

THE BIG IDEAS

Fluency vs. Mastery

Don't just go w/your feelings.

Cranberries + Testing

Active retrieval is where it's at.

Curveballs

Interleave yourself some curves.

Elaboration

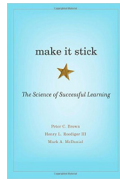
Explain it like I'm 5.

Testing

Static vs. Dynamic.

You Think You Can?

Wit + wisdom.



Make It Stick

The Science of Successful Learning

BY PETER C. BROWN, HENRY L. ROEDIGER III, MARK A. MCDANIEL · BELKNAP PRESS
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“People generally are going about learning the wrong ways. Empirical research into how we learn and remember shows that much of what we take for gospel about how to learn turns out to be largely wasted effort. Even college and medical students—whose main job is learning—rely on study techniques that are far from optimal. At the same time, this field of research, which goes back 125 years but has been particularly fruitful in recent years, has yielded a body of insights that constitute a growing science of learning: highly effective, evidence-based strategies to replace less effective but widely accepted practices that are rooted in theory, lore, and intuition. But there’s a catch: the most effective learning strategies are not intuitive. ...

This is a book about what people can do for themselves right now in order to learn better and remember longer. ...

We write for students and teachers, of course, and for all readers for whom effective learning is a high priority: for trainers in business, industry, and the military; for leaders of professional associations offering in-service training to their members; and for coaches. We also write for lifelong learners nearing middle age or older who want to hone their skills so as to stay in the game.

While much remains to be known about learning and its neural underpinnings, a large body of research has yielded principles and practical strategies that can be put to work immediately, at no cost, and to great effect.”

~ Peter Brown, Henry Roediger, Mark McDaniel from *Make It Stick*

“ Learning is deeper and more durable when it's effortful. Learning that's easy is like writing in sand, here today and gone tomorrow.”

~ Peter Brown, Henry Roediger, Mark McDaniel

Want to learn about the science of successful learning?

Then this is the book for you. [Make It Stick](#) is written by story-teller [Peter Brown](#) and two leading cognitive scientists who have spent their careers studying learning and memory: [Henry Roediger](#) and [Mark McDaniel](#). (Get a copy [here](#).)

It's a fascinating exploration of what science says about the most effective learning techniques—shining light on the techniques that actually work and those that do not work—even though we may *think* they do!

Hint: Rereading, massed “practice-practice-practice” sessions, and cramming are not wise strategies. Active retrieval, interleaving, spaced repetition, reflection, elaboration, getting your mind right and practicing like an expert, on the other hand, are very good strategies.

The book is packed with Big Ideas and I'm excited to share some of my favorites we can apply to learning in general and to optimizing our lives in particular so let's jump straight in!

... We'll start by taking a quick look at what *doesn't* work then dive a little deeper into some strategies that do work!

FEELINGS OF FLUENCY VS. TRUE MASTERY

"Where more cognitive effort is required for retrieval, greater retention results."

~ Peter Brown, Henry Roediger, Mark McDaniel

"Learning is deeper and more durable when it's *effortful*. Learning that's easy is like writing in sand, here today and gone tomorrow.

We are *poor judges* of when we are learning well and when we're not. When the going is harder and slower and it doesn't feel productive, we are drawn to strategies that feel more fruitful, unaware that the gains from these strategies are often temporary.

Rereading text and *massed practice* of a skill or new knowledge are by far the preferred study strategies of learners of all stripes, but they're also among the *least productive*. By *massed practice* we mean the single-minded, rapid-fire repetition of something you're trying to burn into memory, the 'practice-practice-practice' of conventional wisdom. Cramming for exams is an example. Rereading and massed practice give rise to feelings of fluency that are taken to be signs of mastery, but for true mastery or durability these strategies are largely a waste of time."

Conventional wisdom tells us the most effective ways to study and learn involves tons of highlighting, rereading and "massed practice"—focusing on one topic deeply until you totally get it (or, at least *feel* like you get it).

The authors come back to the fact that, although these approaches are the most prevalent and *feel good* as you do them, they are also the least effective.

They make the important point throughout the book (via an effective learning strategy called "spaced repetition"), that there's a (huge!!) difference between "fluency" with a topic—a feeling of familiarity—and true mastery of that topic.

To get true mastery and "make it stick," we need to engage in more effective strategies.

Let's take a quick look at a few of my favorites!

