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How Memory Works and Why Your Brain Remembers Wrong

Course Guidebook

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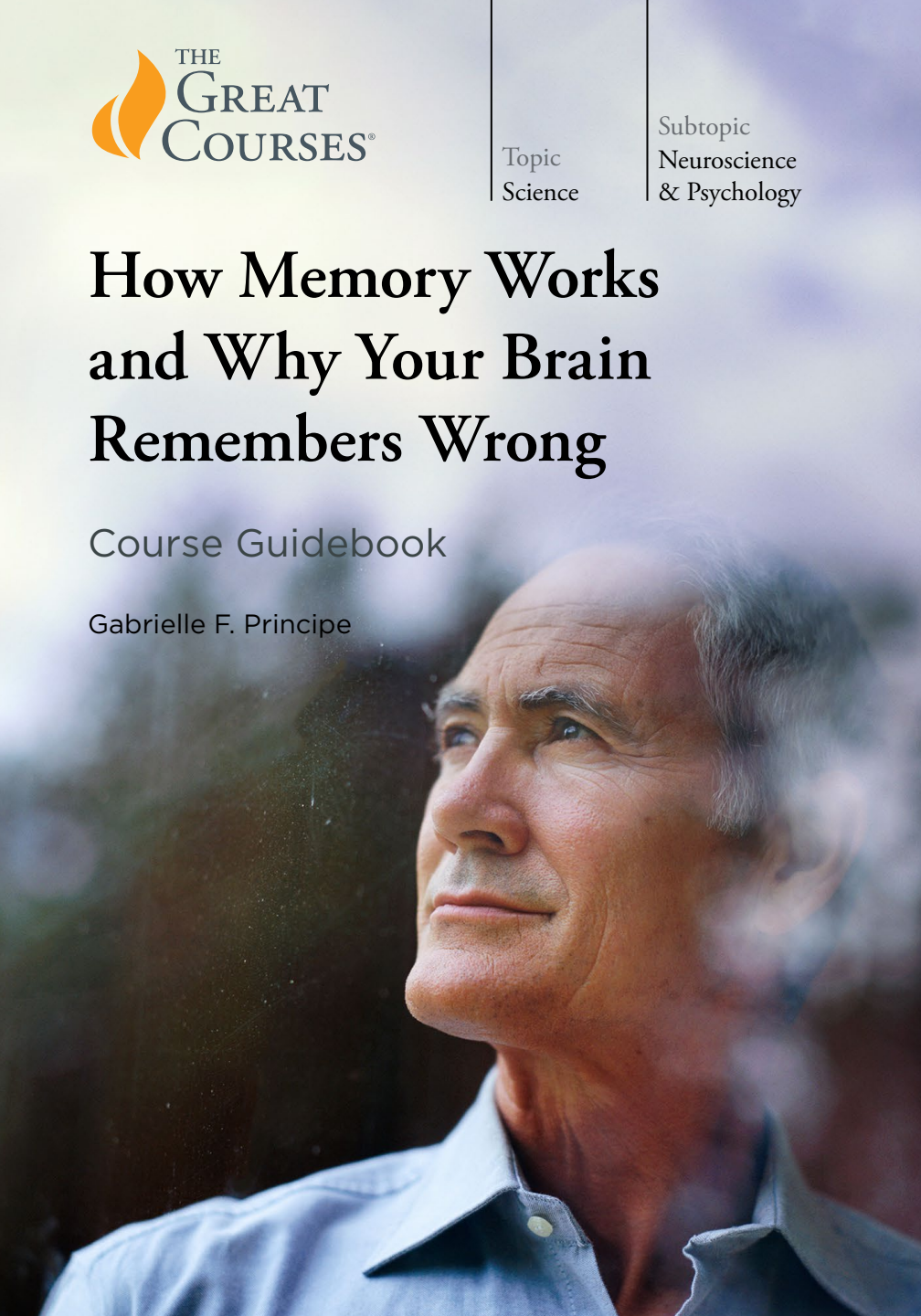

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The Surprising Pliability of Memory

Unsettling as the idea is, your memories are highly malleable. They are prone to an incredible array of modifications, distortions, and errors. Even the most meaningful, cherished, or painful memory can be completely forgotten, wildly misremembered, or entirely false. The consequences of your memory distortions can be extremely real, potentially causing real joy, upset, and even trauma. This course centers on the idea that memory doesn't work the way you think it does; doesn't capture information as faithfully as you think it does; doesn't store information as securely as you think it does; and doesn't retrieve it as reliably as you think it does. You'll explore why memory works in this way and how the malleability of your memory system is exactly what makes you human.

