is the one to two days right before a test. That's when focusing only on the immediate subject, if you're able to, can be beneficial.

When you know how much time you have to prepare, and when you'll do it, it's smart to think carefully about how you'll spend that time. What parts of the curriculum will you focus on? How much time will you spend solving past exam problems, reading, reviewing notes, and discussing with peers? Sum your thoughts up in a quick study plan. If you want, you can go into more detail for a specific subject.

DETAILED STUDY PLAN FOR SPANISH

Tue	Solve past exam questions (4hr) Study group (2hr)
Wed	Study chapters 1-2 (3hr) Make notes (2hr)
Fri	Study chapters 3-4 (3hr) Make notes (2hr)
Mon	Study chapters 5-6 (3hr) Make notes (2hr)
Wed	Study group (2hr) Past exam questions (3hr)
Thu	Past exam questions (4hr) Review notes (1hr)
Fri	Past exam questions (4hr) Review notes (1hr)
Sat	Past exam questions (4hr) Review notes (1hr)
Thu	Past exam questions (7hr) Review notes (3hr)
Fri	Exam

All this is similar to what you would do, say, if you were studying for an MBA while working a full-time job and juggling family responsibilities. In this case, buy-in from your family matters as well. You'll be making sacrifices and will probably suffer from undesirable lack of sleep on occasion, but that's just the way of things. Do the best you can, realizing that there is no optimal strategy, but that planning your time as carefully as you can is important.

It's common to be overly optimistic, so it's okay to change your plan as you go along and get a better feel for how long your studies will take. Incidentally, the value of planning isn't the completed plan as much as it is the reflections and considerations you have to do in order to create the plan.

Do your best to set aside enough time for sleep, especially in the days leading up to the test. Even if you struggle to fall asleep on the night before a test, you can tackle test day much better if you've stored several nights of good sleep already.

Read the Instructions, and Each Question, Carefully

Olav once had to take a computerized multiple-choice test to qualify for a job interview. The test had thirty questions about a text and its related numbers and graphs. Olav skimmed the instructions and hit the start button. It all went well at first, but as he neared the end of the allotted time, many questions remained. He didn't want to miss potential points, so he randomly selected the remaining answers. Once the test was submitted, Olav reread the instructions. That's when he discovered that the test had been designed so test-takers couldn't answer all questions. The instructions warned against guessing—wrong answers meant a lot of negative points.

In other words, Olav had just taken one of those rare tests in which a wrong answer was much worse than a blank answer. Of course, he failed the test—not because of his qualifications, but because he hadn't read the instructions carefully.

People misread and misunderstand all the time. On tests, however, this can be devastating. **Be sure to read any test instructions carefully.** If a test has five essay questions, you need to know whether you're to answer all five or only one. It can also be wise to look at each question three times: before you start your answer, midway through, and when you're done with your answer. This will help you stay on track as you're answering. Sometimes, our understanding of a question improves or changes once we have activated our knowledge, which typically happens when you have worked at a problem for a bit.

Keep Track of Time

Olav used to struggle with completing tests. He would typically run out of time toward the end of a test and sometimes leave significant parts unanswered. On one such occasion, he left the last question on a five-question math exam unanswered. It didn't matter that he had answered four questions well. It couldn't make up for the fact that he left 20 percent of the exam unanswered, which significantly reduced his grade on the test.

To avoid running short on time, it can be wise to have a mental time plan to follow, and to check the clock several times throughout the test to know if you're on track. One approach is to divide the total test time by the number of questions on the test, adjusting for any questions that are weighted more. That will give you a rough benchmark of how much time you have for each question.

IT'S ALL IN THE TIMING

Taking practice tests—and timing them to be similar to the amount of time you will have on the real test—is one of the best ways to make sure you're on track time-wise during the real test.

Practice tests can be a dry run to help give you a better idea of what might take longer or be more difficult.

Say you have 60 minutes to answer ten questions. That's six minutes per question. When you're halfway through the time, that means you should have completed five or six questions. If you've only answered two questions in 30 minutes, you're heading for trouble.

If you aren't disciplined enough to make yourself stop working on a question and carry on to the next, the risk is that you will spend way too much time on some questions at the expense of others. Although you might have written a fantastic answer to some questions, it's unlikely to make up for incomplete or blank answers on other questions (as Olav painfully experienced).

Keep in mind the Hard Start approach: start with what seems to be the hardest problem—but only work on it for a few minutes, until you get stuck. When you move to an easier problem, your diffuse mode can work in the background on the harder problem.

The discipline you use to pull yourself from a problem in the Hard Start Technique is the same discipline you will use to keep yourself on schedule with answering questions. You don't want any one question to hook you in too completely!

Review Your Answers

If you have some time at the end of the test, use it to review your answers. Check to see whether your diffuse mode has anything to add or whether it nudges you to change any answers. Interestingly, research has found that when test-takers do change their answers during reviews, the changes are generally from incorrect to correct.³ This is also a good time to catch and correct ambiguous language. Another tip is to note down your most common types of errors so you can check your work with more specific focus.

As you do the final review, make sure that you don't leave hard questions blank, unless a wrong or incomplete answer gives you negative points. Instead, write down whatever relevant information you can think of. For example, you might note down the steps you would have taken or the formula you should have used. This can give you partial credit. Students sometimes neglect to provide answers if all they have are definitions or what they assume to be common knowledge. That may well be exactly what is being sought.

Dealing with Test Anxiety

Being a bit anxious or stressed before an important test is normal and actually *beneficial* for a good test performance.⁴ So instead of feeling that you're stressed because of the test, reframe it as "I'm stressed because I'm gearing up to do my best!"

IF POSSIBLE, CHOOSE COURSES STRATEGICALLY

When Barb studied engineering, she used to select her classes based on final exam dates to avoid having, for example, two consecutive final exams in a day. She found that being able to space out final exams over as many days as possible gave her more time to prepare and made exams less stressful. She also preferred courses that had exams lasting three hours instead of, say, one hour. Why? Barb noticed that the longer exams usually allowed more time per question, taking away some pressure and allowing for more diffuse mode thinking. **Being a bit strategic when you plan your courses, if you can, can help you earn better grades.** For example, if you typically perform better in classes where the grade is based on many small assignments, as opposed to one final exam, then that's something to consider when you choose classes.

Some "night owl" students struggle in the mornings—it's wiser for them to aim for late afternoon or evening sections. Others do best with online video lectures that they can stop and

restart if they lose track of an explanation. It helps to analyze what specifically worked for each course that turned out well, and what didn't work for courses that didn't turn out so well.

You'll put more effort into well-designed courses with good instructors. This means that getting "intel" on courses from other students or websites such as Class Central and Rate My Professors can be beneficial. Keep in mind, however, that sometimes students can give unworthy ratings when they don't get the grade they want.

In the end, remember that although grades matter, what you have learned and what you will learn will matter far more. The real prize of an education is to become an effective lifelong learner.

If you suffer from serious anxiety, creating strong sets of links in both declarative and procedural memory by using the study techniques we've shown you in this book is the best way to reduce that anxiety and do well on tests.⁵ In the stressful time leading up to an exam, it's also better to focus on *process* goals (such as completing three hours of studying) over end goals (such as getting an A). Focusing on the *process* will take away some pressure and make you more likely to reach your end goal anyway.

Just as the test is being handed out or you hit "start" for an online exam, you may feel your anxiety turning to panic. This can happen because while stressed, you might tend to breathe shallowly, only drawing air into the top of your chest. You don't get enough oxygen, and your body panics. To tackle this, watch your breathing. Just before you might go into panic mode, put your hand on your belly and try to draw air so deeply into your lungs that your hand moves up and down. This deep breathing can allow you to grow calmer and steadier.



In the next and final chapter, we'll look at how you can get the most out of the tools in this book and how to continue to improve your learning.

KEY TAKEAWAYS

FROM THE CHAPTER

Before the test:

- **Familiarize yourself with the test and the type of questions it will likely ask.**
 - Review information about the test.
 - Clarify things you're uncertain about.
 - Discuss the upcoming test with others.
- **Practice with as many previous test questions from old tests as possible.** Don't just look at the answers—that simply loads the information into working memory, where it can easily fall out.
- **Make a test preparation plan** that specifies how much time you will spend and what you're going to focus on to prepare for the test.
- **Choose courses strategically.** Remember that the real prize of education is to become an effective lifelong learner.