CRANBERRIES + THE TESTING EFFECT

"Empirical research shows us that the testing effect is real—that the act of retrieving a memory changes the memory, making it easier to retrieve again later."

~ Peter Brown, Henry Roediger, Mark McDaniel

"A child stringing cranberries on a thread goes to hang them on the tree, only to find they've slipped off the other end. Without the knot, there's no making a string. Without the knot, there's no necklace, there's no beaded purse, no magnificent tapestry. Retrieval ties the knot for memory. Repeated retrieval snugs it up and adds a loop to make it fast. ...

Today, we know from empirical research that practicing retrieval makes learning stick far better than reexposure to the original material does. This is the testing effect, also known as the retrieval-practice effect.

To be most effective, retrieval must be repeated again and again, in spaced out sessions so that the recall, rather than becoming a mindless recitation, requires some cognitive effort. Repeated recall appears to help memory consolidate into a cohesive representation in the brain and to strengthen and multiply the neural routes by which the knowledge can later be retrieved."

That's from the chapter, "To Learn, Retrieve." It's the first Idea the authors share on how to make it stick.

They make the important point that mindlessly *rereading* material DOES NOT lead to mastery. But... Practicing *retrieving* the material DOES lead to mastery.

It's a lot harder to close the book and ask yourself what you just learned than it is to simply scan your highlights and, as we discussed in the last Idea, FEEL like you have a sense of mastery (which is really just fluency).

So, the lesson is clear: If we want to master material and tie the ol' knot to keep those cranberries from slipping off, we need to test ourselves.

"If it's important, it needs to be practiced, and practiced again. And don't put stock in momentary gains that result from massed practice. Space your testing, vary your practice, keep the long view."

~ Peter Brown, Henry Roediger, Mark McDaniel

Quick quiz: What have you learned so far in this Note? Without going back and reviewing, make a mental (or actual!) note of the key Ideas we've explored so far.

Here are some of the main Ideas I've gleaned thus far: _____

THAT is active retrieval.

It's not particularly comfortable and it "feels" like you haven't understood as much as you'd like. Although it would "feel" better to just go back to the top and re-read stuff, the act of testing yourself gives your little neurons a workout and helps us MAKE IT STICK.

It's kinda like going to the gym and just lifting Styrofoam weights (rereading) vs. lifting the heavy stuff (retrieving)—one leads to strength development and the other does not.

Remember: Testing itself is a form of learning. So... After reading a great book or watching a TED talk or reading/listening to one these Notes, try quizzing yourself on what you remember! (And, of course, support your kids with this process as well!)

INTERLEAVE YOURSELF SOME CURVEBALLS

"When the baseball players at Cal Poly practiced curveball after curveball over fifteen pitches, it became easier for them to remember the perceptions and responses they needed for that type of pitch: the look of the ball's spin, how the ball changed direction, how fast its direction changed, and how long to wait for it to curve. Performance improved, but the growing ease of recalling those perceptions and responses led to little durable learning. It is one skill to hit a curveball when you know a curveball will be thrown, it is a different skill to hit a curveball when you don't know it's coming. Baseball players need to build the latter skill, but they often practice the former, which, being a form of massed practice, builds performance gains on short-term memory. It was more challenging for the Cal Poly batters to retrieve the necessary skills when practice involved random pitches. Meeting that challenge made the performance gains painfully slow but also long lasting."

That's from a chapter called "Embrace Difficulties" in which the authors chat about "desirable difficulties." <— "Short-term impediments that make for stronger learning."

We talked about desirable difficulties in our Note on [Malcolm Gladwell's *David and Goliath*](#).

"We acknowledge that everyone has learning preferences, but we are not persuaded that you learn better when the manner of instruction fits those preferences."

~ Peter Brown, Henry Roediger, Mark McDaniel

Here's what he shared: "The CRT is really hard. But here's the strange thing. Do you know the easiest way to raise people's scores on the test? Make it just a little bit harder. The psychologists Adam Alter and Daniel Oppenheimer tried this a few years ago with a group of undergraduates at Princeton University. First they gave the CRT the normal way, and the students averaged 1.9 correct answers out of three. That's pretty good, though it is well short of the 2.18 that MIT students averaged. Then Alter and Oppenheimer printed out the test questions in a font that was really hard to read—a 10 percent gray, 10-point italics Myriad Pro font—so it looked like this:

1. A bat and ball cost \$1.10 in total. The bat costs \$1.00 more than the ball. How much does the ball cost?

The average score this time around? 2.45. Suddenly, the students were doing much better than their counterparts at MIT.

