52 ACES

MEMORY FUNDAMENTALS

ACE EDDLEMAN

Memory Fundamentals

By Ace Eddleman

Table of Contents

Introduction

Memory is a central function of your brain and in many ways defines your experience as a person. Without memory, life would be impossibly hard - we would not be able to form a cohesive idea about what's going on around us and our odds of survival would go down dramatically. In other words, **your memory is a critical piece of who you are and you should do everything you can to safeguard and strengthen it**.

It's also widely misunderstood and misrepresented. Movies, TV and everyday experience do a poor job of dealing with this subject and you're more likely to run into inaccurate “folk wisdom”-based representations of it than to stumble upon the truth. Too many people still believe in mythical concepts like photographic memory, and much of that is due to how memory is portrayed in media.

There are also the so-called "memory gurus" whose expertise lies solely in memorization tricks, usually by way of mnemonic techniques such as the method of the loci.

These people have a specific set of skills designed more or less to impress people into thinking that they have great memories, when in fact they have little to no understanding of what scientists who actually study memory have discovered about it. Their understanding of learning tends to be poor as well.

The gurus rely on tricks (such as memorizing decks of cards) that are easy to demonstrate and leave an impression on viewers to ply their trade. While I don’t think there’s anything wrong with developing these types of skills if you are interested in entering memory competitions or impressing people at parties, I do think it’s dishonest to develop them if your goal is to convince people you’re a memory expert.

Memory is not merely a matter of memorizing things in rapid succession. It serves as a foundation for our most basic survival capabilities, and is intimately connected to how we learn. By making it seem like memorization is the holy grail of memory, these “gurus” are doing a real disservice to anyone who is interested in truly getting the most out of their memory.

On the one hand, it's not surprising that there's so much memory flim-flam out there. Everyone has an abundance of experience with memory (since we all have a memory system), and we are, as a species, fond of weaving elaborate stories. Scientific explanations are less interesting to many people, and we haven't had the tools to accurately describe anything about the brain until relatively recently.

On the other hand, we do know quite a bit about how memory functions (at least from an external perspective) and how it influences learning at this point, so both Hollywood and the so-called "gurus" are out of excuses. Any amount of ignorance they display in their work is a matter of laziness, deception, or both.

Neuroscientists have not come up with a complete model of memory as of yet, but we do have a sizable body of work that has demonstrated some basic truths about how it works. In other words, we can observe memory’s effects on our behavior and cognition, but we still haven’t figured out how our brain cells (called neurons) make it all happen from the inside.

That's largely why I wrote my first book, *The Learning Factory*, and started creating content under the 52 Aces brand. I was tired of being misled - intentionally or otherwise - when it came to memory and learning.

As a result, a large chunk of my life up till now has been dedicated to educating both myself and others about both memory and learning.

I see these concepts as being perhaps the two most important subjects going forward. Why? Because we all depend on learning and memory for our ability to adapt, and our fast-moving, increasingly automated world demands that we keep our adaptation skills as sharp as possible.

Anyone who refuses to maintain that edge will get left behind as their previously-secure positions in the world get replaced by faster moving people and the rapid advance of increasingly sophisticated machines.

This small book is not a complete view of memory or learning, but is rather designed as a quick dip into the specific subject of memory. It's an introduction that will give you a baseline of knowledge to help you better utilize what your brain has to offer, and to see through some of the memory-related bullshit that's floating around in the world.

Think of this book as a way to dip a toe into the waters of learning and memory. You might read it and decide you want to take a deep dive and get serious about understanding how your brain works. Or you can simply use this as useful information and move on.

Either way, it won't take up a ton of your time or energy. My goal is to give you just enough to get the most important concepts across, and if you want more you can find it in my other work or in the third-party material I reference at the end of this book.

Although everything I'm going to tell you is in line with what science currently has to say about memory, I've purposefully simplified my explanations. Please don't crucify me for not going deeper into detail if you're well-versed in any of these subjects! Again, this is a book designed for laypeople who want to get a quick intro to memory - not neuroscience PhDs.

In fact, I’m assuming that you don't want to become a neuroscientist and want the most useful, juicy pieces of information possible. I'm also assuming that you don't want to be bored out of your mind, so I'm not going to get into the finer points of biology or anatomy. Every chapter involves a concept that could be elaborated into full-sized volumes on their own (and there are in fact many such volumes out there).

As I’ve elaborated on my blog, I don’t see much value in bombarding my readers with avalanches of information. Instead, I see my role as a sort of filter: I use my years of experience to take in information, find the most useful and relevant bits, then package it for other people to use. This book is simply a continuation of that policy.

-Ace

Your Lazy Brain

Before diving directly into memory, we need to confront a basic truth about our brain: it's extremely lazy. It's not an exaggeration to say that it's around the same level as The Dude from The Big Lebowski (who is correctly identified as quite possibly the laziest person in the universe).

Your brain is at roughly this level of laziness.

This probably sounds counterintuitive, since we all think of our brains as the seat of our incredible, world-dominating cognitive abilities. Strangely enough, it is precisely because we *can* do so much with our brains that our brains do their best to slink off to take a break whenever possible.

The reason for this is simple: our brains are energy hogs. Even though your brain only takes up around 2% of your body weight, it blows through roughly 20% of your daily energy supply! This might sound crazy, but consider this: your brain doesn't just control what you think about consciously. It’s controlling every sub-system within your nervous system as well - basically every system that keeps you alive at all times.

In fact, that’s mostly what it does and it does it in a subconscious way. This allows you to do things like breathe, eat and respond appropriately to external stimuli without any conscious effort on your part.

All of that requires energy. I'm not talking about "energy" like auras, chakras or any other crazy New Age nonsense. I mean the stuff that gives your brain the ability to do work, such as glucose. A large portion of that glucose goes to the subconscious processes I mentioned before, and the “surplus” energy can be used for other things, such as conscious thought.

Here’s the problem: conscious thought kicks up the pace of energy burn significantly. Anything you need to focus on with intent will always increase the amount of energy required by your brain. Anything that you can do automatically will not affect your energy supply that much, although everything you do with your brain carries at least a small energy penalty.

A simple way to think of this is to equate attention with energy burn. The more intensely you need to focus, the more energy you’re plowing through on a moment-to-moment basis. Eventually, you won’t be able to pay attention any more. If you’ve ever been to a long, boring lecture in person then you already know what this feels like.

The analogies I like to use for this relationship are driving to work and airline travel. If you’ve been working at a job for ten years and driven the exact same route every day for that entire span, your daily commute is not going to use much “juice.”

The process has been repeated so many times that you don’t need to focus on the details of your route to accomplish the task of getting to work, so your energy expenditure is minimal. You can get to work feeling not much worse than when you got into your car.

Contrast this situation with what it's like to fly commercially. Unless you're a true road warrior and are on planes all the time, the whole process of getting to the airport, passing through security, boarding the plane, etc. is going to be exhausting.

I'm getting exhausted just looking at this picture…[1]

Why? Because you have to consciously consider so much of what you're doing. Even though it might seem like you just drove to the airport, hopped into a big metal tube, sat there for a few hours and then got off, it's much more taxing on your brain than you think.

This is why you're likely to feel disproportionately tired after even a short trip on a plane. There's just so much internal processing going on that your brain starts to run out of resources fairly early on.

[1] Picture courtesy of Politikaner via Wikimedia Commons

It’s useful to think of your brain as having a sort of gas tank. It’s filled when you wake up from a full night of sleep, and as the day progresses that gas gets burned. If you smash the gas pedal the whole day, you’ll run out quickly. But even if you don’t use it that much, it will eventually reach a point of depletion that will require another fillup.

Viewed this way, it becomes clear that maximizing your brain’s abilities - including memory - is largely about intelligent management of your daily energy supply.

This analogy also leads us into why the brain is such a “lazy” organ. Because it is so energy-demanding, it has evolved many clever mechanisms for saving energy whenever possible.

It makes sense from an evolutionary standpoint, since our sophisticated brains are what allow us to survive. When the brain runs out of juice out in the wild, survival probability goes down because problem-solving abilities are diminished.

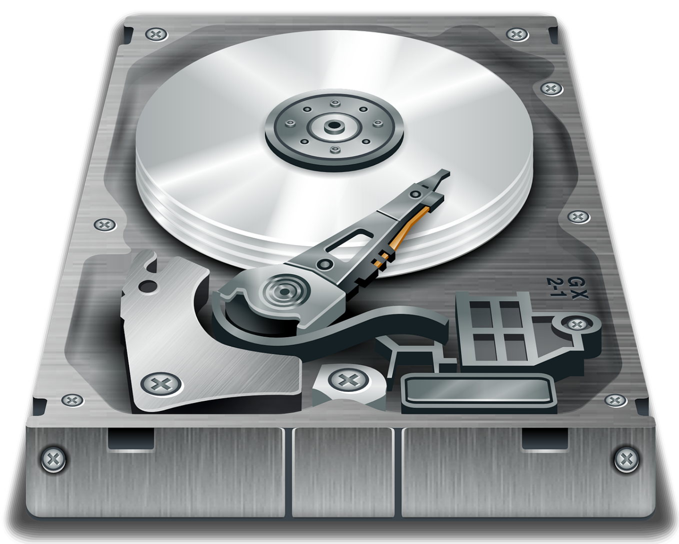
Understanding memory is heavily dependent on understanding this resource-management dynamic. As you’ll see (both in these pages and in your own experience), much of what makes our memory function how it does is driven by your brain’s desire to avoid excess work whenever possible.

A Simple Overview

Take a moment and ask yourself this question: *how do I think my memory works?*

The most common model people come up with is similar to how a computer stores data: two cameras (eyes) send information to a hard drive (the brain), and when we want to remember something we simply open up the relevant memories. Any failure to pull those memories is due to a “poor” memory and not an issue with the storage system.

While it’s worth repeating that neuroscience has not come up with a complete neurological explanation of memory, we can confidently dismiss that model. Our brains are extraordinary in many ways, but they are biological and simply don’t operate with the same level of precision as the computers that we’re so used to dealing with.



Your brain is not a hard drive.

The core of the problem is that the information we get from the outside world is not being stored as a one-to-one representation in the brain. First of all, our sensory organs (such as our eyes and ears) do not provide us with perfect inputs. We never get a complete picture of our environments because of limitations associated with these organs. So right off the bat, we have a distortion of what's being stored in memory.

For example, if you have poor eyesight, that's going to affect how you view the world and process incoming visual information. Inputs from the outside world that seem obvious and clear to those with 20/20 vision can be far less certain if you have vision problems. Your impaired vision is creating distortions that are very difficult, if not impossible, for you to avoid.

Then there is our brain's tendency to be selective about what to remember. So even if we had perfect sensory organs (which we don't), our brains are fairly choosy about what they want to remember.

This is the first mental "shortcut" your brain will take to conserve energy: filtering out anything that isn't viewed as relevant. The next steps in the memory process require additional energy, so the brain has developed ways to ensure that it only expends energy on what might be important in one way or another. That's yet another layer of imperfections being added to your memories.

If something is viewed as important enough (the scientific term is ***salient***, which we'll talk about more later), the brain then starts the encoding process, where information from the environment is transformed into a useful construct for later recall. You can think of it as a sort of "simplifying" process, where the complexities of a concept are boiled down into features that can be more easily remembered.

Encoding introduces a variety of distortions, morphing new information based on your pre-existing biases, knowledge and other subconscious processes.

Once a memory has been properly encoded, it's different in subtle ways. That changed piece of information is stored in memory, where it is likely to be connected in some way to other bits of data that were there before it. If you never make an effort to recall this memory, it will likely decay and either become either very difficult or impossible to recall.

If you can recall a memory, then you introduce a whole new set of distortions as well. Memory is considered a reconstructive process, which simply means that memories are "built" or "constructed" every time they're recalled. You aren't directly fetching a single coherent memory when you remember something - instead, you're engaging in a sort of search process where you memory looks for pieces and glues them together as they're found.