During the test:

- **Read test instructions and questions carefully.** Rereading the question when you're already a little into your answer can improve your interpretation of it.
- **Keep track of time on tests.** Know the approximate amount of time you have for each section of the test and check the time regularly to ensure that you're on track.
- **Spend whatever time you have left reviewing your answers.** Make sure you have answered all questions (unless guessing is penalized) and that your answers are clear and include all the important points.
- **Remember the Hard Start Technique.** Where possible, start with the most difficult questions or problems first. If stuck, stop, continue with the rest of the exam, and come back to the difficult question later. Let that diffuse mode work for you!
- **Moderate amounts of stress before and during a test can actually be advantageous.** Be sure to breathe slowly and deeply, down into the lower parts of the chest, just before the test to ensure you're calming your autonomic nervous system.

11

How to Be a Pro Learner

“You can’t sing,” the judges repeat. The contestant gapes, unable to believe what he’s hearing, then angrily drops the microphone and storms offstage.

If you’ve ever watched a talent show such as *The X Factor* or *America’s Got Talent*, you’ve probably seen this happen. But here’s the important question: Why do so many people think they’re so good at something when they obviously are not?

Let’s pause for a moment to look at what we’ve covered. So far, we’ve shared some of the best mental tools that science and experience have taught us, such as:

- Using the Pomodoro Technique and setting up a distraction-free environment to beat procrastination.
- Taking breaks and using the Hard Start Technique on tests to overcome being stuck.
- Studying actively: testing yourself, elaborating, interleaving, and spacing out your sessions in order to form strong sets of neural connections in both your declarative and procedural systems.
- Using acronyms, sentences, vivid images, the Memory Palace, and internalization to memorize and internalize.



- Planning when, where, and how to respond to obstacles in order to exert more self-discipline.
- Finding value, ensuring mastery, and setting goals to motivate yourself.
- Previewing, practicing active recall, and annotating in order to read effectively.
- Analyzing and practicing with previous tests and monitoring your time to earn a good grade on exams.

These are all powerful tools that, if applied correctly, will help you become a better learner. But how do you ensure that you apply the right strategies at the right time and in the right manner? And how do you adapt these strategies to new situations outside your studying? How do you *really* learn like a pro?

For this, you need what researchers call **metacognition**.

The Importance of Metacognition

You can think of metacognition as an extra brain outside your main one. This extra brain thinks about *how* you are thinking (metacognition means “thinking about thinking”). This extra brain pauses to consider how you should best approach problems and what strategies you should use. It stops you midway through a session (perhaps several times) to assess whether the approach you are using is working. And at the end of a session, your extra brain looks back to see if you should do something differently. In other words, metacognition is what allows you to learn *when* to use the tools, and improves your ability to *use* those tools. It’s critically important in becoming a pro learner.



And that extra brain is also critical to avoid being surprised by harsh judgments in talent shows. Why are some contestants so surprised? In

addition to lack of talent, they most likely lack proper metacognition. Had they been metacognitive, they would have actively sought out objective feedback and tried to assess themselves from a distance, accepting and learning from criticism.

Why are some people more metacognitive than others? Research indicates that, no surprise, people who are overconfident in their own abilities have poorer metacognition.¹ But anyone can become more metacognitive with practice.

Asking Yourself Metacognitive Questions

The easiest way to become more metacognitive is simply to start asking yourself higher-level questions, such as:

- What are the resources available to help me when I struggle?
- ★ • Do I focus on the right things at the right level in my studying? Should I prioritize differently?
- Can I be a more effective student? What can I improve?
- What do I find difficult and why?

A Model for Being a Metacognitive Learner

A more structured way to become a metacognitive learner is to follow this four-step model for self-regulated learning, based on the work of Canadian psychologists Phil Winne and Allyson Hadwin.²



在害羞什么？



给你个机会得到我



听叔叔一句劝



我还是很帅的



女人就是口是心非



小姑娘都喜欢大叔吧



头像是我 你不满意？

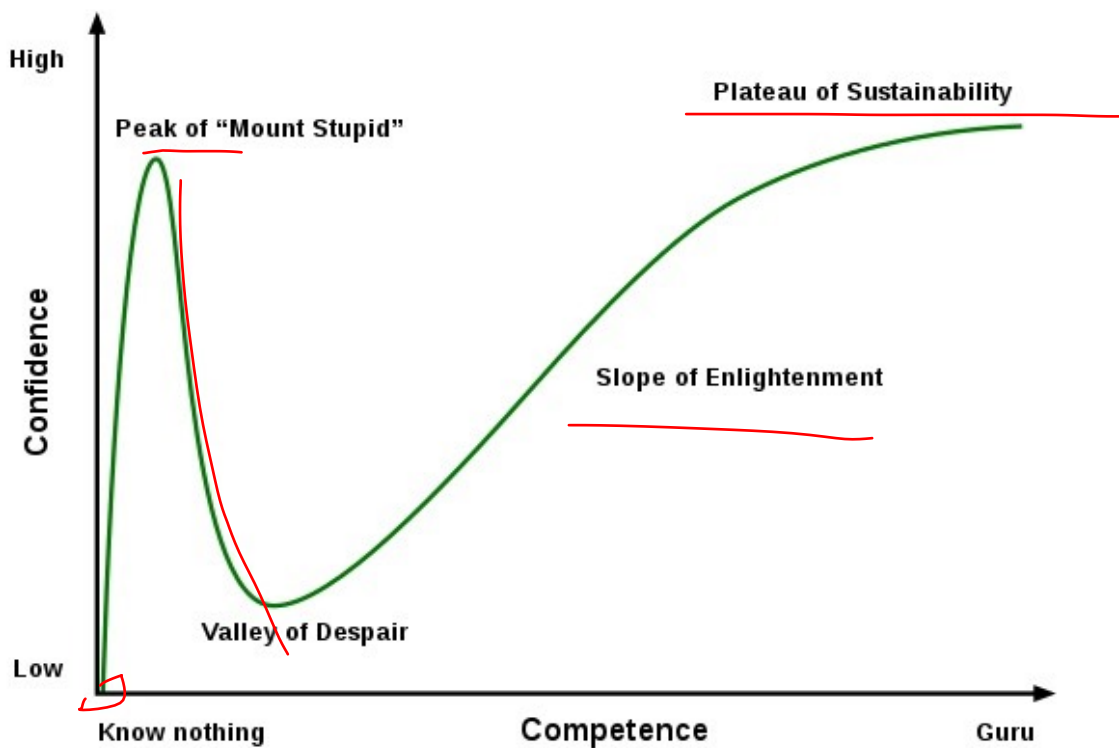


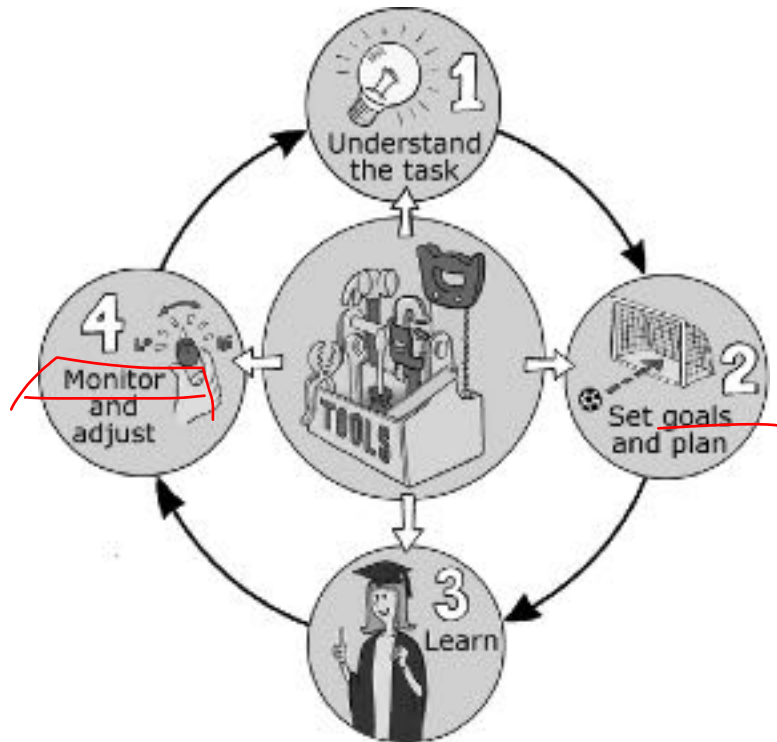
想我出轨和你在一起？



对我有欲望也是人之常情

Dunning-Kruger Effect





The four steps of being a self-regulated learner.

Step 1: Understand the Task

Understand what's required of you, how you'll be assessed, and the time and resources you have available. If you're studying a topic at a company workshop, online, or in college, you may use learning objectives related to that topic to guide you to exactly what you need to learn. If you're preparing for an exam, you might analyze past exams to better understand what kinds of questions you will likely have to answer. You could also ask your instructor and peers for their understanding of the task. If you don't know where to start on a task, that's typically a sign that you haven't understood the task well.