That's strange, isn't it? Normally we think that we are better at solving problems when they are presented clearly and simply. But here the opposite happened."

Just making something a little harder actually IMPROVED performance. Fascinating.

*"Practice like you play,
because you will play like you
practice."*

~ Peter Brown, Henry Roediger,
Mark McDaniel

Desirable difficulties.

Back to our Cal Poly baseball players. The authors share a study in which the team is split up such that some players practice hitting curveball after curveball after curveball (called "massed practice") while others are thrown random pitches ("interleaved" practice).

As per our growing theme, the curveball + curveball + curveball + curveball batters FELT (and looked) like they were getting better and better. But their gains were based on short-term memory not true, deep learning.

On the other hand, the batters facing random pitches had to work a lot harder to identify what pitch was coming and respond to it appropriately. —> *"Meeting that challenge made the performance gains painfully slow but also long lasting."*

The technical terms for this: "massed practice" vs. "interleaved practice."

Massed practice is how we typically approach learning—whether it's via curveballs or math problems—we work through a set of similar problems until we attain a perceived level of mastery and then move on.

Interleaved practice, on the other hand, is a much better course to mastery. Whether it's mixing up the types of pitches we're facing or the types of math problems we're solving, we want to keep ourselves on our toes and not make it too easy.

Counterintuitive but remember (echo!): Easier isn't better.

P.S. As I banged out my burpees this morning interval-style (10 in ~40 seconds then ~20 second rest = 100 total burpees in < 10 minutes), I had the thought that interleaving practice is kinda like interval training. It's *much* easier to go for a jog (or whatever) at a steady state than it is to bust out x intervals of high intensity followed by quick recovery. AND... It's much more effective conditioning to do the interval training.

ELABORATION + EXPLAIN IT LIKE I'M 5

"In a cartoon by the Far Side cartoonist Gary Larson, a bug-eyed school kid asks his teacher, 'Mr. Osborne, can I be excused? My brain is full!' If you're just engaging in mechanical repetition, it's true, you quickly hit the limit of what you can keep in mind. However, if you practice *elaboration*, there's no known limit to how much you can learn. Elaboration is the process of giving new material meaning by expressing it in your own words and connecting it with what you already know. The more you can explain about the way your new learning relates to your prior knowledge, the stronger your grasp of the new learning will be, and the more connections you create that will help you remember it later."

Elaboration. (I love this one.)

Let's do another quick, practical check in: What's your favorite Big Idea we've *ever* explored? The one that's had the most positive impact on your life so far?

Explain it in your own words and connect it to other wisdom in that wonderful mind of yours!

That technique is called elaboration. It's one of the most effective (and fun!) ways to learn.

—> Say it in your own words. Connect it to something you already know.

Remember: There's NO (!) known limit to what you can learn when you connect a new piece of information to an existing memory.

P.S. Another facet of elaboration is explaining an Idea to people—which reminds me of a gem from [Barbara Oakley's *A Mind for Numbers*](#) (check out that Note plus her class [Learning How to Learn](#)—which is one of the biggest classes in history with 1 million+ students!).

"How ably you can explain a text is an excellent cue for judging comprehension, because you must recall the salient points from memory, put them into your own words, and explain why they are significant—how they relate to the larger subject."

~ Peter Brown, Henry Roediger, Mark McDaniel

Here's how Barbara puts it: *"The legendary Charles Darwin would do much the same thing. When trying to explain a concept, he imagined someone had just walked into his study. He would put his pen down and try to explain the idea in the simplest terms. That helped him figure out how he would describe the concept in print. Along those lines, the website Reddit.com has a section called 'Explain like I'm 5' where anyone can make a post asking for a simple explanation of a complex topic.*

You may think you really have to understand something in order to explain it. But observe what happens when you are talking to other people about what you are studying. You'll be surprised to see how often understanding arises as a consequence of attempts to explain to others and yourself, rather than the explanation arising out of your previous understanding. This is why teachers often say that the first time they ever really understood the material was when they had to teach it."

Want to see if you've mastered something?