As you can imagine, this is an imperfect process. Memories often get bundled together for a variety of reasons, with the most common being interference. Interference is the competition that takes place between memories, which in turn leads to problems with recall.

It's an especially big problem when there are multiple similar memories and you're trying to access a specific one. Your brain is likely to "borrow" bits from all of those episodes to give you an answer (unless the specific episode has a high level of salience).

The Conveyer Belt

The analogy I like to use for all of this is a conveyer belt in a factory. First, raw material is brought to the factory to be inspected. Most of the material isn't deemed worthy of processing and gets discarded (this represents all of the non-salient information you come across). Once some decent material is found, it’s placed on a conveyer belt where several workers stand on either side.

The memory process is like an assembly line in a factory.

Each worker picks up the material in front of them and alters it in some way. These workers represent the different ways your brain manipulates and changes information as it comes in - the encoding process. Once each worker has had their chance to change the material, it’s placed in a box and shipped out to storage.

A delivery truck picks up the boxes and takes them to a warehouse. On the way, the boxes bounce around and the items inside change a little bit more. Sometimes, a box falls out of the truck and the driver doesn’t notice. These represent the continual process of change that occurs even as a memory is stored.

Whenever you want to recall a memory, think of this whole process in reverse. First, the package needs to be found in the warehouse. Sometimes this works, and sometimes it doesn’t.

Packages get piled up and it can be hard to find specific ones - especially if the packaging is similar. However, if the memory is successfully recalled, the package is sent back to the factory, where it is placed on another conveyer belt. On this conveyer belt, the memory is unpacked and goes through another round of changes from the belt workers.

After the workers have done their jobs, the memory is finally within conscious reach.

This might sound bizarre because, well, it is. Your memory can be very *weird*, particularly when it comes to the encoding process. Life is more difficult in many ways because of all the processes your brain forces new information to go through. It would be much simpler to just have a clean, clear one-to-one storage process like the one you can use on your computer.

Unfortunately, your lazy brain does not allow this and so we have to work around our own limitations.

The silver lining here is that, despite all of this weirdness, all healthy brains operate the same way at a fundamental level. Even though people have plenty of differences between them (intelligence, knowledge, etc.), the same sorts of things are happening across the board.

From this, we can deduce a simple and powerful idea: **maximizing your brain is a matter of exploiting its weird tendencies**. Your brain is a strange, fairly mysterious entity - but it can be leveraged to do all sorts of incredible things if it is pandered to.

Encoding

How you encode information dictates, to a large degree, how well you'll be able to recall it in the future. **If a memory is weakly encoded then the memory is likely to be hard to recall.** As a result, it's important to understand the encoding process and what it entails.

Consider the absolute first step in the conveyer belt analogy, where raw materials are being either accepted or discarded. When your ears, eyes and other sensory organs are taking inputs from the outside world, those inputs get placed in what's known as ***sensory memory***.

Sensory memory holds the "raw material" of perception - the sights, sounds, smells and other sensory events that are happening all around you. This raw material is kept in sensory memory for less than a second, at which point it is either used further on in the memory process or discarded.

Because of the limitations laid out in the "Lazy Brain" section of this book, we cannot hope to hold on to more than a small fraction of what we perceive. Most of the raw material that lands in sensory memory is discarded, since it isn't classified as relevant enough for the brain to go to the trouble of saving it.

If information does get past this initial filter and moves on from sensory memory, it is then transferred to what's known as ***working memory***, which is considered a sub-system of ***short-term memory***. The difference between the two is that short-term memory is purely for storage that lasts somewhere in the range of a few seconds, while working memory actively manipulates and organizes information.

You can think of short-term memory as what's used to pull information out of the primitive, raw data within sensory memory. Working memory is a further refining and processing register that further changes that data into something useful for long-term storage.

Working memory is basically where you do your thinking, as information is compared to and combined with what you already have in memory. You should view short-term memory as the loading area where raw materials are brought to the factory, and working memory is the first area inside the factory itself where those materials get sorted.

Another analogy you could use for this part of the process is shaping clay into pottery. Information is the lump of clay, and encoding is what turns it into something that can be useful later on - after some deliberate work on your part.

Encoding is similar to shaping clay (information) into pottery (useful memory constructs).

Types of Encoding

There are a variety of ways information can be encoded. At the most basic level, encoding can be initiated by interactions with images (***visual encoding***), sounds (***acoustic encoding***) or even physical touch (***tactile encoding***). Nearly any sensory input can kick off the encoding process, although the manner in which you interact with those inputs can make a substantial impact on how effective that process is - a topic we'll dive further into later on.

You can also encode based on elaboration (***elaborative encoding***) or meaning (***semantic encoding***).

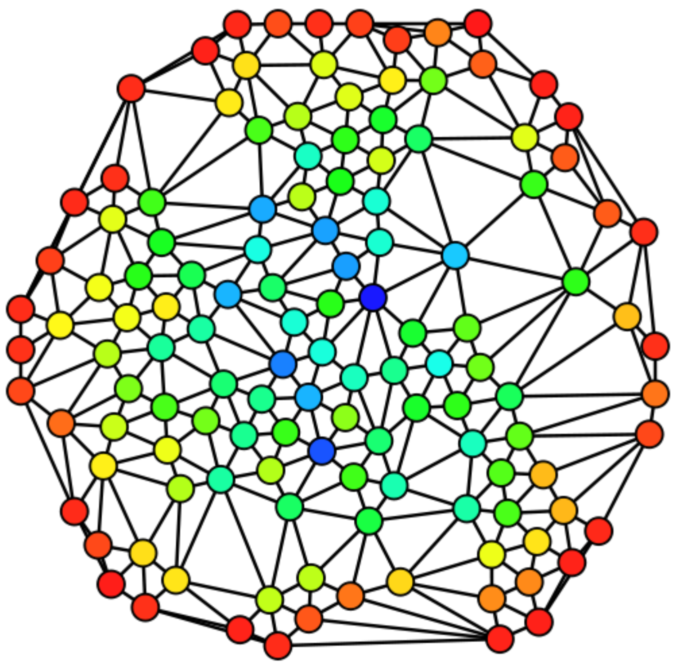
Elaborative encoding involves connecting what you already know to what you're thinking about. This type of encoding can be thought of as what allows you to have "a-ha" moments, where new information allows you to see something new in a concept you already know. The connection by itself is enough to kick off the encoding process, giving you a high chance of recall later on.

Semantic encoding involves attaching meaning to a memory. An example of semantic encoding in action would be remembering a phone number because it belongs to someone you care about. The digits on their own are meaningless, but they're encoded effectively because you attached meaning to them via a personal connection.

Another common example of semantic encoding is name mnemonics, which is the process of associating concepts with a simpler, easy-to-remember name.

One that most people are familiar with is PEMDAS, a simple, short word which is used to remember the order of operations in mathematics. Rather than having to remember each step individually - which is difficult without any kind of assistance mechanism - this handy shortcut allows you to rely on recalling the word itself, then working through the letters.

The key to encoding is creating associations between what you want to remember and what you already know. Memory in general is an associative process, so it's worth understanding how your brain makes these associations.



Memory operates much like a network of nodes, with links (associations) between nodes (individual memories/concepts)[2].

We'll go over some of the finer details of this in the next chapter, but for now it's worth exploring another critical concept: ***depth of processing***. The general idea behind depth of processing is that *increased processing equals increased recall.*

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[2] Image by Claudio Rocchini via Wikipedia Commons.

What does “processing” mean? While there is some debate about that (it’s basically the focus of the whole field of cognitive science), for your purposes you can view it as “thinking.” The more you think about something and the more *ways* you think of it, the stronger your ability will be to recall it later.

For example, if you read about something in a book once and never think about it again, there’s not much of a chance you’re going to remember it. But if what you read really struck you as important and you followed up by reading about it from a bunch of different perspectives, you’re far more likely to remember it.

Memory has a sort of dimensionality to it that needs to be pandered to if you want to remember something. If you want a simple, effective way to boost your recall, just **find a variety of ways of interacting with whatever it is you want to remember**.

Don’t just read books - go to lectures, talk to experts, watch videos and get hands-on (if possible). While your visual channel is capable of taking in the most information at once, you need to be using all of your senses if you want to properly remember (and ultimately understand) anything complex.

The deeper you process, the stronger the memory will be.

To make this concept even easier to understand, you can break it down into this simple maxim: **the more associations you create between concepts, the better.** Each association can be viewed as another "level" of processing depth that your brain can take advantage of next time it tries to remember whatever it is you want to recall.

It's also easy to fall into the trap of believing that you are a "visual learner" or "auditory learner," since these concepts make sense at an intuitive level. The truth is that "learning styles" like this have never been proven to exist (a topic I cover in my book *The Learning Factory*). We all utilize multiple senses to learn about and understand our world, and the more senses you get involved, the better.

Here are the two key takeaways for effective encoding:

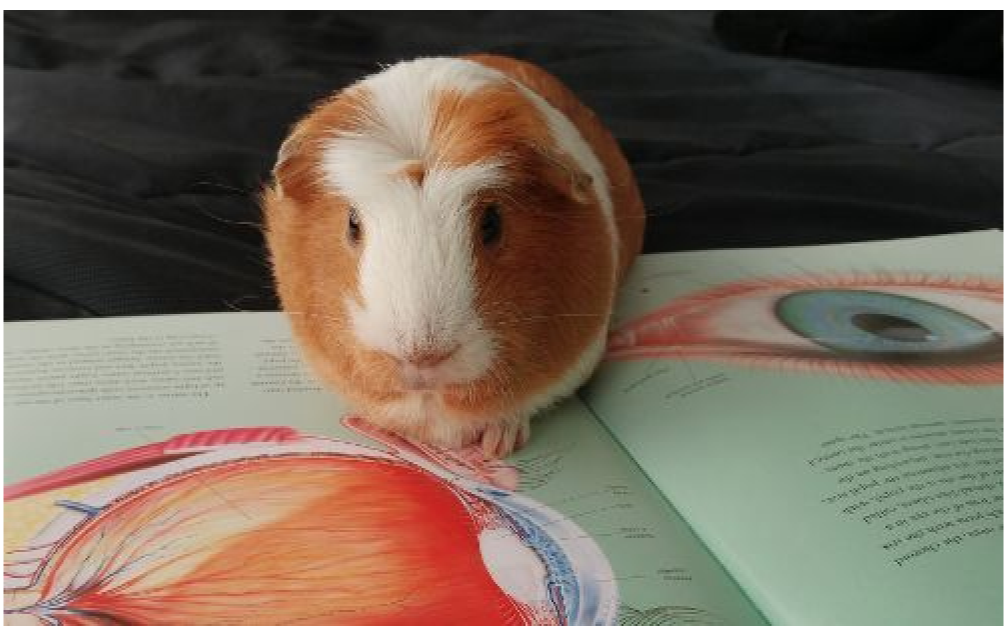
1. **If you want to remember something, create associations between concepts.**

2. **Always look for ways to create "depth" for your memories.**

Salience & Cues

It's helpful to think of your brain as a sort of radar, scanning its environment for anything that might be interesting. To make it even more simple, we can say that our brains are really just "change detectors." We notice the things around us that are different in some way, and largely discard everything else.

Your brain is actively searching for what's called ***salience***, which is simply the quality of standing out within an environment. Any time you encounter something in your daily life that makes you stop and say "That's unusual," your brain is taking notice of something salient.



Didn't expect to see a picture of Stevie the guinea pig reading a book, did you?[3]

[3] No guinea pigs were harmed in the making of this photo. In fact, Stevie was given a treat shortly after it was taken.

Salience can be viewed as anything that holds your attention when there are other things competing for it. Whatever stands out the most is what is most salient, and hence most likely to be remembered.

On the other side of the coin, things that you do all the time - like using the bathroom for the millionth time - are not considered salient, and end up getting tossed.