Step 2: Set Goals and Plan

Think about your ambition—at what level you want to perform—and then break your task down into concrete goals. Once you have set some goals, plan when, where, and how you will work to achieve them. That includes selecting appropriate learning techniques. If you're studying a list of Italian

vocabulary, you may set yourself a goal of memorizing 100 percent of the words, and plan to make flash cards for the words and use retrieval practice 10 minutes a day for five days, spaced out over a period of two weeks. If you're studying photosynthesis, you may set yourself a goal to be able to understand the process so well you can explain it to anyone. To achieve this, you may plan to read about photosynthesis from three different sources and practice using the elaboration technique.

Step 3: Learn

Learn according to your plan, experimenting with different tools.

Step 4: Monitor and Adjust

As you're learning, make sure to take a step back regularly to assess how your studying is going. Assess whether you're actually progressing in your learning, and whether you're using the best learning strategies. You might need to adjust the way you're learning, and that's perfectly fine. In fact, changing practices when progress is slow or nonexistent is an important part of being a self-regulated learner. For example, if you realize that you're struggling to understand a difficult text, you might want to try studying another source, such as an explainer video on YouTube or an online course.

This four-step process is recursive, meaning that you'll likely go through the steps several times on your way to mastering a difficult subject. Once you've been through a cycle, you often have a better understanding of the task, and you may have learned some things that make you update your goals and plan. Based on that, you change the way you study, and as you progress, you may improve your task understanding and make further changes to goals and plans.

Practicing to become more self-regulated in your studying can really pay off: one study found that training students to become self-regulated learners could move them from the fiftieth to the seventy-fifth percentile.³

Learning from Past Exams

One way to evaluate your performance (step 4) on tests is to use a structured form like the one shown below. Such a form forces you to think about the different aspects of the test-taking experience and to reflect on what you could have done better.

WHAT YOU DID BEFORE THE TEST

Question			What can you do differently next time to improve?
	Yes	No	
Did you acquire enough information about the exam beforehand to know what and how to study?			
Did you set aside enough time to be able to prepare properly?			
Did you study all the relevant parts of the curriculum?			
Did you work effectively and in a focused fashion during the time you had set aside for studying?			

WHAT YOU DID DURING THE TEST

Question			What can you do differently next time to improve?
	Yes	No	
Did you understand the instructions and questions well?			
Did you answer all the questions?			
Were you tired or hungry so that you could not concentrate well?			
Did you panic or experience severe anxiety so that you could not concentrate well?			
Did you distribute the time well among the different questions?			
Did you make any careless mistakes?			
Did you remember the main ideas for each question?			
Did you remember the details for each question?			
Did you organize your response in a clear and cohesive way?			

A Final Word

Your brain is the most valuable and complex tool you possess. We hope that this book can help you get more out of it, and that it has inspired you to improve the way you learn. So let's end this chapter, and book, with a metacognitive question:

Write it down: What are your biggest takeaways from this book?
What will you do differently in your studies going forward?

KEY TAKEAWAYS

FROM THE CHAPTER

- To become an effective learner, you need to apply the right learning tools at the right time and constantly think about how you can improve.
- To do this, you need metacognition—a brain outside your brain—that takes a step back to pause and ask high-level questions.
- Ask yourself metacognitive questions, such as:
 - What are the resources available to help me when I struggle?
 - Do I focus on the right things in my studying? Should I prioritize differently?
- Use the four-step self-regulated learning model to make a habit of being metacognitive:
 - Step 1: Understand the task.
 - Step 2: Set goals and plan.
 - Step 3: Learn.
 - Step 4: Monitor and adjust.

What to Do and What *Not* to Do in Your Learning

Now, back to the main lessons of the book.

You know that *recall* is one of the best ways to learn. So here's my second challenge of the chapter. See if you can make a list of what *you* think are the main lessons from this book. You can include ideas to help your learning, as well as pitfalls to avoid.

What are your top five favorite ideas from the book? No peeking until you've got at least five in mind! Don't worry if you have to strain your brain to come up with these. Your attentional octopus hasn't grabbed these brain-links very often yet, so it's just getting used to them. Don't worry if your listing looks a little different from mine. If you have some of the same key ideas, that's what counts.*

Here's my list of some of the top ideas in the book to help your learning:

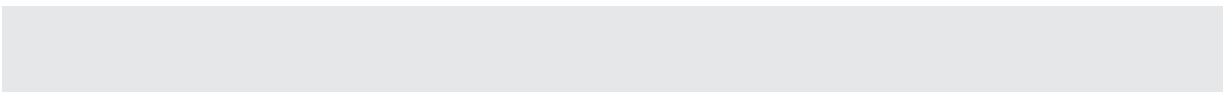
1. Make use of both the intense **focused** and relaxed **diffuse** modes. If you are getting frustrated, it's time to switch to another topic. Or get some physical exercise!
2. Create **sets of brain-links** with practice, repetition, and recall. Practice important problems so you can easily recall each step. Solutions, concepts, and techniques should flow like songs in your mind.
3. **Interleave.** Don't just keep practicing with slight changes in the same basic technique. Switch back and forth between different techniques. This will allow you to see *when* to use a technique. Books usually don't help you interleave. You will have to practice skipping back and forth between the ideas in different chapters yourself.
4. **Space out your learning.** Practice over at least several days. This gives time for your new synapses to form.

5. **Exercise!** Exercise feeds your neurons. It also allows you to grow new and stronger synapses.
6. **Test** yourself. Have others test you. Teach others. All of these are related to *recall*. Testing and recall are the best ways to strengthen your learning.
7. Use **funny pictures and metaphors** to speed your learning. Start using memory palaces.
8. Use the **Pomodoro Technique** to build your ability to focus and relax. Just turn off all distractions, set the timer to 25 minutes, focus, and then reward yourself.
9. **Eat your frogs first.** Start your most difficult work first. That way you can either finish it or take a break to let your diffuse mode help you.
10. **Find ways to learn *actively*, outside of your usual classes.** Look online for other explanations. Read other books. Join a club. If you don't find a club in the subject that interests you, see if you can start one.

And here are ten pitfalls to avoid in your learning:

1. **Not getting enough sleep.** Sleep makes your brain-links stronger. It washes away toxins in your brain. If you don't get a good night's sleep before a test, *nothing else you have done will matter*.
2. **Passive reading and rereading.** You need to practice *active recall*, not just let your eyes pass over the same material.
3. **Highlighting or underlining.** Don't be fooled! Just highlighting or underlining big chunks of text doesn't put anything in your head. Make brief notes about the key concepts you are reading. Do this in the margin or on a piece of paper. These notes help you create *brain-links* of the key concepts.

4. **Glancing at the solution to a problem** and thinking you understand it. You need to solve the problem yourself.
5. **Cramming.** Last-minute learning doesn't build solid brain-links.
6. **Lazy learning.** Don't just practice easy material. That's like learning to play basketball by focusing on your dribbling. Use *deliberate practice*—focus on what you find most difficult.
7. **Ignoring your book.** If you are using a textbook in your studies, remember to take a picture walk through your book or course notes before you get going. And *be sure* to read about how to *do* problems before trying to *solve* problems!
8. **Not clearing up points of confusion.** Are there just a few points you don't get? Chances are, these are precisely the points that will be asked about on the test. Be sure to get help from your teacher or your friends.
9. **Distractions.** Choose somewhere you can focus when you study. It's often a good idea to leave your smartphone turned off and out of reach.
10. **Chatting with friends instead of studying with them.** Good study groups can be a great way to help you learn. But “study groups” that mostly gossip instead of study aren't much use.



- **“5 Memory Tips to Get You Started,”** by Nelson Dellis. Four-time US Memory Champion Nelson Dellis has a wonderful series of memory tip videos—this is a good one to help you get started. https://www.youtube.com/watch?v=bEx60e_45-Q. See also Nelson’s book *Remember It!* on p. 219.
- **“Learning How to Learn: Powerful Mental Tools to Help You Master Tough Subjects,”** a massive open online course by Barb Oakley and Terrence Sejnowski through University of California, San Diego. <https://www.coursera.org/learn/learning-how-to-learn>.
- **“Mindshift: Break Through Obstacles to Learning and Discover Your Hidden Potential,”** a massive open online course by Barb Oakley and Terrence Sejnowski through University of California, San Diego. <https://www.coursera.org/learn/mindshift>.