Explain it like I'm 5. :)

STATIC VS. DYNAMIC TESTING

"Sternberg's concept of developing expertise holds that with continued experience in a field we are always moving from a lower state of competence to a higher one. His concept also holds that standardized tests can't accurately rate our potential because what they reveal is limited to a static report of where we are on the learning continuum at the time the test is given. In tandem with Sternberg's three-part model of intelligence, he and Grigorenko have proposed a shift away from static tests and replacing them with what they call dynamic testing: determining the state of one's expertise; refocusing learning on areas of low performance; follow-up testing to measure the improvement and to refocus learning so as to keep raising expertise. Thus, a test may assess a weakness, but rather than assuming that the weakness indicates a fixed inability, you interpret it as a lack of skill or knowledge that can be remedied."

This is part of a longer conversation, but I want to quickly highlight something important here.

Although the book is deliberately about how *individuals* can optimize their learning not how *societies* can optimize their approaches to education, the authors make the important point that standardized tests are simply STATIC measures of current abilities in a particular domain. They do **not** predict our potential in the area tested—whether that's reading or math or IQ—nor do they reveal our overall effective intelligence.

Robert Sternberg is one of the world's leading researchers on what he calls "successful intelligence" and his work establishes the fact that success isn't about IQ. It's about optimizing three aspects of successful intelligence: analytical + creative + practical intelligences.

And, he makes the point that the best way to do that is NOT via standard, static testing but via what he calls *dynamic* testing in which weaknesses are revealed and then worked on and then retested and optimized. Static vs. dynamic testing. Big difference.

This idea that intelligence is both broader than it is currently defined and more malleable than believed leads us to our final Big Idea:

YOU THINK YOU CAN?

"Let's return to the old saw 'If you think you can, or you think you can't, you're right.' It turns out there is more truth here than wit. Attitude counts for a lot. The studies of psychologist Carol Dweck have gotten huge attention for showing just how big an impact one simple conviction can have on learning and performance: the belief that your level of intellectual ability is not fixed but rests to a large degree in your own hands. ...

*"In Sternberg's view, we're all in a state of developing expertise, and any test that measures only what we know at any given moment is a static measure that tells us nothing about our **potential** in the realm the test measures."*

~ Peter Brown, Henry Roediger, Mark McDaniel

"Are there strategies or behaviors that can serve as cognitive 'multipliers' to amp up the performance of the intelligence I've already got? Yes. Here they are: embracing a growth mindset, practicing like an expert, and constructing memory cues."

~ Peter Brown, Henry Roediger, Mark McDaniel

Dweck's research has been triggered by her curiosity over why some people become helpless when they encountered challenges and fail at them, whereas others respond to failure by trying new strategies and redoubling their effort. She found that a fundamental difference between the two responses lies in how a person attributes their failure: those who attribute failure to their own inability—"I'm not intelligent"—become helpless. Those who interpret failure as the result of insufficient effort or an ineffective strategy dig deeper and try different approaches."

That's from a chapter on how to "Increase Your Abilities." As you've probably noticed by now, it's impossible to study nearly ANY topic related to optimizing and actualizing and not rub up against [Carol Dweck's](#) research. (Check out our Notes on [Mindset](#) and [Self-theories](#).)

For now, what do you want to master in your life? Is it a particular subject? Or building a new habit? Or achieving success in your business or new coaching practice or whatever?

Whatever it is, *do you think you can do it?* There's as much wisdom as wit to Henry Ford's adage that whether we think we can or think we can't WE'RE RIGHT.

This Idea plays a huge role in [Piers Steel's Procrastination Equation](#) as well (see Notes). As we've discussed, Steele tells us that our motivation is a function of wanting something AND believing you can have it.

Short story: If you don't think you can you'll be pulled off track and procrastinate.

So, as we get out there and tie the knot in our string of cranberries while interleaving curveballs and explaining it like I'm 5, let's remember it all starts with KNOWING that we can improve our abilities if we're willing to put in the effort and persist.

To optimizing and actualizing and making it stick!

B

Brian Johnson

If you liked this Note, you'll probably like...

[A Mind for Numbers](#)

[The Talent Code](#)

[Mindset](#)

[Self-theories](#)

[The Power of Habit](#)

About the Author of "Make It Stick"

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Brian Johnson loves helping people optimize their lives as he studies, embodies and teaches the fundamentals of optimal living—integrating ancient wisdom + modern science + common sense + virtue + mastery + fun. Learn more and optimize your life at brianjohnson.me.