Why does the human brain operate this way? The simple answer is that it's another shortcut that our lazy brains take to conserve energy. By only focusing on those things that "matter" in some way, your brain can skip any energy-intensive processing that might get kicked off by things that don't affect your survival.

The familiar sound of another caveman burping wouldn't have affected our ancestor's ability to survive and reproduce, whereas the unusual rustling of leaves indicating an approaching predator did. Our brains caught onto this via natural selection, and so the burp gets ignored while the rustling leaves grabs our attention.

You can see this in your own modern, non-caveman life that is (hopefully) free of natural predators. For example, let's say you have a morning routine of eating breakfast and driving to work. If it's your first day doing this, you'll probably remember it because it's unfamiliar. All the new (salient) sights and sounds will be actively processed by your brain, specifically because they're new.

Once you've done this routine for a period of time - let's say a year - that experience is no longer salient to you. You stop remembering your drives to work and what you ate for breakfast. All of your experiences start blending together into a single concept of "morning routine" and you end up forgetting most of them. However, you will remember mornings where something broke that routine.

Images of the aurora borealis are extremely salient to most people because the sky doesn't glow like this in most places. To someone who grew up around the auroras, however, it is not particularly interesting.

If the toaster you use to make your daily breakfast toast ends up setting your house on fire, you'll remember that breakfast. Or if you get into an accident on your way to work. Or if you get laid off that day. All of those experiences are salient, and will stick with you.

Perceptual Learning

This process of interpreting things as salient or not is largely tied into what's called ***perceptual learning***. Perceptual learning is what happens when you find new ways of "seeing" your environment. You could say that it's how we develop an ability to discriminate between different objects in your environment.

As you develop skills and expertise in a subject, you start to see the world in new ways. This is perceptual learning in action. Salience is important to how you perceive the world, since it's what drives the encoding process, which in turn creates memories that we reference when we come in contact with things in our environment.

Whenever your ability to determine what is worth paying attention to changes, your perception of the world changes along with it. Details start to stand out or not depending the perceptual learning you've generated by interacting with salient stimuli. The more you learn about something and build up memories about it, the more you'll be able to spot it out in the world. More importantly, you'll be able to spot it *even in the presence of other objects competing for your attention*.

This is tied into what we view as "expertise." For example, if you don't know anything about airplanes, they all appear to be roughly the same. They all have wings, they fly through the air and they make loud noises via their engines. But to an aviation expert, whose perception has been altered by a large number of memories associated with airplanes, every airplane is more or less unique.

Someone who has spent time developing expertise about airplanes (especially World War 2-era airplanes) will recognize this as a P-51 Mustang. But people without that perceptual tuning will only see "an airplane."

Retrieval Cues

Remember how we explored the idea of "association" in the last chapter? Well, salience plays a very important role in how you build associations between concepts.

Associations depend on what are called ***retrieval cues*** (aka ***cues***). These are specific sounds, smells, tastes, etc. that can be linked to a memory. In general, effective encoding involves both salience and a link between a cue and a specific memory trace.

More cues means a higher chance of recall, so you're more likely to remember something if it isn't presented to you in a single format. Seeing an image one time can trigger encoding, but it's far more likely that you'll remember the concept associated with that image if there are also sounds, smells or even physical touches attached to it.

This is the meat of what was discussed earlier in the section about "depth of processing." Each new layer of sensory cues adds depth of processing, and depth of processing creates stronger memories.

One example from my own life involves angel food cake. When I was a kid, my family used to keep all kinds of food in the oven as a means of saving space. If anything was going to get cooked in the oven, whoever was cooking was expected to remove whatever food was already in there before firing it up.

My sister decided to skip that crucial "remove food from the oven" step and preheat the oven with a brand new angel food cake inside. This particular cake also happened to be encased in plastic.

Nobody noticed at first, but it quickly became apparent that something was wrong when the wretched, disgusting smell of burning plastic mixed with burning angel food cake filled the kitchen. She realized the mistake she made and opened the oven, at which point a cloud of smoke poured out. Inside, we found the deformed and burnt remains of the cake and its plastic casing.

It was an extremely unique smell, one that I hadn't encountered before and haven't encountered since. Because of this experience, I cannot stand angel food cake. Every time I get a whiff of it, my brain automatically reminds me of that horrible smell and I get away from it as fast as I can.

This memory is very strong for a couple of reasons: 1) it's very salient, as I'd never smelled anything like that before (or since), and 2) there were some very strong smell cues linked to it. The smells and visual images alone were stamped into my mind forever.

Never again.

You don't have to wait until something gnarly like that happens if you want to effectively encode memories. As long as you can deliberately find ways to build sensory associations and salience into the things you want to remember, you can use your brain's evolved laziness to your advantage.

How to Remember Someone’s Name

Name mnemonics were mentioned earlier, but combining images with meaning creates the most effective way to remember things on the fly. For example, I once met a man named Logan. He happened to have very long “mutton chop” sideburns - just like the Marvel character Wolverine (whose “real” name is also Logan).

I was a massive X-Men fan as a kid, so the image of Wolverine is already burned into my brain for the rest of my life. This makes it an ideal image to use for this new association.

Once I met him, I generated a mental image associating his long sideburns with the Wolverine/Logan character. Since this particular facial hair style is pretty unusual (salient) and resembled an image I was familiar with (Wolverine), it was very easy for me to remember his name.

If you find yourself forgetting people’s names regularly, this is a great way to exercise your new knowledge of how memory works. Find something salient about them (everybody has something!) and then associate it with an image you’re familiar with - you’ll be amazed at the results!

Long-Term Memory

Where do memories go once they've been encoded? The answer is ***long-term memory***, a massive, extremely durable memory register that holds all the information you think of as "knowledge." Any time you automatically conjure up the name of your father, or your birthday, or how to use a computer keyboard, you're utilizing your long-term memory.

Long-term memory is essentially the opposite of working memory, which is very low-capacity and deals with information for brief periods of time.

The two are interrelated in that memories have to go through working memory (along with sensory memory) before they can be transferred to long-term memory. You could say that learning revolves around this "transfer" dynamic between long-term and working memory. New information always has to go through working memory, and only what is truly learned ends up in long-term memory.

Because long-term memory is where you keep all of your stored knowledge, it's worth considering what role it plays in your ability to learn and act in the world. The first concept to understand is that working memory - which, again, is tightly coupled to long-term memory - is largely responsible for your thinking capacity. Having a larger, faster working memory is critical for your ability to quickly pick up information and understand it.

Unfortunately, working memory is believed to be largely constrained by genetics. So far, nobody has been able to come up with a method for improving working memory in any significant way. Even worse, working memory ability peaks relatively early (sometime in the 20s) and declines as you age, although the decline appears to mostly revolve around speed[4].

The conclusion is simple but not particularly comforting: your ability to think is largely constrained by factors you can't control. Your genetics and your age dictate your working memory abilities, and you'll always be forced to work around your limitations. All the crosswords and N-back tests will not change this brute fact of the brain.

But all is not lost. As it turns out, long-term memory does **not** suffer from these limitations. For one, it's positively gigantic. Nobody has been able to pin down an exact capacity, but it is clearly massive - which makes sense when you consider that it needs to store useful information over the course of an entire lifespan.

Long-term memory is also not constrained by genetics nearly as much as working memory. We are all born with a tremendous capacity to remember things in the long-term, even if we aren't all created equal when it comes to thinking ability. Everybody has a substantial amount of space in their long-term memory that can be maximized, although most people do not bother to utilize that space.

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[4] In other words, it gets slower but it doesn't lose its overall capacity for quality thinking. I've written about this particular issue on my blog: http://52aces.com/blog/am-i-too-old-to-learn-x/

You can think of your long-term memory like a safe. There's plenty of space, it's durable and whether it's worth anything is dependent on what you put into it.

The lesson to take away from this is that, despite limitations that you can't do anything about, there's still quite a bit that can be improved and optimized with effort. It may not be possible to make your working memory larger and faster, but you can absolutely build a large, long-lasting base of knowledge.

Most of my work focuses on the idea of getting the most out of what you're born with, and looking for any edge you can get. Some people are born with superior intelligence, but they don't necessarily use it in ways that give them an advantage.

Long-term memory's capacity and durability means that, with time and work, you can build up a knowledge advantage over people who may have other advantages over you.

Someone with a world-class IQ isn't going to be worth much if they haven't made an effort to build up knowledge over the long-term, while someone with an average IQ can end up extremely valuable if they've maintained a knowledge accumulation habit over a long period of time.

Even more relevant is the fact that a life-long habit of building up long-term memory is *extremely* difficult to compete with. Someone with a superior intelligence who has spent all their time hanging out in bars, playing video games or otherwise neglected the process of knowledge accumulation has virtually zero chance of catching up with someone who has taken it seriously over a long period of time.

Going forward, it's worth considering where you stand on the spectrum of genetic advantage. You might be a genius - or maybe you possess an average intelligence. Either way, you need to make a point of filling your long-term memory with as much useful information as you can (if you don't already do this). Over time, disadvantages can disappear.

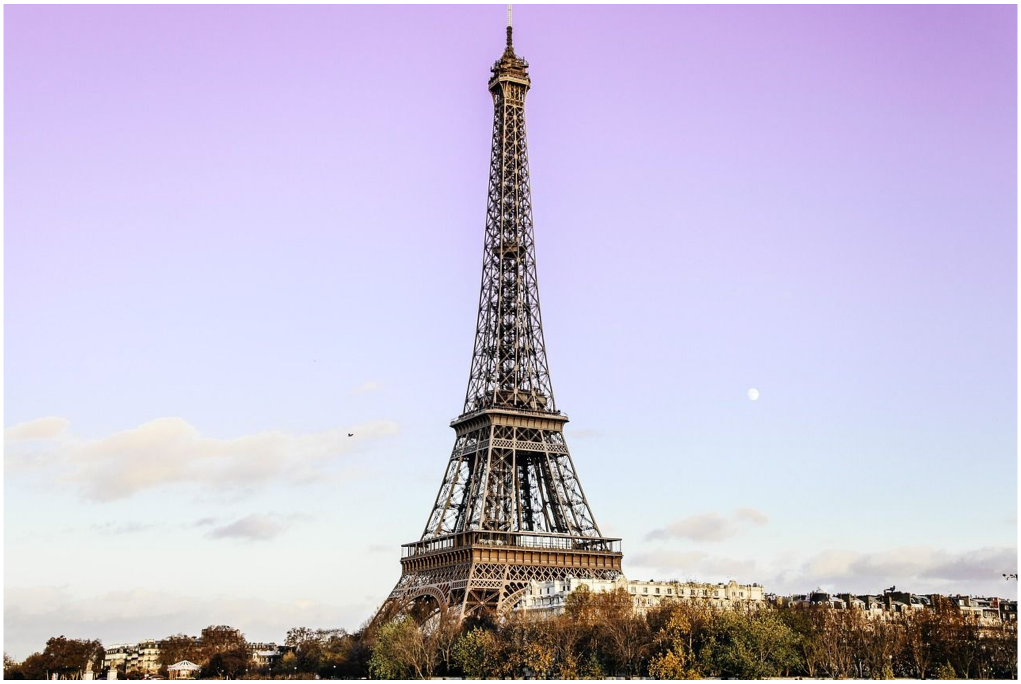
Declarative Memory & You

Before moving forward, I'd like you to answer two questions:

1. **What is the capital of France?**
2. **Where were you on New Year's Eve last year?**

Each of these questions requires you to use ***declarative memory***, which is the type of long-term memory that deals with memories of facts, concepts and past events. More specifically, the first question is a demonstration of a subtype of declarative memory called ***semantic memory***, and the second is a subtype known as ***episodic memory***.