Books for Young Adults About the Brain

- *My First Book About the Brain*, by Patricia J. Wynne and Donald M. Silver (New York: Dover Children’s Science Books, 2013), 32 pages. This award-winning coloring book is so informative that it is used in some regular classes. Suitable for ages 8–12, but grown-ups also seem to enjoy the relaxing process of coloring while they learn.
- *The Brain: All About Our Nervous System and More!*, by Seymour Simon (New York: HarperCollins, 2006), 32 pages, for ages 6–10. Features color images taken with radiological scanners, discussions of long- and short-term memory, neurons, dendrites, and more.
- *What Goes On in My Head?*, by Robert Winston (New York: DK Publishing, 2014), 96 pages, for ages 9–13. A colorful book that “helps you wrap your head around how the brain works.”

Top Neuroscience-Based Programs for People with Learning Disabilities

including struggling readers and people with dyslexia, auditory processing disorder, autism spectrum disorder, and more general learning disabilities

- <https://www.scilearn.com>, in particular, their “Fast ForWord” and “Reading Assistant” software.

Neuroscience-Based Program for English Language Learners

- <https://www.scilearn.com>, in particular, their “Reading Assistant” software. (There are many programs and centers around the world.)

Books for Adults About Learning

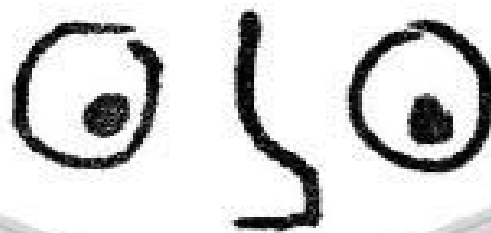
- *The Art of Changing the Brain: Enriching the Practice of Teaching by Exploring the Biology of Learning*, by James E. Zull (Sterling, VA: Stylus Publishing, 2002).
- *The Art of Learning: An Inner Journey to Optimal Performance*, by Josh Waitzkin (New York: Free Press, 2008).
- *Deep Work: Rules for Focused Success in a Distracted World*, by Cal Newport (New York: Grand Central Publishing, 2016). Learning often involves being able to focus intently, and Cal’s book gives great ideas along those lines.
- *I Am Gifted, So Are You!*, by Adam Khoo (Singapore: Marshall Cavendish, 2014). We love Adam’s personal story and practical insights.
- ✓ *~~Make It Stick: The Science of Successful Learning~~*, by Peter C. Brown, Henry L. Roediger III, and Mark A. McDaniel (Cambridge, MA: Harvard University Press, 2014). One of our very favorite books on learning for adults.
- ✗ *A Mind for Numbers: How to Succeed in Math and Science (Even If You Flunked Algebra)* by Barbara Oakley (New York: Tarcher/Penguin, 2014). Even if we do say so ourselves, this is actually a great general book on learning—it relates some of the ideas

of *Learning How to Learn* but from an adult prospective that includes many additional insights.

- *Mindshift: Break Through Obstacles to Learning and Discover Your Hidden Potential*, by Barbara Oakley (New York: TarcherPerigee, 2017). This book explores how you can change yourself through learning—sometimes more than you might think!
- ✓ *Peak: Secrets from the New Science of Expertise*, by Anders Ericsson and Robert Pool (New York: Eamon Dolan/Houghton Mifflin Harcourt, 2016). Incidentally, what Anders calls a “mental representation” is analogous to what we in *Learning How to Learn* call a “set of brain-links.”
- *Remember It! The Names of People You Meet, All Your Passwords, Where You Left Your Keys, and Everything Else You Tend to Forget* by Nelson Dellis (New York: Abrams Image, 2018). One of the best books on memory development for adults.

From the bestselling author of *A Mind for Numbers* and the creators of the popular online course Learning How to Learn

LEARNING



HOW

TO

LEARN

How to
Succeed in
School Without
Spending All Your
Time Studying

A
GUIDE
FOR KIDS
AND TEENS

BARBARA OAKLEY, PhD, AND
TERRENCE SEJNOWSKI, PhD,
WITH ALISTAIR McCONVILLE

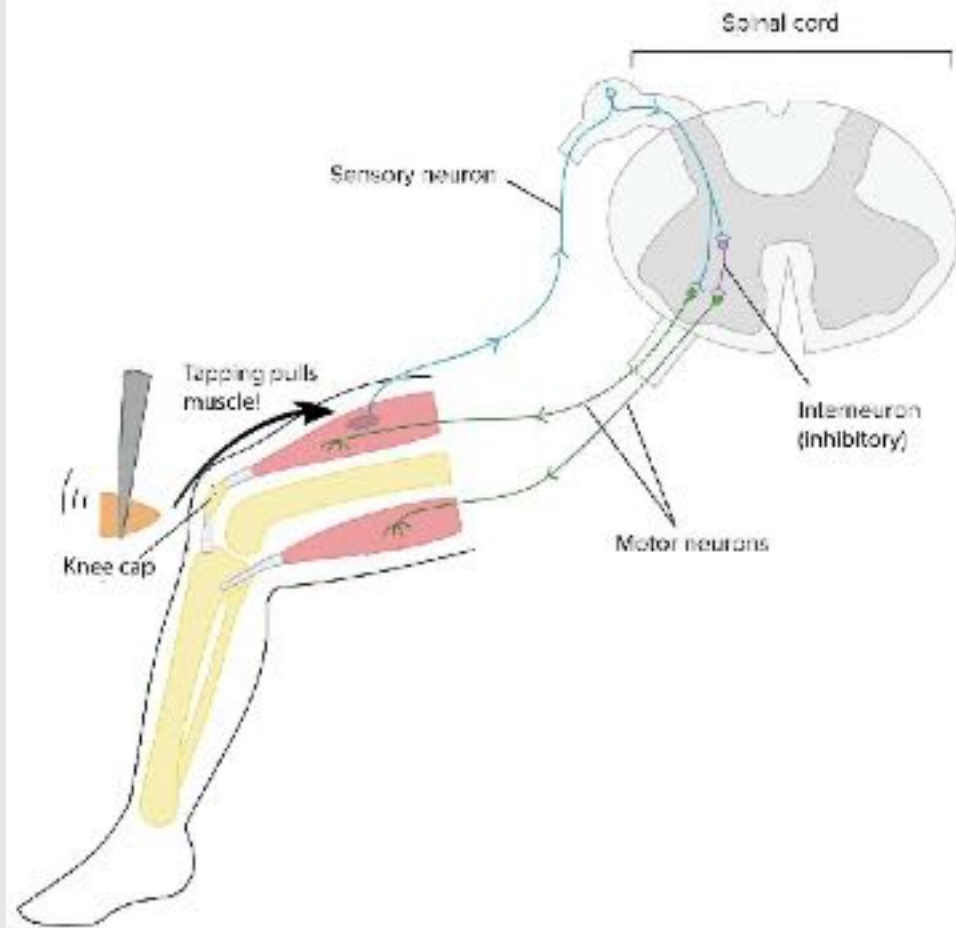
Now You Try! Check Your Synaptic Links

Neurons aren't only in the brain. They are also in other parts of the body. You can actually see your neurons and synapses at work. Try this experiment.

Sit on a bed and dangle your feet over the edge. Then hit your knee gently just below the kneecap. (It won't work if you don't tap just the right place.)

Be careful not to hit it too hard, but just enough to get your knee to jerk automatically. This is called a *reflex*. When you gently tap below the knee, it causes a muscle to pull above the knee. This muscle then sends a signal through a sensory neuron that travels to your spinal cord. There, the signal jumps across a synapse to a motor neuron that twitches your muscle. The strength of the synapse (that is, the strength of the signal that crosses the gap between the neurons) controls how far your knee jerks. A strong set of synapses makes your knee fly fast, but weak synapses won't move it much. This is what doctors are checking for when they tap your knee. (Don't worry if you can't make your knee jerk—some people just don't respond to the knee tap and that's still perfectly alright.)

There are many different kinds of reflexes. If someone makes a loud noise in front of your face, you will blink. If you put your fingers in a baby's palm and press, the baby will grasp them. What's cool about many reflexes is that they protect your body. When you touch a hot stove, for example, your reflexes react quickly to prevent a burn. The information only needs to travel from the muscle to the spinal cord and back, without needing to travel all the way to the brain. Traveling to the brain takes time! When your hand is on a hot stove, you want to move it as quickly as possible, and not wait to think.



Your doctor is checking the connections of your synapses when she gently taps below your knee. You can do this, too.