Memory as a Recording Device

You likely know that individuals who suffer from neurodegenerative disorders, such as Alzheimer's or other forms of dementia, lose the ability to remember their past. However, misremembering important facts and experiences isn't something that most people expect a healthy person to do because they think memory works like a recording device—a mechanism that picks up and permanently etches life's experiences into our brains exactly as they happened. It can feel as if memories must be like snapshots in a photo album that, if properly stored, remain forever accessible in their original, pristine form.

However, the idea that memories are like snapshots in our minds is simply wrong. For example, mistaken eyewitness identification is the number one cause of wrongful convictions overturned by DNA evidence in the United States. Innocent defendants are found guilty at a rate of about 5%, meaning that in 1 out of every 20 cases, the court or the jury gets it wrong.

Memory doesn't literally record reality. Your memory doesn't record everything; it stores only what it needs to and no more. However, if our memory system isn't a recording device, then how does it work? How do our experiences turn into memories that we can later retrieve and use?

The Importance of Memory and Its Fallibility

Memory is involved in every single thing we do. We use our memories to build bonds with our friends and family by reminiscing about camping trips and concerts. We teach our children lessons by reflecting on past failures and misbehaviors. We plan for the future by looking back on our memories of earlier experiences. Our very identities are built on our personal memories of things we've thought, learned, and done.

In fact, our whole society functions on memory. Medical professionals rely on their patients' accounts of the duration and severity of their symptoms to prescribe treatments. The legal system uses the testimony of eyewitnesses as

evidence in criminal trials. The histories of our civilizations are assembled on the collective memories of those before us. Given the pervasiveness and significance of memory in our everyday lives, at both an individual and a societal level, learning how memory works can help us navigate through our days, relationships, and histories.

The first thing you need to know about memory is that it's highly fallible. Many memory errors are in the nature of cognitive shortcuts that benefit us, not only in terms of making us efficient actors but also in terms of keeping us mentally healthy and generally happy. Surprisingly, many of these errors can be better for our well-being and identities than the truth. In addition, the more we know about how our own memories shape and misshape our experiences, the better our lives and relationships can be.

However, some of our misrememberings can have unhealthy—if not disastrous—consequences for our behaviors, well-being, and relationships and even broader society. The notions of false memory and memory distortions are particularly relevant to the criminal justice system. In a court of law, fact finders rely heavily and often exclusively on the memories of eyewitnesses, victims, and suspects.

One of the questions experts have explored is how confusions between fantasy and reality can influence the way that children make sense of and remember certain types of experiences. To study this issue, researchers asked kindergarteners for their memory of what happened when they lost their last baby tooth. All of the children they talked to engaged in tooth fairy rituals, such as putting the fallen-out tooth under their pillow at bedtime in the hope of finding a gift in the morning.

Not all of the children believed in the tooth fairy. The firm nonbelievers and those wavering in their beliefs stuck to the facts in their recollections, but the believers told extremely different stories—absolutely fictitious memories that often included reports of hearing or seeing the tooth fairy. However, most of the believers in the research didn't generate completely fantastical stories out of thin air. Rather, their stories were the result of misinterpreting real things that happened through the lens of their beliefs about the tooth fairy. The researchers knew this as they were smart enough to ask parents for any "evidence" of the tooth fairy's visit that they planted. For example, some parents cracked open bedroom windows to suggest how the fairy came and went. The expectations created by the children's parents led the children to interpret a witnessed event incorrectly.

This finding is important because it shows that we can come to misremember an entire event based on inferences triggered by what we think must have happened—even when those inferences are completely and utterly unrealistic. It also illustrates that, based on such inferences, we can come to remember "seeing" things that didn't happen at all. Seeing can be believing, but seeing can also be constructed completely inside our heads. This suggests that testimony laced with fantasy needs to be analyzed carefully before it can be considered reliable evidence.

How Are Memories Made?