Semantic memory is what you use any time you dig into your own mind for things you "know." These types of memories often don't contain any kind of time or place information, and instead focus on the core characteristics of a concept. Do you remember when and where you learned that Paris is the capital of France? It's unlikely that you can, and yet you can pull that fact from memory without much effort.



Even if you've never been to the capital of France, you're likely aware of what it is and that the Eiffel Tower is its most famous symbol. You know these facts because you have semantic memories of Paris.

You rely heavily on semantic memory on a day-to-day basis, as it's what gives useful information that you haven't necessarily experienced first-hand. You don't need to have any memories of getting hit by a car to know that you should look both ways. Your semantic memories about things like how fast and heavy cars are enough to tell you that stepping out blindly into a busy intersection is a bad idea.

Episodic memory, on the other hand, is tied to memories from past events in your life. Any time you think about what you've experienced, you're using episodic memory. Every memory you have of personal experiences is classified as an episodic memory. Birthdays, graduations, births, deaths - all of it is episodic.

This is, as you may have already figured out, the memory store most vulnerable to the distortions I laid out earlier in the book.

This is largely because episodic memory is formed after a single exposure (since we don't get "do overs" in life, as much as we might want them) and we don't have the ability to clarify those memories. Sometimes we have video or images to assist us, but more of than not, we have to rely on our flawed memory systems.

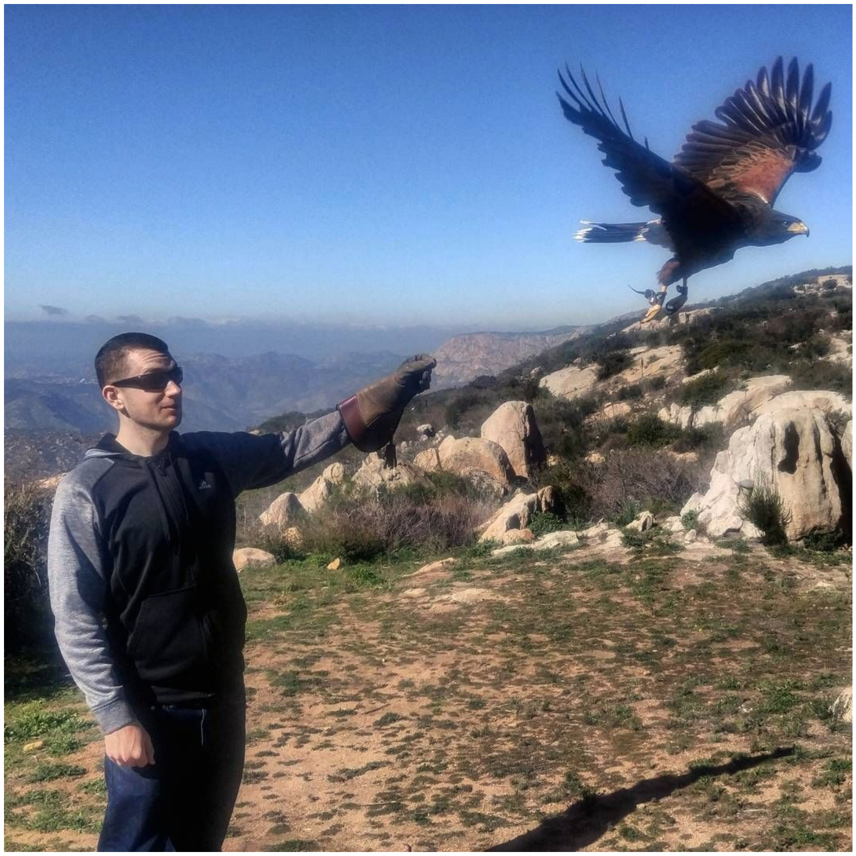
Semantic memories are much easier to manage, primarily because you can reinforce, verify and otherwise ensure the accuracy of your knowledge at will. If you forget the capital of France, you can look it up on your phone and update your semantic memory without much fear of distortion. You might not remember the act of looking it up, but the knowledge will be there nonetheless.

Episodic memories, on the other hand, are much trickier. You only have one exposure and, unless you have the aforementioned help of images from an event, you have to rely on yourself. You don't necessarily have a way to ensure the accuracy of what you're remembering, and that can cause a variety of problems (which we'll explore shortly).

What's interesting is how these two memory registers interact. While it might be easier to view them as entirely separate, that's not always the case. In fact, semantic memory is heavily influenced by what you experience in your day-to-day life.

Anytime you've learned something on a conceptual level from an experience, your semantic memory has been influenced by your episodic memory. The combination of these two types of memory is often referred to simply as ***autobiographical memory***.

For example, you might have learned that driving too fast is a bad idea after you wrecked your car (although many people fail to see the lesson in this situation…). Or you might have realized that you don't like being out on the ocean because the first time you tried it you got horribly seasick (I'm speaking from experience here).



This is a picture from when I tried falconry, an example of both autobiographical memory in action and using photos to reinforce an episodic memory. Although I still don't know very much about falconry, I can trace my small bits of knowledge (semantic memories) to this single experience (episodic memory). This combination contributes to my autobiographical memory.

You could learn about either problem without experiencing them. It's not difficult to look up "car crashes" or "seasickness" on the Internet to discover how bad either one is, and by doing so you can give yourself some semantic memories of their negative sides. But experiencing the effects of either one first hand is going to provide a much stronger memory boost, largely because of salience and depth of processing that comes from such intense experiences.

The Downsides of Declarative Memory

Because our day-to-day experiences influence the way we form knowledge, it can also backfire terribly - both on an individual and societal level.

An all too common example is racism. If an individual has a bad experience or a set of bad experiences that involve people with different colored skin, that individual may use those memories as a way to form a conclusion about entire racial groups. Their salient episodic memories end up influencing their semantic memories about the world, and they will update their behavior to reflect that. Racism begins to take hold when people are convinced by experience that they "know" not to trust people of other races - a sadly common chain of thought.

Denial of science is another depressingly common result of the interaction between episodic and semantic memory.

An example from my own life comes from when I went to Iceland several years ago. My girlfriend and I were on a guided tour through some of Iceland's underground lava tubes, and the tour guide stopped us to talk about some of the beautiful rock formations we were looking at.

The guide discussed the conditions in the cave, how the rocks were formed and a variety of other interesting factoids about the environment we were in. Then things took a turn for the political, and he began to talk about how nobody in Iceland believes that climate change is real (including him). The reason for this denial was purely experiential: Iceland was still very cold, and if global warming were true, then shouldn't Iceland be getting warmer as well?

Despite the overwhelming evidence gathered by climate scientists the world over, the power of episodic memory and its ability to influence our concept of knowledge is extremely powerful. In this man's case, his personal experience of his surroundings has created "knowledge" that he feels cannot be modified by an external source. It would be very difficult - if not impossible - to change his mind about this.

While I'm confident that his declaration that nobody in Iceland views climate change as real, this sort of thinking is incredibly common. On the one hand, it's not a good idea to ignore experience. Doing that is a bad idea, and we evolved the ability to remember largely so we could pay attention to past experiences and learn from them ("Grognak was eaten by a sabertooth tiger when he walked past that rock, so I won't walk past that rock in the future.")

On the other hand, it's always worth keeping in mind that these evolutionary mechanisms were generated long before things like societies, statistics and the scientific method showed up. Experience can be a powerful teacher, but we always need to be wary of what kinds of conclusions we draw from our day-to-day lives. **Just because you've seen, felt or touched something doesn't mean you understand it.**

Episodic memory is also easily influenced by the imperfections of our information processing mechanisms. So not only are we forced to contend with the sheer emotional and cognitive power of episodic memory, we also need to always be on alert for the imperfections it introduces.

The one example that takes the cake in this respect is eyewitness testimony. Using people who were at the scene of a crime has been a staple of law enforcement for many years, yet it's been shown to be extremely unreliable.

There are a variety of factors at play when someone witnesses a crime that can make their testimony suspect, even if they're doing their best to be honest and have only the best intentions.

The first is the infamous attentional effect known as ***weapon focus***, where a person's attention is drawn to the most dangerous object in the environment - the weapon being used by the criminal. Whenever guns, knives or other weapons are involved in a crime, witnesses tend to zoom in on them and, because attention can't be meaningfully focused on more than one thing at a time, other details of the crime get ignored.

Secondly, our ability to recall faces is not particularly good, particularly when the environment is stressful or poorly lit. We like to fool ourselves into believing that we can instantly recognize faces we've only seen once under duress, but the reality is that we're not very skilled at that. Instead, when given a choice of suspects, we often find ourselves scrambling to make a choice (any choice) and that often leads to false identifications - and false convictions.

The bottom line is that we're not very good witnesses, especially if the circumstances demand our attention but don't allow us to use it in a meaningful way. Anytime we're rushed, feeling threatened or simply not able to stay calm, our memories will be distorted in a major way.

Although I'm not going to fully go down this rabbit hole, it's worth mentioning that politics is heavily influenced by this dynamic as well. It takes a variety of different forms:

1. Political candidates make a point of meeting people, listening to their concerns and then doing their best to leave a good impression on them. They do this so that people will have positive memories of the candidate that will override any objections they might have about

their political positions.

2. Voters ignore a candidate's position on a large-scale topic (such as jobs, infrastructure or taxes) purely because they have personal experiences that don't match with that position.

3. Voters disagree with news stories because the conditions in their local environment don't match with descriptions of a larger entity (such as a state, city or nation).

These are just a few examples - the list could go on for quite a while. The overall idea here is simple: people have a tendency to overvalue their episodic memories and (limited) semantic knowledge, even in the face of counter-evidence. Your experiences aren't always invalid, but when it comes to larger issues it's safe to say that most people underestimate the scales that are being discussed.

It's always worth taking a second look and examining whether your memories are worth as much as you think they are. Experiences are important, but you should always be on the lookout for how they - and your brain's inherent shortcomings - shape your view of reality.

Consolidation

What is it that allows memories to stick around after they go through the encoding process? Why don't memories just disappear into the mist instead of making their way to long-term memory? The answer is a process known as ***memory consolidation*** (or ***consolidation*** for short).

Encoding should be viewed as the "front-end" of the overall memory process. It's something you have to put some effort into and it's absolutely critical for starting the transfer to long-term memory. Consolidation, on the other hand, is the "back-end" of the memory process. It largely takes place in the background.

Here's a useful analogy: these memory processes are like taking off in an airplane. There's a bunch of stuff that needs to happen on the ground (loading passengers, getting clearance from the tower, etc.) before you even get on the runway.

Then, once you're on the runway, you need to put a bunch of effort into making sure the takeoff and descent are done safely. After that, it's much simpler - you switch on the autopilot for the climb out, then level off at 30,000 feet. Now you're at cruising altitude, and all you have to do is watch the instruments to make sure everything goes as planned.

Encoding is all the stuff you do before you switch on the autopilot, and consolidation is the autopilot. There's a decent amount of work that needs to be done in the early stages but, once that's completed, it's mostly a matter of watching over the automatic processes.

Encoding is like takeoff in an airplane and encoding is like that stage of the flight where you're cruising at 30,000 feet[5].

You're probably wondering, "Why do I need to go through all this effort?" The answer is that, like I mentioned before, your brain is lazy. And, because it's lazy, it doesn't automatically solidify new memories. Instead, new memories need to be "stabilized" in order to make it all the way to long-term memory.

If they aren't, their fragility will leave them vulnerable to forgetting or ***interference*** (we'll talk more about this later) from competing memories. Although this makes sense at a biological level - again, your brain is just looking to manage its limited energy supply by limiting what it focuses on - it means that you need to put real thought into how you learn new things. If you don't, you risk losing what you picked up during your learning sessions.

[5] Picture courtesy of Sergey Kustov via Wikimedia Commons.

Memories are fragile, much like pottery. You need to make an effort to solidify them if you want to keep them around.

For example, if you wanted to learn the capital of a country that is less well-known, you'll need to engage in some kind of effortful action to remember it. You can create flashcards, watch documentaries, read books or, if you're truly adventurous, go there in person. After those exposures, you'll have a baseline that can be used to form semantic memories.