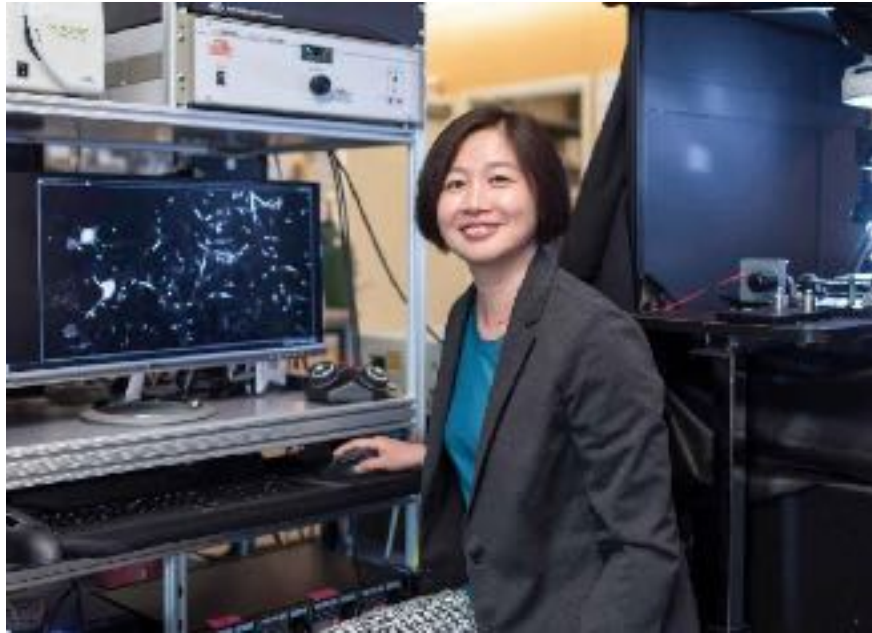
Now You Try! Taking a Break

Al McConville found that taking diffuse breaks between his Pomodoros helped him to learn.

Take out a sheet of paper and make a list of favorite activities that work for you when you are taking your diffuse breaks. If you'd like, ask a friend to do the same thing. Then compare your lists.

SUMMING IT UP

- **It's possible to learn new subjects that you never thought you could learn.** You can do this even when you are an adult!
- **Learning about new subjects can empower you.**
- **Use tools like the Pomodoro and active recall, and be sure to exercise** (you'll learn more about that soon!) to boost your learning.
- **Check the internet** for other explanations if the first explanation doesn't make sense to you.
- **Ask other people for help when you are stuck.**
- **Don't be afraid to go back to a beginner's level,** even if you are older than other students.



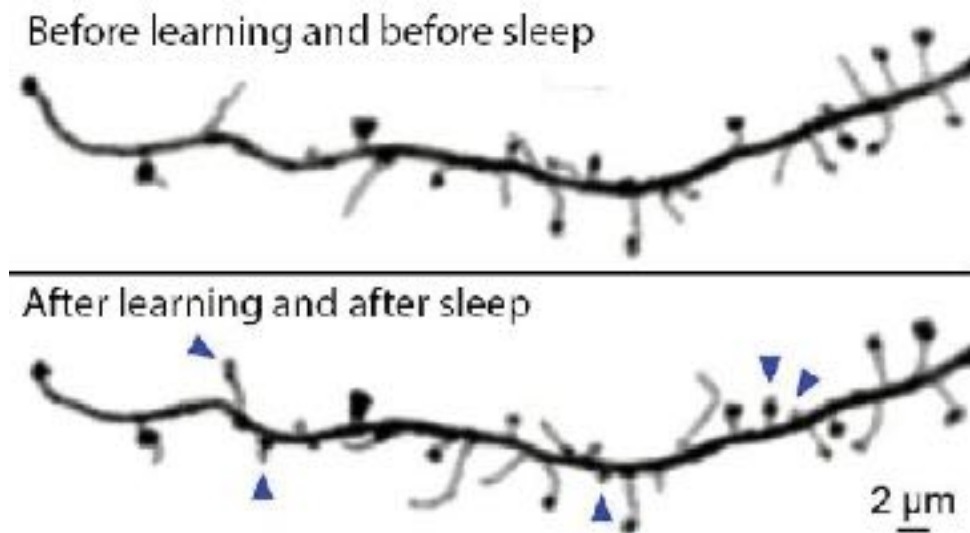
Research scientist Guang Yang and the team she works with made important discoveries about learning.

The Power of Sleep

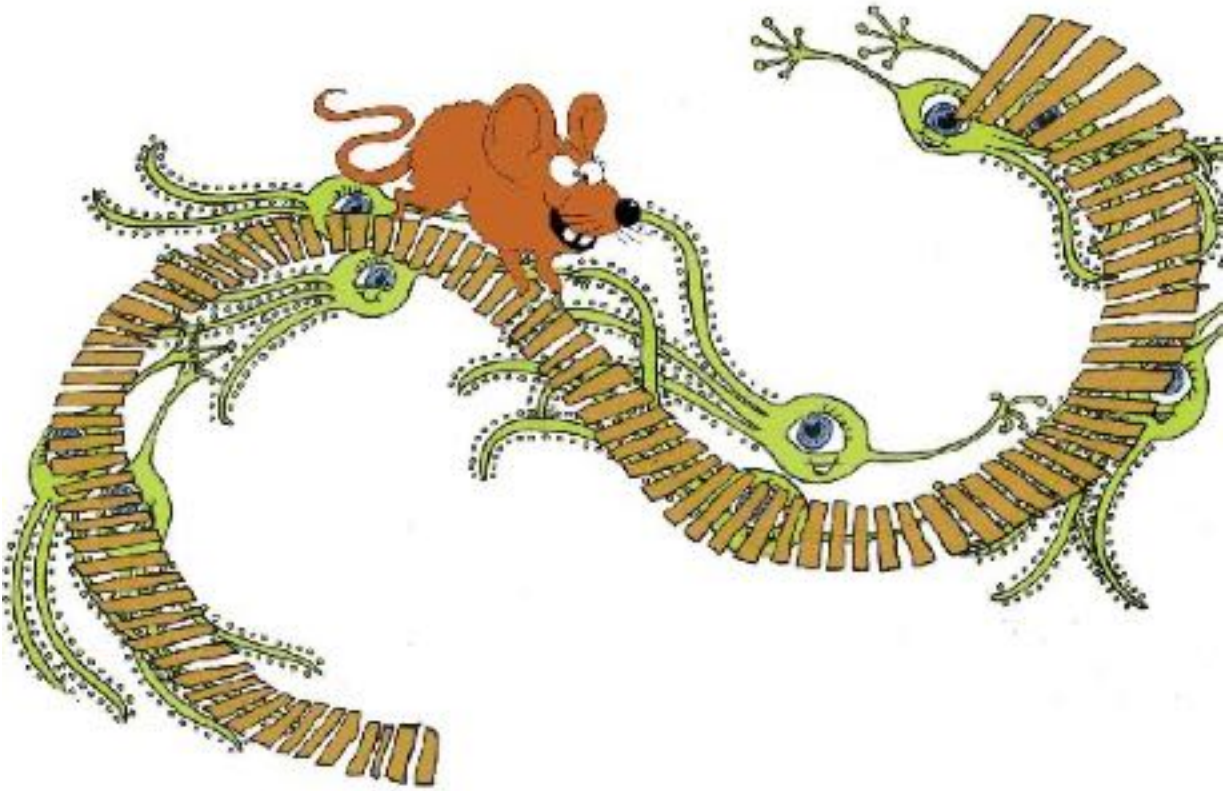
Research scientist Guang Yang* studies neurons. Guang is interested in making discoveries, like Santiago Ramón y Cajal in chapter 4. She is particularly interested in how we learn. Guang wondered whether neurons change when we learn something new. If neurons *do* change when we learn, this might give us clues about how we can learn better.

Guang found that neurons *do* change. And the big change happens after we learn something *and then go to sleep*.

Using new techniques, Guang took a picture of a living neuron. Guang's picture, below, shows part of a dendrite. You can see the dendritic spines (the “toes”) that are growing out of the dendrite.