With regard to how a memory is and isn't made, the first thing you need to know is that whenever we experience something, we miss most of it. Right now, by the act of paying attention to these words, you're ignoring an unthinkably large amount of information continuously buzzing in and

around you—the tension in your shoulders, the taste this morning's coffee left in your mouth, or the sound of the traffic driving up and down your street. If you shift your attention to any of these things right now, they stand a chance of being remembered later. However, the point is that only a fraction of our experiences make it into our memories.

In addition, only a fraction of what gets into our memories is retained: Most of it fades or decays, and once it's gone, it's gone for good. Among the things that make it in and stay, some become difficult or even impossible to retrieve. If you had the right cue, you could probably get somewhere. This is why police officials sometimes take witnesses back to the scene of the crime and why you remember you need to buy toothpaste not when you're at the drugstore but rather only at home at your bathroom sink—when the right cue triggers your memory.

The final piece is that when we recall a memory, we don't simply retrieve a copy of the original information like we do a book in the library. Rather, we take the fragments of fragments that remain and try to reconstruct the totality of an experience from them. As we work to recreate or reconstruct our experiences, we are prone to incorporating fragments that weren't part of the original event, and this changes the memory. When we later recall that event, we typically remember the embellished memory instead of the original experience.

One way this can happen is when there are gaps in our memories and we fill in the missing pieces with inferences or guesses, which can be way off the mark. For example, a whole host of cognitive biases can influence how we fill in the blanks. We might mistakenly remember that our coworker Jen was at happy hour last Friday, not because she was but because she usually is. Expectations such as "Jen is always at happy hour, and therefore, she must have been there last week" can distort memory when our expectations are unaligned with what in fact happened.

The suggestions of others can seep in, too. For example, in one study, psychologist Elizabeth Loftus got a quarter of participants to remember they had gotten lost in a shopping mall as children simply by telling them so—adding that, although they might not remember getting lost, their parents had confirmed it. Some participants even shared their "memories" in vivid detail, but none of it ever happened.

Memory as Constructed Reality

Usually, most of our false memories go unnoticed and cause no major problems, but they can—such as when our therapist suggests that our inability to maintain a romantic relationship likely stems from childhood neglect and we repeatedly conjure up images of what this might have looked like. Our minds confuse these mental pictures with memories, and we wrongly come to believe that it must be so because it feels like it must be so.

Far from being a recording device, you can see now that memory is more of a process where things inside of us, such as our beliefs, biases, goals, and expectations, along with things outside of us, such as the suggestions of others, combine with the sensory experiences that are constantly coming at us to construct a version of reality. These versions are dynamic and changing and personal and not only incomplete but also inexact.

This is the slippery, shape-shifting nature of human memory. To be aware of its workings is to become aware that even our most formative memories—the ones that we feel in our hearts make us who we are today—can be unreliable and that this can be so even when we try to be completely honest with ourselves. What's more, we can also experience intrusive recollections that we wish we could forget—and these, too, can be inaccurate.

2

Context: The Connective Tissue of Memory

The human memory system has been revised, reworked, and repurposed in different ways through evolutionary time. This means that your memories are not uniquely designed but historically designed and that inheritance has endowed humans with a context-guided system. In this lecture, you'll explore how having a contextual memory can both have its disadvantages and give you much-needed flexibility. You can activate the same memory with multiple cues, which is useful in a constantly changing world, and you can deliberately change the contexts in which you live and work to help you more easily remember both minor and significant things. You can use context in a reparative way by associating good memories with certain places, events, and people. In this regard, you'll learn that context is, in some ways, your memory's superpower.

Imperfect Memory and Evolution

Even if you think of your memory as generally reliable, you've got to admit that it has some rather major flaws that get in your way on a regular basis. Despite all that you count on it for, it routinely lets you down. You find yourself unable to remember the name of the person who just introduced herself to you or why you walked into the kitchen.

Imagine that you have been asked to create the human memory system. You'd probably design a device that precisely records, forever preserves, and reliably retrieves everything so that you'd never forget. You might look to your computer for inspiration. It can retrieve every word of every email you've ever sent, all the photos you took on every family vacation, and the date and time of all your past appointments—all in perfect detail, every single time.

You can't even come close. Your memory doesn't even stack up to that of other humans. Take Jill Price, who has highly superior autobiographical memory. People such as Jill—there's fewer than 100 of them—can recall the precise minutiae of their lives, across decades. However, whenever Jill recalls something from the past, it triggers the retrieval of another related memory in a perpetual cascade. She describes it as "nonstop, uncontrollable, and totally exhausting." If that's not enough, it seems that recalling the past so effortlessly and so completely can make it extremely difficult to get over painful experiences, such as a breakup. This tells you something important about human memory: Having a good memory can be bad.