Remember depth of processing? Yeah, there's another reason you need to keep it in mind: it helps to remove the fragility of new memories. Adding cues (and hence depth) makes memories stronger.

If they're not stabilized, memories can become difficult or impossible to recall. For example, if you just read about that exotic capital once and never revisited that information, you're very likely to forget it. Memories, especially semantic memories, require additional processes in order to become solidly entrenched in your long-term memory.

That's where consolidation comes into the picture. Consolidation is the process which provides that stabilization and "solidifies" a memory on a long-term basis. Without consolidation, your memories would never come together to form useful cognitive structures and your ability to learn would be completely compromised. As such, it is a critical component of your overall memory system.

The relationship between encoding and consolidation can't be severed: without encoding, consolidation would never be utilized because there wouldn't be any memories to stabilize, and without consolidation, encoding would be futile because nothing would ever be placed in your long-term memory.

Consolidation comes in two forms: ***synaptic*** and ***systems***.

Synaptic consolidation is a short-term process that begins working in the background shortly after you start encoding something. Assuming that the memory in question is encoded properly, this process continues to work over an average of about a week. After that week, the memory construct enters the systems consolidation phase.

Here's a rule of thumb: **any single concept you want to learn is going to take *at least* one week of effort.**

Systems consolidation is long-term, and can take years to complete. Anything that you absolutely, 100% know (like your own phone number, birthday or other personal details) has completed this process. You could say that the goal of learning is to get as much relevant information through this cycle as possible.

Even though systems consolidation takes a long time to complete there is some good news. Once synaptic consolidation has run its course, that memory is going to be relatively stable. In other words, once you make it past that initial synaptic period, your memories will be fairly strong and difficult to disrupt. It can still happen, but the likelihood goes down significantly.

What ties all of this together is the combination of both time and sleep. Although there is still room for debate on this given the mysterious nature of sleep, there is evidence that sleep is critical for memory consolidation. When you sleep, it is believed that your brain is going through some kind of "sorting out" process, where it figures out what to keep and what to get rid of.

Some studies have gotten even more detailed about this process, demonstrating that memories with strong emotional cues are prioritized over less emotional memories during sleep[6]. This ties in with the general finding that emotionally salient (there's that concept again!) memories tend to be remembered better than less emotional memories.

Because of this sleep-dependent dynamic, time becomes a critical component of learning and memory. Since your brain needs sleep to consolidate memories and can only process a certain amount of information within each sleep period, time is needed for consolidation to work its magic.

This bottleneck of information processing means that reading a whole textbook in one sitting is generally a bad idea - there's only so much your brain can handle during one learning-consolidation cycle. Trying to violate that is largely a waste of time.

You could sit down and read that beastly book in one sitting, but your chances of remembering anything substantial are going to be **zero**. The encoding process will get worn out early on, and your brain won't be able to consolidate what it takes in after that stops working.

[6] Hu, Stylos-Allan, and Walker, 2006; Payne et al., 2008; Wagner, Gais, and Born, 2001

This is bad news for the "crammers" of the world, who prefer to learn in a "just-in-time" fashion. Your brain can only meaningfully hold on to a limited amount of information, and if you aren't giving it a chance to consolidate what it takes in, you'll end up losing most of it.

If you've ever been frustrated by your inability to remember everything you "learned" after cramming for a big exam within a short time after passing said exam, this is why.

The answer to better learning and memory doesn't revolve around trying to jam your brain with information. It comes from understanding how it naturally absorbs and processes incoming data, and then optimizing your learning environment to reflect that understanding. Part of what makes for a successful learning environment is allowing enough time for subconscious processes like consolidation to work their magic.

I consider this point the single most important to understand: **learning takes time**. No matter what you do, there's a natural bottleneck driven by your brain's need to effectively encode and consolidate new information. That process can be heavily influenced by your actions, but it requires time and sleep to complete.

This is one of many reasons you should be incredibly suspicious of anything that says "Learn [insert complex skill here] in 24 Hours![7]" Effective learning ends up being far more about being good at consistently improving knowledge (since the process you use is largely within your control), not necessarily improving knowledge quickly (since speed is largely outside of your control).

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[7] If you've ever been on Quora, Reddit or any other major online forum, you'll inevitably run into people either looking for or selling "lifehack"-style solutions like this. For the record, you can't learn pick up any truly useful skills in these short periods of time. You *can* learn rapidly, but only in a highly salient, episodic fashion. For example, if you get shot at on a battlefield, you'll learn within moments how to find cover. However, you aren't going to learn how to speak a language, program a computer, play an instrument or master physics in a day.

Chunking

You now should understand why you can't sit down, read a giant textbook and walk away with anything approaching an in-depth understanding. Your brain can't meaningfully encode and consolidate huge amounts of information all in one sitting - it takes time, effort and sleep. But what about at a smaller, day-to-day level? What kinds of information processing limits exist there?

That's an important question to ask, and it's *extremely* important to answer if you care about making the most out of your learning sessions. The amount of information you attempt to deal with from moment-to-moment is deeply connected to how much you retain later on, and it's all tied into how working memory functions.

We've talked about working memory before: it's the "thinking" area of your memory, where you take small bits of information and manipulate them over very short periods of time. Since it's where thinking occurs, respecting your working memory capacity is critical to generating useful thoughts.

When you try to take too much information in at once your brain isn't particularly helpful about it - you don't get a "working memory full" warning or anything. Instead, you will start fumbling the information and attempt to continue working, even though you're essentially failing.

There's a great old analogy for what happens when you try to learn too much at once: ***"it's like trying to drink from a firehose."*** This is a perfect description of what happens when people try to violate the limits of their working memory. Yes, you will take in *some* of what you want to learn - much like you would take in *some* of the water from a firehose - but most of it will be wasted.

Go ahead, try to take a sip.

To combat this problem, you need to utilize a technique known as ***chunking***, which is a process that involves breaking down large, complex blocks of information into smaller, easy-to-digest pieces (chunks). Without chunking, you're bound to run into serious frustration when diving into a new subject - especially if you're fond of diving into the "deep end" of a domain.

Many parts of your day-to-day cognitive life are built around the limitations of working memory. For example, if you want to remember a phone number, you naturally break it down into chunks so that it's easier to recall. Don't believe me? Take a look at the following two phone numbers and tell me which is easier for you to remember:

1. 4157801576
2. 415-780-1576

The answer is, naturally, number two. By turning this long string of numbers into a set of smaller numbers that can each be viewed as separate chunks, your working memory can cope with the size[8].

When your brain sees the first string of numbers, it will have a very hard time remembering them because there's no discernable way to break them down - and a string that long exceeds pretty much everyone's working memory capacity[9].

This dynamic is absolutely critical to understand if you want to learn new things and develop expertise in a specific domain. If you attempt to stuff your working memory beyond capacity all the time (I'm looking at you, exam crammers), your learning will be heavily handicapped.

Any body of knowledge should be viewed as a sort of upside-down hierarchical structure, with the most general concepts forming a foundation on the bottom and a large (potentially infinite) collection of specific concepts stacked on top of them.

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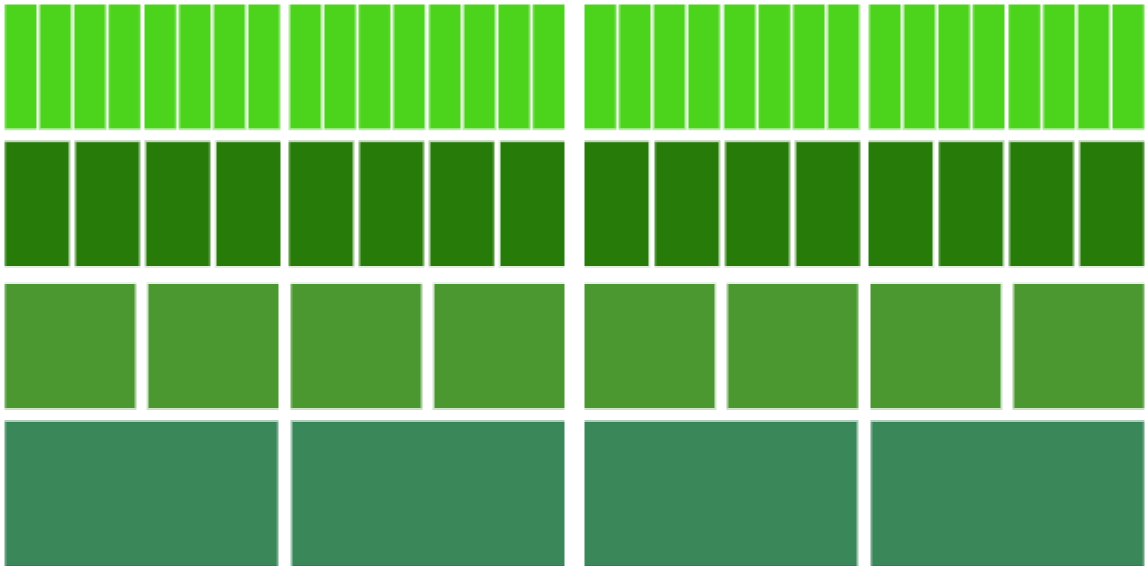
[8] One exception to this rule is when there are easily-predicted patterns within the blocks you're trying to remember. If you want to remember 55555555 it's pretty easy, because you can compress the eight digits into two simple chunks: "eight fives." This is largely covered by a concept from information theory called Kolmogorov complexity: https://en.wikipedia.org/wiki/Kolmogorov_complexity

[9] The average adult working memory capacity is believed to be around seven "chunks."



Each one of these boxes represents a conceptual chunk, and in order to become knowledgeable about any subject you need to have a large library of these in your long-term memory. The problem is that you can't process everything all at once - largely because your working memory can only deal with a few items at a time.

This is why, when you're in the first stages of learning, everything you do is slow, plodding and difficult. You're trying to account for a large number of concepts all at once, and you can't do very much meaningful processing when your working memory is packed with information.

Since you can't do anything about your working memory capacity, the solution is to change the size of the chunks you're dealing with. Instead of focusing on a large, complex subject (such as "astrophysics"), you should start with small, bite-sized blocks of information connected with that overall subject (basic concepts from physics like "levers" or "fulcrums," for example).

At first, even the basic concepts will be difficult to understand and process. But with enough time, effort and practical application, you'll start to see how each concept connects to the other. As you do this, all of these related concepts start to form larger and larger chunks.

You go from having to focus intensely on simple things to use them in an appropriate context to not even thinking about them.

Think about the process like driving a car: at first, you had to think pretty hard about how to do things like change lanes or brake correctly. These concepts were foreign to you before you started driving, and each step of the action of driving was essentially taking up a slot in your working memory.

You couldn't think of the whole experience as "driving" - it was "put foot on brake pedal," followed by "turn ignition until engine starts," then "get into reverse gear," and so on. All of these discrete actions overwhelmed your working memory, preventing you from performing them smoothly.

While it might have seemed like you were hopeless, you were actually doing exactly what your brain needed you to do: create chunks. With each experience, you built or reinforced memories needed to drive. Once you drove enough and gained familiarity with each step, the chunks started to come together to form a single, higher-order concept: "driving." After you reach this point, driving takes up very little working memory space.

You can perform each step of the process in a nearly automatic way, because your long-term memory has taken over and working memory is barely involved.

It can be frustrating for beginners to go through this process, because it's difficult to see the forest for the trees when you're at such a basic level. You will undoubtedly wonder if you're wasting your time learning such simple things when your goal is to understand something much greater.

You might also wonder if you have what it takes to learn a new thing when your performance is so poor at the beginning. Well, I have good news: it’s not just you - everyone goes through this because our brains are simply built that way.

It’s not a bit of cheesy self-help to say that you really should just keep going. Your brain *will* adapt eventually and you’ll build the chunks (and the connections between those chunks) necessary for expertise.