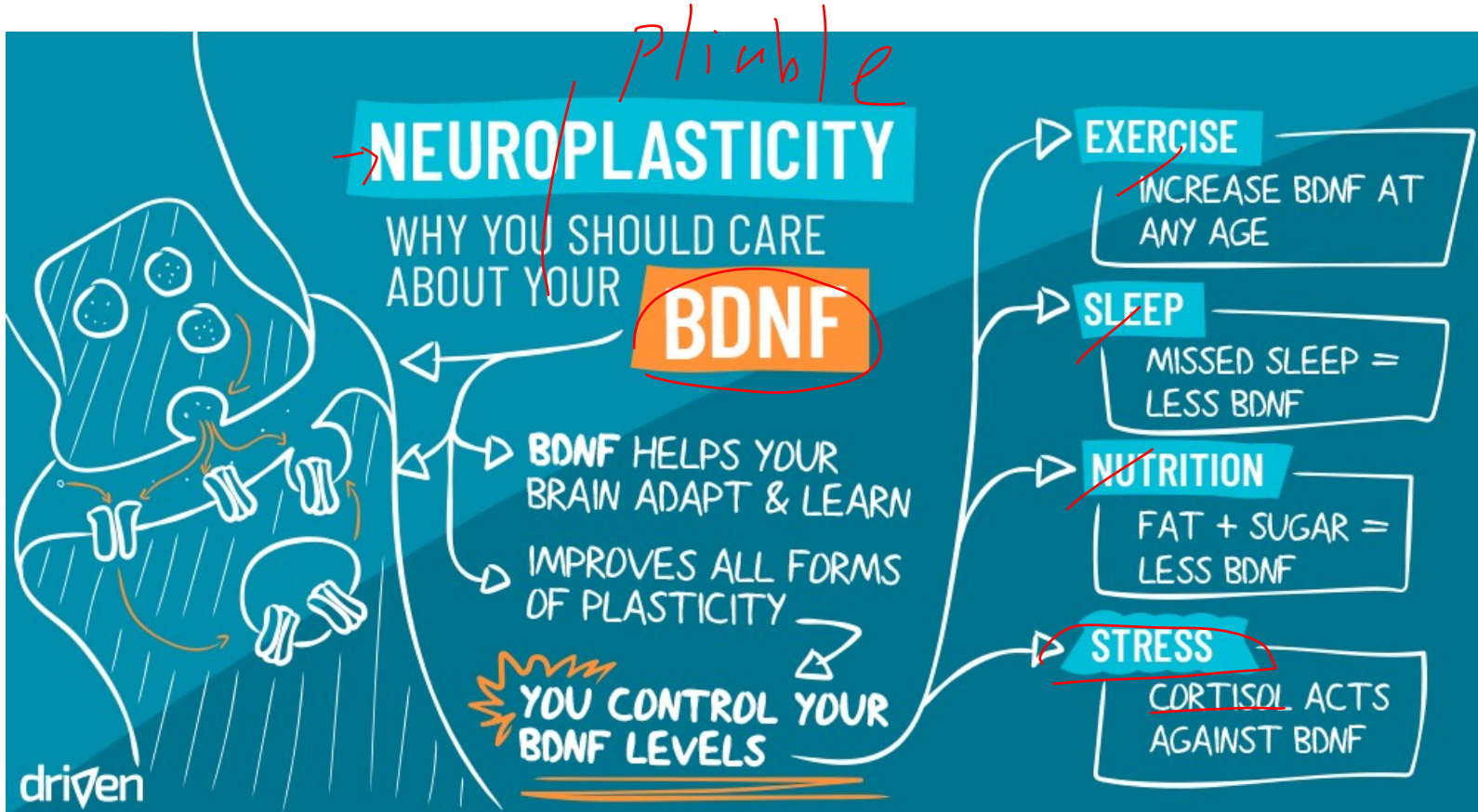
These two images show a neuron before learning and before sleep (above) and afterwards (below). The arrows on the lower picture point to new dendritic spines that grew during sleep. Notice that a few of the spines are missing. What happened to them? (Hint: See the discussion on synaptic vacuum cleaners that lies a few pages ahead!)



*Neural paths get wider and easier to travel on the more your mental
“mouse” runs along the path.*

Don't worry that you might accidentally use up all your neurons while you're making bigger and wider brain-links. You've got *billions* of neurons —and your brain is growing new neurons all the time. More than that, you can make billions and billions of connections *between* neurons!

The fact that trails in your brain can change and grow is called *neuroplasticity*. (It's pronounced “new-row-plas-TI-sity.”) This fancy word just means that your neurons are like clay you can mold. That is, your neurons can change. This is why *you* can change!



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Neuroplasticity

The ability of the brain to rewire and rebuild itself to form new neural networks and reinforce familiar neural connections.

Why should you care about your

BDNF

?

Brain Derived Neurotrophic Growth Factor is a key neurochemical responsible for the growth and maintenance of neural connections.

- BDNF helps your brain adapt & learn
- Improves all forms of plasticity

YOU control your BDNF levels

Nutrition

Sugar reduces BDNF Levels while Fasting, Ketosis and Omega 3 fatty acids improve BDNF levels.

Sleep

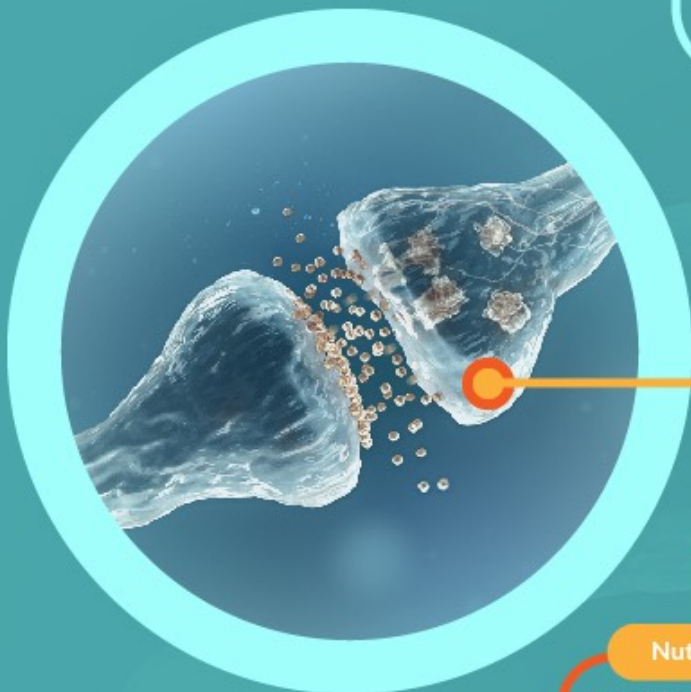
Poor Sleep reduces BDNF Levels.

Exercise

Movement and exercise at any age improves BDNF levels.

Chronic Stress

Imbalances in cortisol and adrenaline lower BDNF levels.



Spaced Retrieval Practice: How to Build a Brick Wall of Learning

So, to recap: The more you learn, practice, and sleep, the more you grow new dendritic spines and synaptic links. *Stronger* links plus *more* links. Wow! What a powerful learning structure!

Good learning structures are like solid brick walls. They grow bit by bit, getting stronger all the time. If you spend some time learning a particular item each day for several days, it allows you to get several periods of sleep. This gives more time for new synaptic links to grow and helps the new learning to really take hold.² The neural pathway gets trampled on again and again by your mental mouse, which continues running at night, while you sleep. (Mice tend to be nighttime creatures, remember!) Practice makes permanent—or at least a lot stronger!



If you “let the mortar dry” between layers of brick by sleeping, you build a solid neural foundation. That’s the wall on top. If you don’t let the layers dry and cram your building (learning) into one day, the wall becomes a jumbled mess. This is also what can happen to your learning if you put everything off to the last minute.

“Cramming” means procrastinating and doing your studying at the last minute. **Now you can see why cramming is a bad idea. Leave your work to the last minute, and you have less time to repeat and fewer nights of sleep to grow new synapses— so you won’t recall the details well.** There’s also less time to connect your new idea to other ideas.

Some students do “reverse procrastination.” If they’re assigned a homework problem that’s due on Friday, for example, they might do the entire homework set on Monday so it’s done and out of the way. Reverse procrastination is great, but it’s nice to supplement it by a little bit of review here and there before you turn the assignment in, just to give your brain a chance to strengthen the connections.

This reemphasizes the fact that when you learn something new, you want to revisit it soon—before the dendritic spines and synaptic links begin fading. If the dendritic spines and synaptic links fade away, you have to start all over in the learning process. Build on what you’ve already learned. Look over your notes. Explain them to a friend. Make flash cards. You can check them less often as you become better at retrieving the information.³



Recall is one of the most effective ways to boost your learning.

Another person tries to do all their learning on the Monday morning before the test. Even if they throw several hours into it, they won't have had any sleep after their learning to let the new synapses begin to form. The pathways won't begin to grow until the person goes to sleep on Monday night. Unfortunately, that's after the test—too late. The synaptic janitor soon cleans away the weak pattern. They lose!

Even worse, after cramming for a test, it's easy to think "I'm not going to use this stuff." So you don't practice with it. When you don't practice something you've only just learned, it makes it easy for your synaptic vacuum cleaners to sneak through your brain and suck away those new dendritic spines. The new links you were trying to develop end up disappearing.