Our brains—along with those of every other living thing—reflect millions of years of evolutionary history. Evolution is constrained to work with what is already in place, remodeling, retooling, or otherwise refashioning what's already there through natural selection. In this regard, our brains have been crafted from the same cells that made up the first nervous systems some 600 million years ago. These cells, called neurons, have not changed substantially since that time, which means that our brains and our memories operate on the same cells that run all animals.

Neuron Networks

How do our brains manage to create human memory with primeval, hand-me-down parts? The answer is sheer numbers. The human brain has 86 billion neurons, each of which is connected to, on average, at least 5,000 other neurons. That's an astounding network of 430 trillion connections. The human brain enables complex behaviors, such as human memory, as the result of the number of interconnections among neurons that can do some incredibly special things.

Neurons don't touch each other but are connected by tiny gaps called synapses, which are where the chemicals from one neuron are released. The next neuron detects those chemicals and then passes electricity down its length to the next neuron and so forth. The brain forms our memories of experience by wiring them into our neurons. It does this by converting the physical stimuli we perceive out in the world during our experiences—the photons of light that hit our eyes, the sound waves that collect in our ears, the pressure on our skin—into patterns of electricity involving a specific chain of neurons. Then, when that same sequence of neurons becomes electrically active again, we recall that experience.

The way to think about it is that your brain is a flow of electricity between different neurons. Depending on which neurons are active, you might be experiencing and perceiving or remembering something. Everything we experience and remember about those circumstances depends on which neurons in which sequence are electrically active at any moment.

Now, the way we experience the world might make it seem like our experiences become stored in our brains as sights and sounds or feelings and words. However, our experiences are stored in the brain merely as patterns of electricity and neurons that, when repeated, give us the sense that we're experiencing the thing again. It's like a Morse code of some sort, where the message all depends on how the chain of signals is arranged and ordered.

The Importance of Context

Memories aren't made or stored independently of one another. Everything we experience takes place in a context; therefore, everything we remember takes place in a context. This turns out to be extremely important. If you ask someone her dog's name, she doesn't recall only his name; the context of naming him comes rushing back, too. This happens because a memory's context in our minds reflects the activation of other neural circuits related to it in our brains. Each individual thing we remember or want to remember is linked to other things in memory by association—some close and some far. When we put in the search terms for what we're looking for, we don't get only one hit: We also get related memories.

An intriguing consequence of having a memory system based on context is that what we remember at any given moment depends on the context in which we're remembering it. The more the retrieval context matches the aspects of the context of our initial experience, the easier it'll be to recall that information. This is why hearing a song that was playing on the radio during our first kiss can make that experience come rushing back to us, even if we haven't thought about it in decades.

In fact, the effects of context can be so powerful that some researchers conceptualize memory as the interaction of what's activated in our brains and what's in the outside world. All the way from the individual to the societal level, we arrange the world so that we remember certain things better. At the individual level, we put our keys on a hook by the front door so that we don't have to use our heads to remember where our keys are. At the group level, we reminisce with our family and rely on Cousin Mac to fill in the blanks about the time we buried him in the sand. At a societal level, we build the Lincoln Memorial so that we—and future generations—remember President Lincoln and his presidency in a certain way.

What's interesting is that memories activated by aspects of the context of our experiences can affect us and our behaviors, even if we're not consciously aware of them. This is known as priming. For example, people tidy up more thoroughly when there is the scent of cleaning products in the air and judge

social interactions as less smooth when they are handling puzzle pieces rough as sandpaper. Priming teaches an important lesson about memory: We're often powerless to control what associations it makes and what it retrieves.

In a world where people have built up negative or undesirable associations, priming can be a disaster. For instance, it can lead to unfair bias against people of particular backgrounds in decisions about hiring or admission to academic programs. It can also reinforce depression because being in a bad mood primes a person to think about past negative experiences, which in turn can worsen depression.