Fighting The Forgetting Curve

Once a memory is stored, our lazy brain steps into the fray once more and frustrates our efforts to remember what we want to remember.

Your brain doesn't just discard things at the encoding stage. It opportunistically looks for memories that have made it to the first stage of consolidation so it can get rid of them as well. Like nearly everything in the science of memory, the neurological mechanisms are still a bit mysterious, but we can see how this process manifests itself externally.

Because your brain is always looking for shortcuts that will allow it to conserve energy, it's constantly pruning memories that aren't being used. Some memories survive this process purely by their salience - such as the angel food cake story I mentioned, which I only experienced once - but most will get weaker as time goes on[10].

Forgetting follows a curve, first discovered way back in the 1880s by Hermann Ebbinghaus. The bad news is that, if you only put effort into encoding and don't follow that up with any sort of repetition, there is a very good chance that you won't be able to recall it within a short period of time.

It works like this: a memory is fresh and easy to recall on the day that you create it (remember the "fragility" we talked about in the consolidation chapter?). After a day, it's more difficult to recall. After several days, it's very difficult to recall. After a couple of weeks, it's more or less unreachable.

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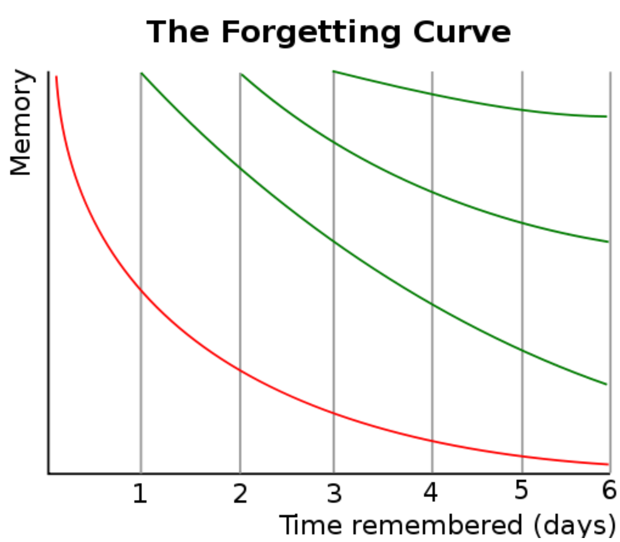
[10] There is still some debate about what exactly causes this, although the leading theory is that it's caused by interference. After enough competing memories have been encoded, the less-activated memories end up getting buried and more or less lost. The passage of time is *not* believed to be, on its own, the primary source of forgetting.

There isn't a consensus on what causes forgetting, but we do know that there is an effective way to fight it: testing.

If you test your knowledge in some way right on the edge of the curve - where you're just about to forget it - you're essentially "refreshing" that memory. By doing this in increasing intervals, you can retain information indefinitely and decrease the amount of forgetting you experience.

This is known as ***the testing effect***. Your memories can be strengthened by pure repetition, but the effect is weak and short-lived. Testing yourself, on the other hand, is a great way to activate what you're trying to remember and bolster the strength of your memories. We'll talk more about *how* to do that in a minute.

I know it seems counter-intuitive to study that way. You've probably been told your whole life that you need to study hard every single day if you want to remember things. Here's the thing: that way of studying does work, but it's not very *efficient*. In other words, you can get results (which is why so many people continue to do it), but it's not the best use of your time.



Here's how the forgetting curve works: the red line on the far left represents a memory that you don't attempt to retain at any point in the future. As time goes on, your ability to remember gets worse and worse, until at about 6 days you barely remember it. But if you make an attempt to retrieve that memory over the next 3 days, you end up with a much stronger memory. After that, you can space out your retention attempts and maintain the memory's strength.

Studying by staring at a book for hours every day feels more effective because you're consciously involved. Your progress can be measured by how many pages you've read, quizzes you've taken or practice reps completed. This way of studying panders to our natural need to see, touch and feel like we're doing *something*, no matter how ineffective it might be.

The problem is that mindless repetition, like all inefficient learning methods, doesn't respect how your brain actually works. When you put effort into studying something once, your attentional resources are focused on that thing and you kick off the encoding process. But each additional repetition within that same study session gets less and less of a response from your brain, and less and less attention gets allocated to it.

Your brain is basically telling you at that point that it isn't getting anything new or useful (i.e. it's no longer salient) out of what you're doing. When that happens, you're better off moving on to other things. But, like I said before, repetition does work to some degree - it's just that you can get the same (or even better) results by studying differently.

Other people do the exact opposite: they only study a topic one time and expect that they'll remember it. They go through their learning session once and then...nothing. They take notes or make highlights when they study, then never revisit what they've written or highlighted.

If, instead of either method (once or too many reps), you space out your study sessions, you'll get a much higher memory benefit. When you review at a later time, your brain's attentional resources get zoomed in again, and your brain will strengthen that memory - which in turn aids the entire learning process.

This is what's known as ***the spacing effect***. Although it's not entirely clear *why* it's so effective, spacing out study sessions works wonders for memories. Utilizing the forgetting curve, you can space out your sessions so that they fall right on the edge of your forgetting - which will maximize the strength of that memory and extend its life even further.

When you space out your learning sessions, it can feel like you're wasting time because you aren't focused on that subject. But, like many other aspects of learning, it's what goes on at a subconscious, biological level that actually makes the biggest difference.

There are a variety of ways you could do this on your own. You could put a spacing schedule on your calendar, where you mark the ever-increasing study intervals for each topic you want to learn. But since we're more concerned with efficiency, I'd advise against that approach.

Instead, you can use ***spaced repetition flashcards***. There are a bunch of different programs out there that all work essentially the same and you'll be hard-pressed to go wrong picking any one of them. My personal choice is a program called ***Anki***[11]. It's relatively easy to shape Anki cards into whatever you want them to be, and if you just want to use the basic card types it's extremely easy to simply install it and go.

If you want an in-depth guide about how to use Anki to maximize learning, that's what my first book, *The Learning Factory*, is all about. For now, you should download Anki and make a few cards to see how it works. You'll see

[11] You can find Anki here: http://ankisrs.net

how spacing and testing both affect memory first-hand, which will only help with depth of processing when it comes to understanding and remembering the concept I've laid out in this book.

Here's the bottom line: **you can get the same (or even better) results by spacing out your studying and utilizing tests (as opposed to simply rereading)**. It's one of the few situations in life where you can have your cake and eat it too - you can study less and still perform well when you need to. Once you know the principles underlying how learning and memory work, you can work much smarter than you might have thought possible.

Not All Forgetting is Bad

Just so there isn't any confusion, I'm not saying that doing this will eliminate forgetting completely. That's not possible, and you should prepare to forget things even if you know them very well. But by following these basic guidelines, you can greatly reduce the amount of forgetting that takes place when you're trying to remember things you care about.

In fact, forgetting plays an important role in the way our brains process information. It's another trick our lazy brain plays on us to keep things running smoothly and keep our energy expenditure in check. If we didn't forget anything, our minds would be extremely cluttered and it would be harder to have, clear precise thoughts about complex subjects.

It's also worth thinking about *why* you forget the things you do. Although it can certainly be frustrating, it's often an indication that the information wasn't particularly relevant to you or what you're trying to accomplish. Ever wonder why you don't do well at trivia that focuses on random factoids? It's because you don't have a good reason to hang on to most of what you come in contact with.

You might even have the answers on the tip of your tongue much of the time, but your brain is effectively saying “Meh, that wasn’t really worth remembering so I’m not going to bother.” Again, it might be annoying when you really want to win that gift certificate at your next local bar trivia, but it’s for the best. Keeping your memory free of clutter is an overwhelmingly positive side-effect of your lazy brain, and you should keep that in mind.

Interference

One of the leading causes of forgetting comes from our brain’s tendency to mix up and combine memories, a process called ***interference.*** Because recall is a constructive process (remember the assembly line analogy?), there's always the chance that memories will collide and mislead you in surprising ways. It’s critical to be aware of interference and know how to lessen its impact if your goal is to retain the information you take in.

At the most basic level, interference pops up when two memories collide with one another due to similarity. Your brain recognizes this similarity and can't figure out which is which - so it just mashes the two together or arbitrarily picks the wrong one.

For example, if someone asks you to recall what you had for breakfast last Tuesday and there was nothing unusual about that breakfast, you're probably going to fall victim to some level of interference. This is because you've had many other breakfasts on many other Tuesdays, and it's likely that your brain will have a hard time distinguishing that particular breakfast from all the others.

Rather than saying, “I don’t know,” if you think hard enough your brain might just come up with a memory about that breakfast. The accuracy of that memory is going to be suspect, to say the least, because there wasn’t anything salient about that breakfast and your brain is nearly guaranteed to mix it up with other breakfasts.

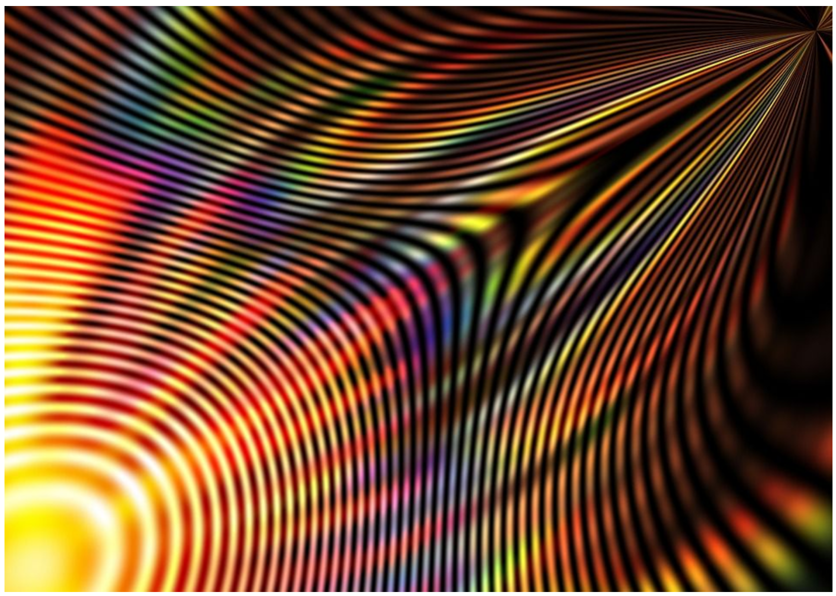
Interference is what makes salience such an important topic in the world of memory. Salience allows us to cut across interference much more easily, and makes recalling what we want to recall simple. When one memory is particularly salient, it's much more difficult for interference to hinder your recall because it has features which are not easily combined with other memories.

For example, I'm not going to confuse my previously-mentioned angel food cake memory with anything else because it was an extremely unique experience. The smell alone is something I still remember as being distinct, and I'll never have to worry about a similar memory covering it up since it's only happened to me once.

On the other side of the coin, I've gone for thousands of hikes in Annadel State Park. Although I have some memorable experiences there, trying to recall specific hikes is going to result in a mish-mash of interference because there are all kinds of weak, competing memories surrounding those experiences. Those memories aren't necessarily *gone* as much as they are *inaccessible*.

The nature of interference can be thought of like graffiti on a wall that's popular with street artists, with the wall representing your long-term memory and your individual memories represented by the graffiti. As graffiti is added to the limited space of the wall, some of it inevitably gets covered up or integrated into other art. It hasn't disappeared, it's simply been obscured by other artwork.

It's critically important that you make efforts to avoid interference at all costs when you're trying to learn new things. Make an effort to make concepts stick out by not using the same retrieval cues over and over again[12]. For example, don't use one image to represent 10 different concepts - interference is guaranteed to occur in that situation. When it comes time to retrieve that memory, your brain will have too many potential targets to give you the quick recall you're looking for.



Eliminate interference by not mixing cues and utilizing salience.