If you don't practice with the new ideas you are learning, your synaptic sweep will sweep, and even vacuum, them away!

There's an important idea to keep in mind here. *Some people need more practice and repetition to get a concept than others.* That's perfectly okay! For example, I often have to practice, practice, practice much more than other people. That's the only way I can learn the information. My coauthor Terry, on the other hand, picks up new ideas and concepts much more quickly. Our third coauthor, Al, learns some things quickly and others slowly. But even though each of us learns in different ways and at different speeds, each of us has had something good to contribute to the world of learning. So don't feel bad if it takes you longer to learn things than your friends. You can still learn the information just as well—sometimes even better!

You may have a lot of subjects you've got to study and keep on top of. That's okay. Each time you take up a subject to study, give it your *full attention* while you are studying it. Don't think about the other things you have to do. When you pick up your work for the next subject, give *it* your full attention. Having to keep up with a lot of very different topics may sometimes seem difficult, but it helps keep you mentally flexible. You can create new sets of brain-links and practice using them with lots of different

subjects each day. Your brain has a galaxy of room inside—you can never even come close to filling it with new ideas and facts, no matter how hard you try!

Time to move on. In the next chapter, we're going to learn about your brain's attentional octopus!

The Memory Palace Technique

Nelson Dellis makes crazy images in memory competitions. But he takes it a step further. To have a chance of winning, Nelson has to remember a *lot* of different wacky things. Hundreds of them. And put them in the right order.

To do this, he uses the “memory palace” technique, which uses a place you are familiar with as a memory tool. The technique has been around for 2,500 years. A famous Roman writer named Cicero used it to recall his speeches. Modern research has shown that using this technique changes your brain and helps you to start having a better memory.³

Imagine a place that you know well, like your house. Then take the things you need to remember and mentally “put” them in places throughout your house as you walk through it. Make sure something is shocking or silly about the way you imagine each of them. Add a little movement to them. Then picture yourself walking through the house and seeing them. Maybe even talking to them.

Let’s say you need to remember some groceries. Milk, bread, and eggs.

Imagine meeting a giant milk bottle with a smiley face that smiles even more broadly when you walk through the front door.

“Hello, Mr. Milk. You’re looking especially enormous today,” you say.

Then in the living room, picture a loaf of bread “loafing” casually on the couch.

“Ms. Bread, you’re such a *pain*. Don’t you have better things to do than just lie about?” (*Pain* is French for “bread.” Extra corny!)

Go through the living room into the kitchen. As you open the door, a box of eggs falls from the top of the door onto your head. Your brother is laughing at you. He set a trap. I’ll let you decide what to say to him.

Do you get the idea? The more vivid and outrageous the images, the better! You can use one memory palace for Spanish words that begin with *a*, and another for words that begin with *b*, and so forth. You can use yet another memory palace to allow you to remember the main ideas, based on a few key words, of a speech you are going to give. You can use memory



Your house's layout can be like a mental notepad.

palaces to remember long series of numbers, or what cards have appeared already in a card game.

The number of memory palaces you can build is immense—you can use a map of your town or country, the layout of your school, a favorite walking path, or places in your favorite video game. The memory palace technique is one of the best techniques of all to build your memory skills. Another nice thing about memory palaces is that when you're bored, like when you are waiting for a teacher, for example, you can revisit some part of a memory palace to help strengthen it. Remember, you can visit your palace from different directions—you can even revisit lists backwards!

Why Does It Work?

This ancient technique works because your brain is fantastic at remembering places and directions. It's all part of the "picture" portion of your long-term memory. Scientists call this the *visuospatial* ("VIZ-you-oh-SPAY-shell") memory. And it's supersized! Some people need a little more practice at tapping into these powers than others. But it's there.

This part of our memory is much better at remembering places and directions than it is at remembering random facts. Think of a Stone Age guy. He needed to remember how to get around. That was much more important to him than naming rocks. "That type of rock is called *quartz*? Who cares? Where's my cave?"

When was the last time you were unable to remember the way to school? Or where your living room is in your house? I'm guessing that's pretty unforgettable information. When you try to remember random things, you need to link them to things you know well. Like the route around your house. This makes them much easier to recall. As Nelson said, you also have to *focus* on the random items while you're putting them in your memory palace. It's harder at first, but you get used to it quickly.

What I Learned at Princeton

I was lucky, and my career in science went well. I received some wise advice from a famous professor, Carl Anderson. Like Santiago Ramón y Cajal, Carl Anderson had won a Nobel Prize. (He discovered the positron. [*](#)) Professor Anderson asked me if I wanted to do theory or experiment. I said: “Why not both?” He said it was possible and gave an example of someone at Caltech, who I later got to know.

Getting advice from someone you respect can have a big impact on your life.

I learned a lot of physics in graduate school at Princeton University. [*](#) I made exciting discoveries about black holes and gravity. I was lucky to have good mentors and smart friends. **It really helps to work on difficult problems with other people. Find people who let you sparkle. Hanging around with people who have good ideas can boost good ideas of your own!**

I had reached a turning point. I had answered my questions about physics and gravity. But I still didn’t know much about the brain. Yogi Berra, the philosopher-catcher of the New York Yankees baseball team, said something wise: “When you come to a fork in the road, take it.” I took the road to biology.

Jumping into the Brain

The mysteries of the brain are as complex as the mysteries of outer space. Like Barb and Al, I had to go back to the basics. It was tough at first because others already knew so much. But I found that my training in physics helped me think about biology in ways that others couldn't. It's amazing how subjects connect in ways that you don't expect!

I had read about neurons in books. However, they only became real to me during a summer course at Woods Hole in Massachusetts, where I got to see them under a microscope. There's an important lesson here. Learning comes to life when you *do* something with information. Make it active. Don't just read it. I recorded electrical signals from many different types of neurons. What I had learned at my high school radio club about radio signals really helped. (You never know when your knowledge is going to come in handy.)

Special Advice for Math, Science, and Other Abstract Subjects

Let's say you're trying to make a set of brain-links in math or science. See if you can work a problem by yourself. *Show your work and write your answer out with a pencil.* Don't just look at the solution and say, "Sure, I knew that . . ."

Did you have to peek at the solution to get a little help? If so, that's okay, but you'll need to focus on what you missed or didn't understand.

Next, see if you can work the problem again, without looking at the solution. And again. Do this over several days.



Try not to peek at the solution!

At first, the problem may seem so difficult that you could *never* work it! But it will eventually seem so easy that you will wonder how you could have thought it was hard. Eventually, you won't even have to write the solution out with a pencil. When you just look at the problem and think about it, the solution will flow swiftly through your mind, like a song. You've created a good set of brain-links.⁶

Special Advice to Improve Your Writing

The techniques we described to improve your math and science skills are very similar to what you can do to improve your writing!

Famous statesman Benjamin Franklin was a terrible writer when he was a teenager. He decided to do something about his problem. He took pieces of excellent writing and jotted down a word or two of the key idea of some of the sentences. Then he tried to re-create the sentences from his head, just using the key ideas as hints. By checking his sentences against the originals, he could see how the originals were better—they had a richer vocabulary and used better prose. Benjamin would practice this technique again and again. He gradually began to find that he could improve on the originals!



Famous American statesman Benjamin Franklin was a lousy writer as a teenager. He decided to change himself by actively developing his writing links.

Eat Your Frogs First!

“Eat your frogs first” means it’s best to get started on the unpleasant or difficult things first in your study session. That way, you can take a break and work on something else if you get stuck. This lets your diffuse mode work in the background to “unstick” you when you return. You might even finish your difficult task at the beginning of your work period, which feels great. (Of course, if you like eating frogs, you will need to change the metaphor. Some people like to think of this as “Save your cookies for last!”)

The Hard-Start Technique: Learning When to Disconnect

For years, students have been told to start a test with the easiest problems first.

Neuroscience says this is *not* a good idea. (Unless you haven't studied at all. Then you should take whatever easy points you can get!)

When you begin your test, here's what you should do. Start by quickly looking it over. Make a little checkmark beside what you think are the hardest problems. Then pick one of the hard problems and start working on it. Yes, that's right—a *hard* problem. (Eat your frogs first!)

Just work on this problem a minute or two—however long it takes until you feel like you're stuck.

As soon as you feel yourself getting stuck, leave it. Look for an easier problem to boost your confidence. Do that next. And then maybe another one.

Then go back to the hard problem. You may now be able to make some progress.

How come?