To avoid interference, here's a rule of thumb: **don't recycle cues**. Although it can be tedious and sometimes difficult, it's worth taking the extra time to make sure any retrieval cues you use don't pander to interference.

Another is ***make it salient***. When something stands out as unique, it's far less likely to be overwritten. Again, it's not always easy to find a way to do this, but it's worth it in the long run if you're looking for easy recall.

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[12] This is a concept known as the ***cue-overload principle***. This principle states that cues become less and less effective as they become attached to more and more concepts. So if you're going to use cues, don't recycle them - make each one as salient as possible. An in-depth discussion of this principle can be found in ***Memory*** by Baddeley, Eysenck & Anderson.

Memory Below the Surface

Up till now, we've primarily discussed declarative memory and its associated processes. These are clearly very important, but there's a whole other side of memory that involves information you deal with on a subconscious level. It's worth exploring because it's a critical component of both your day-to-day existence and the process of learning new skills.

This type of memory is known as ***implicit memory***, and it's involved in anything that you have learned "mindlessly." For our purposes, we're going to focus on a specific type of implicit memory called ***procedural memory***.

Procedural memory is the type of memory you utilize when you learn something without having conscious recollection of all your learning experiences. Every skill you possess has an element of procedural memory attached to it, largely because a significant portion of learning occurs below conscious awareness.

For example, you (hopefully) know how to tie your shoes. Think for a moment about how you learned to do that. Did you read a book about tying shoes? Did you take lessons from a shoe tying teacher? No, it was a trial-and-error process that occurred many times. Over time, you made small, subconscious adjustments to your understanding of how to tie shoelaces, and eventually you gained that skill.

Could you verbally explain how to do it? Give it a shot - I think you'll be surprised how vague and inexact your directions are. It isn't because you're a bad teacher or too stupid to explain basic concepts.

It’s because much of what you know is not based on explicit knowledge. You would need to make a conscious effort to examine the process in order to explain it correctly and without providing any kind of visual or physical cues to assist your explanation.

You can certainly create this guide, but up until now you’ve never had to explain it. The fact that you’ve never made an effort to examine it will likely make your early attempts feeble, although with some refinement and practice it’s very doable.

Much of what you do every day depends on procedural memory. Every time you use a feature on your phone, walk to a familiar location, eat food, wash dishes or ride a bike, you’re relying on procedural memory. These all rely on skill memories that were made mostly in the process of practicing them - not through explicit instruction. Again, consider how difficult it would be to coherently verbalize all the minor details of those tasks.

You can think of procedural memory as memories about actions that are very difficult (if not impossible) to explain to other people. These sorts of memories allow you to *just do* things without much thought, and this lack of thought makes explanations hard to weave together.

This partly explains why there is often a large difference between being able to accomplish a task and being able to coach or instruct someone else in that same task. It’s a strange paradox, but it exists in nearly every domain where expertise needs to be communicated from one person to another.

Take a moment and think about how you could explain the process of tying shoelaces to someone else - without providing any kind of physical or visual assistance.

The clearest example is in the world of sports, where it's not uncommon to see world class performers become subpar coaches. A world-class baseball pitcher has a large collection of procedural memories complimenting his declarative memories about pitching, and yet there's no guarantee that he has the awareness or skill to elaborate the necessary procedural knowledge to be a good pitching coach.

Whenever you're learning something new, you should take the time to consider the details of what you're doing. Don't take rough explanations at face value - really distill what you're doing and find ways to come up with analogies and metaphors to help you remember what's going on. If you don't, you could end up as someone who is good at *doing* but not good at *explaining* what they're doing.

Even if you have no intention to be an instructor of any kind, this process can improve your own performance by virtue of the fact that you'll have salient, heavily-processed memories that you can utilize while performing.

By transforming a purely subconscious process into something that is at least partially conscious, you'll gain an edge over your peers and competitors.

While it's tempting to look at whoever is on top for guidance when it comes to learning, it's important to keep the role of procedural memory in mind. It's far more effective to find instructors, coaches and learning materials that make an effort to distill the most fundamental ideas and explain them in great detail.

Amnesia

Amnesia is a subject that is widely misunderstood, and much of that misunderstanding comes from consistently inaccurate media portrayals of amnesia. It's too bad, too - amnesia is a fascinating subject, and it doesn't require any embellishment to be intriguing.

There's something intrinsically horrifying about the prospect of losing your memory. Your memories (particularly your episodic memories) are what give you a sense of *who you are*. Experiences shape how we view ourselves and the world around us. Without those experiences, you're a different person. You might see that as a good thing (you're inevitably holding on to at least a few bad memories), but you would be an altered person if even the most unpleasant past experiences were removed from your memory.

If you've ever known someone with amnesia (or something similar, like Alzheimer's), you know exactly how devastating it can be.

When I was a kid, a friend's stepfather fell down a staircase and suffered head trauma that removed **years** of memories. When my friend's mother (his wife) first spoke to him in the hospital after the incident, he was confused and asked her who she was. Even worse, he asked where his ex-wife was, believing that he was still married to her even though they'd been divorced for quite some time.

I saw the effects of this first-hand when I saw him a while later at a local video store (yes, I'm old enough to have visited video stores). We made eye contact and, despite the fact that we'd interacted many, many times in the past, he clearly did not recognize me. Once we saw each other, he looked at me as if I were just another stranger and carried on doing what he'd been doing before he saw me. It was a strange moment, to say the least.

What my friend's stepfather suffered from is what's known as ***retrograde amnesia***, which is an inability to access previous memories. People with retrograde amnesia are missing pieces of the past, but are still capable of making memories. The opposite of retrograde is ***anterograde amnesia***, an inability to form new memories.

If you've ever seen the movie *Memento*, the main character (an amnesiac looking for revenge played by Guy Ritchie), suffers from anterograde amnesia as a result of an attack that resulted in the death of his wife. The plot is formed around the main character's inability to remember things after very short intervals (usually a few minutes) and his quest to find his wife's killer using various shortcuts (such as tattoos) he's created for himself. Just like a real amnesiac, his memory for life before amnesia is mostly intact.

What's intriguing about both types of amnesia is that other types of memory are normally not affected. Systems like procedural memory and working memory are not usually damaged in amnesiacs, and their ability to do physical tasks that they learned before becoming amnesiacs is often untouched.

In other words, an amnesiac with retrograde amnesia may not remember something that happened last week (or will forget something that just happened), but they still know how to play the saxophone and can usually think at the same level as they did before their amnesia occurred.

This is pretty counterintuitive. You'd expect that someone who is incapable of recalling vivid, highly salient past events would also forget the complex movement sequences of playing a musical instrument. But amnesiacs seem, at least initially, to be normal and essentially the same people they were before becoming amnesiacs.

The fact that it is largely declarative memory systems that are impacted explains why my friend's stepfather looked unchanged when I saw him, even though he clearly did not have the episodic memories I expected him to have. His mannerisms and physical abilities were identical, yet there was a huge chunk of his life missing.

It's an uncomfortable truth that we're all capable of finding ourselves in this position, where we are same on the surface but lacking in experiences that allow us to do things like relate to friends and family.

The bulk of our scientific understanding of amnesia comes from individual cases of amnesia, mostly in cases of people who have suffered brain damage in one form or another that has led to amnesia. The two most famous cases, Henry Molaison and Clive Wearing, highlight the most important aspects of how amnesia impacts a person's day-to-day life.

Henry Molaison (Patient H.M.)

Henry Molaison (referred to anonymously as **Patient H.M.** in published studies while he was alive) suffered from debilitating epileptic seizures as a young man. These seizures made life extremely difficult for Henry and, at the age of 27, he elected to have brain surgery as a last resort.

The problem was that Henry elected to have this surgery at a time when our understanding of the brain was relatively primitive. His surgeon decided to remove his ***hippocampi***, along with other nearby brain structures. The hippocampi (singluar: ***hippocampus***) are a pair of seahorse-shaped (the name comes from the Greek word for seahorse) structures in the temporal lobe.

The hippocampus (left) has a shape very similar to that of a seahorse[13].

What his surgeon did not know was that the hippocampi are critically important to forming new memories, and Henry now had a new problem: anterograde amnesia. He was essentially incapable of forming new memories, and even had a small amount of retrograde amnesia that prevented him from remembering certain autobiographical details from several years before his surgery.

Much like Guy Ricthie's character in *Memento*, you could say that H.M. lived exclusively in the present tense. He couldn't remember basic, everyday information, such as the names of hospital staff who cared for him or what he had for lunch on a given day. Knowledge that we take for granted, such as who the President of the United States is, were out of reach for poor Henry.

Interestingly, H.M.'s intellectual abilities were largely left alone. In fact, an IQ test taken after the surgery indicated that he had an above-average IQ. His procedural memory and language abilities were also entirely intact. The damage was done almost exclusively to his declarative memory systems, particularly his episodic memory.

[13] Image courtesty of Professor Laszlo Seress via Wikimedia Commons.

H.M. had, without knowing it, become a science experiment who gave us a great deal of what we understand about human memory formation. Throughout his life, researchers observed his behavior and how amnesia had affected his overall cognitive abilities.

His case was instrumental in discovering some critical points about subjects such as the anatomy of memory (we now know that the hippocampi are important for forming new memories) and the relationship between amnesia and procedural memory. Without H.M., the science of memory would be much worse off.

After his death, his brain was preserved and it has been used for further studies. Researchers have even made a "brain atlas[14]" out of it that can be viewed for free online, demonstrating once again how incredibly valuable H.M. has been (and continues to be) for our scientific understanding of the brain.

Clive Wearing

Clive Wearing has a uniquely horrible case of amnesia, considered to be the worst on record. After contracting a case of herpes simplex that eventually made its way to his central nervous system, Clive developed retrograde **and** anterograde amnesia. While H.M. had memories of life before his surgery, Clive doesn't remember **anything**.

Because the infection damaged his hippocampi (the same brain structures that were removed during H.M.'s surgery), he can't form any new memories. Instead, his memory lasts no longer than 30 seconds. This

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[14] You can find it here: http://brainandsociety.org/patient-hm/

makes basic functions, such as having conversations, nearly impossible for Clive.

Clive's days involve him constantly feeling like he's only just woken up from a comatose state of some kind. He has filled out countless notebooks with phrases like "I have now recovered consciousness" or "consciousness has now finally been recovered," always making sure to cross out the previous line. It's not uncommon for him to announce this to visitors as well.

His retrograde amnesia means that he also remembers very little from his past. Some highly salient memories seem to have stuck around, particularly his love for his wife (who he met a year before he became an amnesiac). Whenever he's around her, he becomes overjoyed - believing that he either hasn't seen her in a very long time or they have never met.

This is everybody's worst memory-related nightmare. Living like Clive means living in an infinite loop of confusion. Not only does completely lack the ability to form new memories, he has absolutely no idea what has happened to him in the past. He is forever floating through his days, not sure from one moment to the next who he is, where he's been or what's going on around him.

Having any kind of amnesia would be terrible, but there are at least some upsides to having only one. If you have anterograde amnesia, you may not be able to form new declarative memories, but at least you can remember who you were before you became an amnesiac. If you have retrograde amnesia, you might not be able to remember your past, but you can at least forge a new future for yourself. There aren't really any silver linings when you have both.

What's interesting about his case is that, despite a severe lack of declarative memory capabilities, Clive is still capable of conducting his old choir (he was a musicologist and musician). Even though he has absolutely no recollection of learning how to do it, his procedural memories allow him to execute this extremely elaborate skill.

Clive does have some basic aspects of his previous life lingering in his mind, such as his musical abilities and love of his wife, but nearly everything else is gone. Furthermore, he's not capable of improving his situation.

Until the day he dies, Clive Wearing is going to believe that he just regained consciousness and will continue to be completely unaware of his past, present and future. If his case doesn't showcase how central memory is to your day-to-day existence, I don't know what does!

Photographic Memory

Perhaps the single most-asked question I get is, “How do I develop a photographic memory?” I die a little on the inside every time someone asks me this. It tells me that, despite access to so much information, popular culture and “common sense” explanations about everyday experience continue to dominate people’s thoughts.

Fortunately, this is a situation that can be remedied. We now have enough information about memory and the brain to come up with some solid conclusions about the (non)existence of photographic memory.

From this point forward, you will no longer have to worry about how to develop a photographic memory. And if you ever ask me about it, then I’ll ~~hunt you down~~ simply ignore you.

As you learned earlier, the memory process is not perfect by any stretch of the imagination. While most people tend to think of memory in terms of a “hard drive connected to cameras” analogy (where information is perfectly preserved in your brain), the reality is much more complicated.

Your brain is not a perfect encoding or storage medium, and is instead an ***information processing system***. When you take in information through your senses (eyes, ears, hands, etc.), your brain processes it and, as a result, information in your memory never ends up exactly as it existed outside of it. This is why the assembly line analogy at the beginning of the book is two-way: there’s processing on both incoming and outgoing information.

To be clear, there has never been **a single documented case of photographic memory**. That’s right - not one. As you’ll see, there are people who exhibit memories that, on the surface, *seem* photographic but are not.

Something I run into all the time online is people who get upset when I say this. I've had all kinds of angry responses, typically along the lines of **"NO WAY, MY COUSIN/BROTHER/FRIEND/ROOMMATE HAS A PHOTOGRAPHIC MEMORY!!!!1!! LIES!!!"**

If you find yourself feeling the same way, I have a simple way to resolve this conflict: go find your nearest cluster of neuroscientists (they can usually be found on college campuses) and tell them you have a photographic memory. They'll happily put your claim to the test. Even better, if you are in possession of the miraculous, first-ever photographic memory, then you'll be instantly famous. Money, fame and women (or men) will be in abundance and you can ride off into the sunset.

You might be asking yourself, "How can you be so confident that photographic memory doesn't exist?" While I'll be the first to concede that we still have a long way to go when it comes to understanding all the finer points of brain function (including memory), photographic memory is surprisingly easy to dismiss.

The very premise of photographic memory relies on two ideas that we already know aren't true:

1. **Your brain takes in everything from its surroundings.** False - we actively filter and focus our attention only on a small portion of our surroundings at any given time.

2. **Encoding and recall can both be flawless.** False - both processes introduce distortions to information that are outside of conscious control.

Having a photographic memory relies on both of those ideas being true, and neither one is. In fact, if even one of those facts is false, then the whole idea falls apart.

If you have perfect encoding or recall but don't take in everything, then you have perfect recall of only a small subset of details. And if you don't have perfect recall or encoding but take in everything, then you have all the details you need - but they're going to be inaccurate due to the distortions of your imperfect encoding and recall processes.

When I give talks about memory, one of my favorite things to do is to ask, by show of hands, how many people in the room either A) have a photographic memory, or B) know someone who does. There are always at least a few who raise their hands.

Without any further ado, I tell them, "No, you don't. Nobody has a photographic memory." Not everyone wants to hear this, but it's the simple truth.

Some like to fire back with examples of people such as Kim Peek, the inspiration for Dustin Hoffman's character in the movie *Rainman*. People such as Kim could do incredible things (in his case, he could read a book in less than an hour and precisely recall most of it), but there's a catch: there's just about always a severe price to be paid in other areas of brain function.

Kim Peek[15], American megasavant

In Kim's case, he suffered from severe brain damage that included a complete absence of his corpus callosum, which is a bundle of nerves that connects the two hemispheres of the brain together. One theory about his abilities is that the lack of a corpus callosum created a unique situation where his neurons made connections that they otherwise would not.

Unfortunately, his extreme memory capacity was complimented by an equally inferior ability to do just about anything else. Although it's not fully understood how he (or other similar people) can accomplish these feats, it's clear that they come at a steep cost. People such as Kim Peek tend to develop highly-specialized, domain-specific abilities that allow them to do things that seem superhuman because their brains are so heavily focused on those abilities - which in turn leads to severe disability in other areas.

[15] Photo courtesy of dmadeo via Wikimedia Commons

It's worth asking yourself if you'd trade being able to read a book in an hour and remember most of it for the ability to have a normal conversation with your loved ones. I know I wouldn't.

Another angle that people often miss is that having a photographic memory would be a **complete nightmare**. While it's easy to imagine how you could benefit from a photographic memory, consider this: if you can remember every single detail of your life, that means you'll vividly remember:

1. Every visit to the bathroom.
2. Every embarrassing moment.
3. Every traumatic experience.
4. Every boring experience.
5. Every bad smell.

Trust me, this would *not* be fun. One of the benefits of having an imperfect memory is that the sting of bad memories eventually fades, and you're not likely to remember all the finer points of uninteresting experiences (like waiting in line at the DMV[16]).

There are actually some people out there that have very highly-tuned episodic memories, a condition known as ***superior autobiographical memory*** or ***hyperthymesia***. These people do not have photographic memories, but can recall many mundane details from their everyday lives. Individuals with this condition can do things like accurately remember what the weather was on a specific day or determine what day of the week a specific date was.

This also does not qualify as photographic memory. While episodic memory is clearly operating at a higher level in these individuals, they tend to be

[16] For all non-US readers, the DMV is the Department of Motor Vehicles. It's where you go to do things like get your drivers license, and it is one of the most awful, boring places on Earth.

either ordinary or below average when it comes to other types of memory. In fact, some with hyperthymesia have displayed significant cognitive deficits that appear to be driven by their strong memory abilities.

For example, the most prominent hyperthymesia patient, **Jill Price** (known in the scientific literature as **AJ**), found her memory to be an incredible burden. Her ability to vividly recall episodes from her past overwhelmed her other cognitive abilities, forcing her to focus intensely on the past while simultaneously blocking her ability to deal with the present.

She also was unable to apply her memory abilities to anything other than remembering her past. You might think that hyperthymesia would help someone study for tests and allow them to breeze through school, but Jill actually did poorly on standardized tests. She simply couldn't sort through all the noise created by her superior ability to remember episodic information, which in turn damaged her ability to study.

Again, it seems that having an abnormally strong memory comes at a high price. Jill doesn't have the severe mental disabilities that Kim Peek did, but she (and the very small number of other people with her condition) have to deal with substantial problems as a result of her memory.

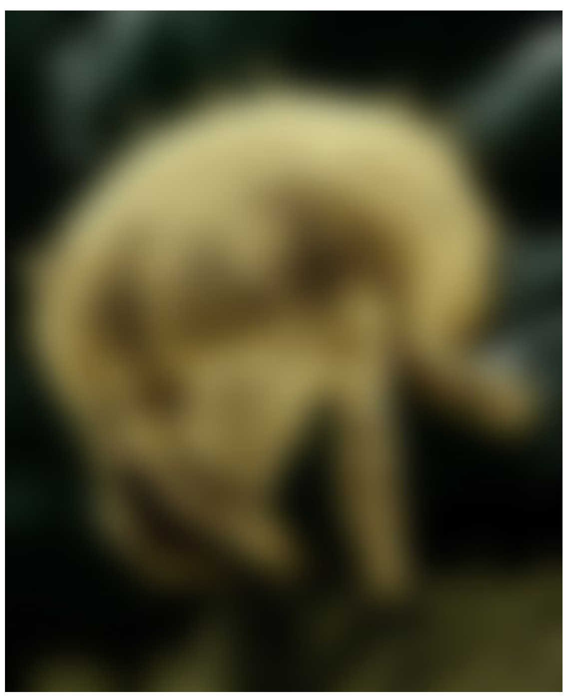
Keep all of this in mind next time you feel frustrated by your memory's shortcomings. Forgetting might seem like a curse, but in many ways it's a blessing.

Outro

If you've made it this far, congratulations: you now know more about memory than the vast majority of people (insert party hats and confetti). Even though this book is short and the subject of memory is vast, you now at least have a foundation of useful knowledge that can help you utilize your memory more intelligently.

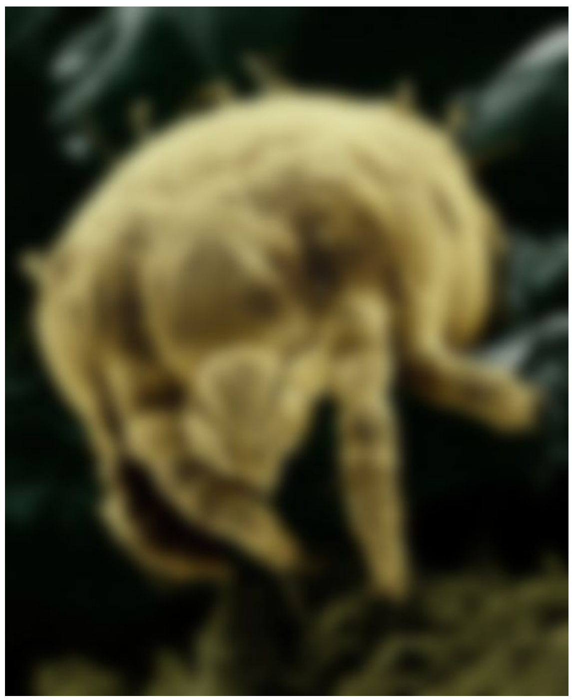
You should now have a basis for understanding of how you take in information, why you forget and how you can do a better job of holding on to memories. Now you (hopefully) won't get frustrated by the strange little tricks your memory plays on you, and that awareness alone is priceless.

The analogy I like to use for big, complex subjects like memory is looking through the blurry lens of a microscope. At first, everything looks like this:



Nothing is clear, all you can see are some colors and faint structures. At this stage it doesn't seem particularly useful to you. If you never go forward, your view will stay blurry. In fact, it's probably going to get blurrier as time goes on.

But if you stick with it, you're rewarded with some clarity. The fog begins to lift somewhat, and you start to understand what you're looking at:



Go even further, and you start to really understand where a subject fits in the world and how you can incorporate it into real life. While I'm not convinced that 100% clarity is possible, you can get pretty close after enough time and dedication[17]:

[17] Images courtesy of Erbe, Pooley: USDA, ARS, EMU via Wikimedia Commons

Memory is like that. It's an incredibly deep subject, and many of the most interesting questions have yet to be answered. But there *is* quite a bit that we already know, and if you're willing to take the time to learn it, your world view can be fundamentally altered.

My hope is that this book acts as an ignitor, something that gets you more interested in memory. It's tied into many other aspects of brain function, most notably learning. Getting a handle on what we do and don't know about memory and its related subjects has the potential to completely change how you interact with the world.

Even if you aren't going to go further down the rabbit hole of memory, at least now you're equipped with enough knowledge to make better decisions about picking up new information. There's much more to it if you're truly serious about optimizing your memory and learning processes[18], but just using what you've read here will put you head and shoulders above your peers.

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[18] My first book, *The Learning Factory*, goes into much more detail about those two subjects.

If you have any questions or comments about any of the subjects in this book, feel free to send me a message via my website at www.52aces.com/contact.

-Ace

Further Reading

If you do want to learn more about memory, I recommend the following two textbooks:

1. ***Memory, 2nd Edition*** by Alan Baddeley, Michael W. Eysenck & Michael C. Anderson - By far the most accessible textbook about memory out there, written by the one of the biggest names in the field.

2. ***Learning and Memory, 2nd Edition*** by Mark A. Gluck, Eduardo Mercado & Catherine E. Meyers - Pretty much the definitive book about the relationship between learning and memory.

These are both substantial time and energy investments, but if you're serious about this subject they're extremely helpful.

If you would prefer something smaller and more immediately useful, you can check out my book, ***The Learning Factory***. It's a complete system built on the principles that I've picked up from years of research and experimentation, and it's a lot easier to get through than either of the monster textbooks above. You can find it on my website, 52aces.com.