Doing the “hard-start” technique allows you to use your brain as a sort of double processor. Your diffuse mode can take over on the hard problem as soon as you drop your focus on it. While the focused mode is tackling the easier problem, the diffuse mode works in the background on the other, harder problem. If you wait until the end of your test session to focus on the hardest problems, your focus prevents the diffuse mode from going to work.



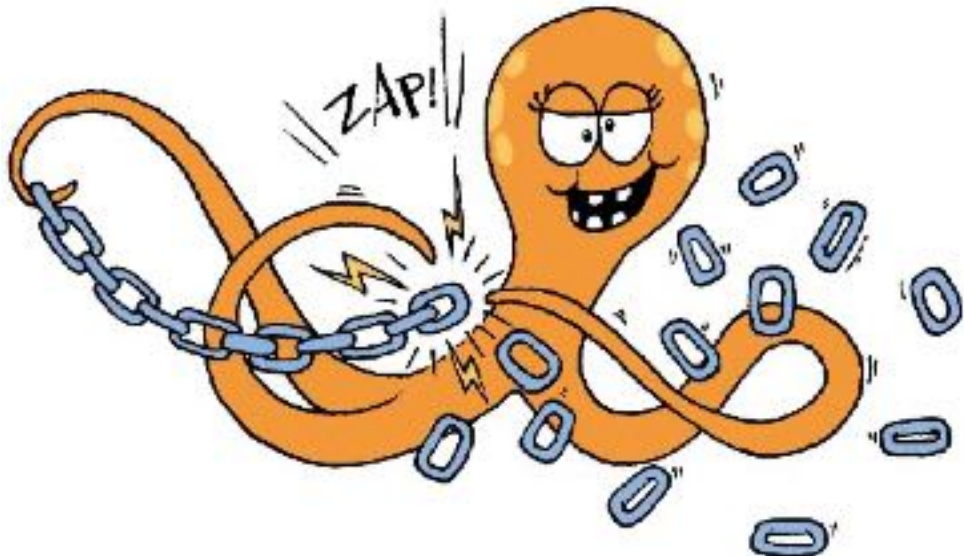
Do You Have a Poor Working Memory? Congratulations!

Here's another learning surprise. *Poor* working memories are sometimes better than *strong* working memories.

How so?

Some people have fantastic working memories. Their attentional octopus may have eight or even more arms, and their octopus's tentacles are incredibly sticky. They can hold a *lot* in mind, and it *stays* in mind. What's not to like about that?

But a poor working memory can also have upsides. If you have only three arms on your attentional octopus, for example, you have to work harder to make brain-links out of the key ideas. You don't have enough arms on your octopus to hold many thoughts in mind, so you have to figure out ways to simplify and link the ideas together.



This means the sets of brain-links created by a person with poor working memory can contain surprisingly elegant simplifications and

creative leaps.² The person with a strong working memory can find this kind of elegant, creative simplification harder to do. Their strong working memory means they don't need to find ways to simplify.

People with poor working memories often find thoughts slipping from their mind. Sounds bad, right? But it can be good! Research shows that when one thought slips from the mind, another pops in. People with poor working memory can be especially creative! This creativity is particularly noticeable in people who have attentional “disorders” (we think the term should be “advantages”) like ADHD.³

People with poor working memory and focus sometimes have to work harder than others to make brain-links. But the trade-off is that it can be easier for them to be more creative. They see elegant shortcuts and have ideas that others miss. The trade-off can be worth it!

Hiker Brains Versus Race Car Brains

So we're gradually seeing how a person who thinks slowly can sometimes do better than a "race car brain" person.

Think about it this way. A person with a race car for a brain can get to the finish line faster. In other words, they can figure out the answers to questions more quickly. The slower thinker, on the other hand, can get to the answer, but much more slowly. (Keep in mind that some people can be race cars in some subjects and hikers in others.)

For the race car brain person, everything goes by in a blur. They're thinking fast, and not necessarily worrying about the details. The "hiker brain" person, on the other hand, moves much more slowly. While they move slowly, they can reach out and touch the leaves on the trees, smell the pine in the air, hear the birds singing, and see the little rabbit trails.

This means that in some ways, the hiker brain can see more deeply than the race car brain.

So if you have a hiker brain on some or many subjects, be happy. It may take you more time to learn something than the race car brain. But you can still learn it just fine—in fact, you can learn more richly and deeply. If you have a race car brain, you can also be happy. But you'll also need to be careful not to steer off track, because it can be hard for you to get back on. We'll talk more about this later.

In the next chapter, we'll move on to one of the most important chapters of the book. How to prepare for tests!

SUMMING IT UP

- **Action video games can improve your ability to focus.** They can also improve your vision. They can be especially useful for older people, to help keep their focus strong.



We're a regular cartoon network!

So, great job! You've let your imagination go to work in learning some challenging science. I hope all those metaphors helped.

In this chapter, I want to revisit the main lessons of the book. After all, you know by now that repetition is one of the keys to learning.

But first I want to ask you an important question.

What's the point?

Really. I mean it. What's the point of all this learning? Why should you bother at all? From one perspective, we're just tiny little specks on a rock in the middle of an unimaginably vast universe.

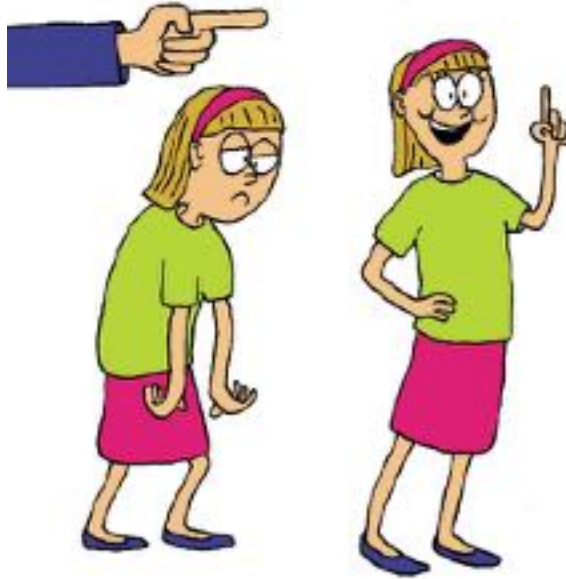
Before you read on, I would like for you to try to answer that question: what's the point of learning *anything*? Try to answer this in as many different ways as you can. Aim for five reasons. Give yourself some thinking time. Find someone to explain your ideas to, and see what they say. Or you could try to write your ideas down. At the very least, think through what your answer would be in your head. Then turn the page to see some ideas that people might give.

Here are some of the things people *might* say about the "point" of learning:

- You *have* to learn because otherwise your mom or dad won't let you go out to play.
- You have to learn because otherwise your teacher will put you in detention.
- You have to learn because the law says so.
- You have to learn so you can graduate, go to college, and get a job.
- You have to learn so you can keep your options open for the future.
- You get to learn so you can go on and follow your passions.
- You get to learn so you can discover more about the mysteries of the universe.
- You get to learn so you can fulfill more of your amazing potential each week.
- You get to learn so you can help humanity solve some of the world's problems.
- You get to learn because you are an inquisitive human being.

Of course, there are other possible answers. But in a way *all* of the above are true.

Did you notice what I did halfway through the list? I switched from “you *have* to learn” to “you *get* to learn.” I changed it from an obligation—something you have no choice about—to a privilege. That is, something you're lucky to be able to do. It's both. You *will* get detention if you don't do your homework. So, unless you like detention, that's a valid reason to do your homework. But it's not an inspiring reason to study. It works a lot better when you can see *positive* reasons for taking an interest in your learning, rather than just avoiding punishment.



Lucky to learn!

We find ourselves on this mysterious rock called Earth, in a particular place and time. And we have (probably) the most advanced technology in the universe *within our skulls*. (Unless there are aliens who have even more extraordinary intelligence than you and me—in which case it will be pretty interesting learning about them!) But wouldn't it be a crazy waste of our time on Earth not to make the most of the astonishing tool between our ears?

The younger you are when you learn how to learn more effectively, the longer you have through your life to enjoy the benefits. Learning is a privilege. In some parts of the world, children have no access at all to books or computers or teachers. I believe that we owe it to those people who don't have access to school to make the most of our opportunities. I want to encourage you in your learning for *all* of those reasons, and more. After all, as Terry says, you never know when your learning is going to come in handy.

Learn how to learn so you can follow your passions. But don't *just* follow your passions. That was my mistake when I was young. There's a lot of learning you can do that will open doors you can't yet imagine. *Broaden* your passions—learn and enjoy new subjects beyond the one you originally thought you could learn. You'll put yourself in a better place for whatever