Not only does context trigger memories, but also different contextual cues out there in the world can ignite the same patterns of chains of neurons, along any part. Said another way, the same memory can be activated by diverse stimuli in our lives. This aspect of contextually driven memory has its benefits. Frankly, it's important to our survival. Imagine you're a toddler and you've burned your finger on your mom's stove. When you visit your grandma's house or your sitter's apartment, neither have the same stove as your mom. However, pieces of their stoves are enough to trigger the memory of the time you burned your finger and therefore keep you from touching a stove you've never even seen before.

Anchoring our memories in terms of context and cues can also, at times, give us trouble. For instance, whenever the context changes, successful retrieval can get more difficult. Likewise, having a memory driven by context means that there's no guarantee that the right memory will get activated. In fact, the more context cues you provide, the more hits your memory will serve up. Sometimes, too many associations take you down a rabbit hole. This is the tip-of-the-tongue phenomenon. In addition, our context-based memory also gives us trouble recalling specific instances of repeated events.

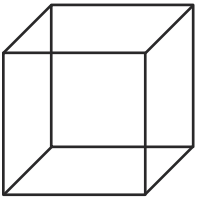
However, this same tendency also comes with some benefits. When we repeatedly experience similar events, such as dinnertime at home, our memories blur and can get represented in the brain as generic. These generic memories are helpful because they allow us to know what to expect as an event is ongoing and behave accordingly. Our automatic building of generic memories from repeated similar experiences helps us in all kinds of ways. It's why we let off the gas when we're about to drive around a curve, for example.

3

Expectation, Perception, and Memory

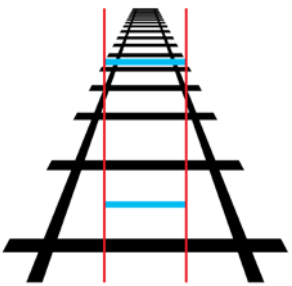
Your perceptions do not exist outside of the information your brain has decided to give you. Thus, everything you feel, hear, smell, taste, and see is an illusion—an interpretation of signals received, assembled by your brain. In this lecture, you'll learn that your brain makes such interpretations because you've had prior experiences of certain things and that these experiences turn themselves into memories. They are classified and stored in your mind so that you can use them in the future to make predictions about what you're perceiving in the present. Therefore, you never see, hear, or feel objective reality, if there is such a thing. What you see, hear, and feel is the story that your brain creates for you, based on your memories.

Perception, Memory, and Illusion



To begin to understand how our brains use memories to construct our story of experience, imagine a line drawing of a cube. It's only a series of 12 straight lines on a flat page, but you see a three-dimensional object because the lines are arranged in a way that matches something your brain experiences in everyday life. Your brain tells you it's a cube. It makes this prediction because it sees cubish shapes all the time.

Most of the time, our brains work smoothly like this. The automatic interaction between what we perceive and our memory lets us make assumptions and educated guesses and creates a story that matches the real, physical world. However, sometimes, our brains get it wrong. This can happen in many different ways. One clear example is with visual illusions, which happen when the predictions our brains make about what we're seeing override what's truly out there. Some visual illusions are so strong that even when you know the reality, you still see the illusory form.



For example, the Ponzo illusion is created with two same-sized horizonal lines, one placed above the other, drawn between two diagonal lines that are closer to each other at the top of the drawing than they are at the bottom. If asked to judge the size of the horizonal lines, what you see is not reality. The top line looks longer than the bottom line, even though they are the exact same size.

There's nothing about the machinery of our eyes that causes this effect. What we see is the story our brains tell us. Our brains tell us this story because they interpret the figure in linear perspective, as they're used to seeing parallel lines recede into the distance—in rooms, highways, buildings, and railroad tracks. Because they understand the figure this way, they make us see depth. That is, our brains interpret the vertical lines as receding into the distance, like a railroad track.

Consequently, we interpret things near the top as farther away than things near the bottom. As things farther away would need to be longer to appear the same length as things closer to us, our brains tell us that the top line is longer than the bottom line.

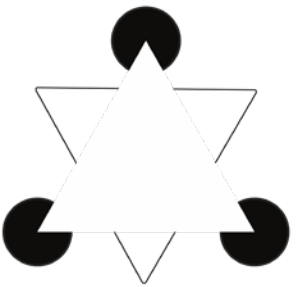
We know this is what our brains do because when the distance cues are gone, we correctly see the lines as the exact same size. Remove the two diagonal lines, and our brains now change their mind and tell us the two horizonal lines are the same size. The lesson here is that the stories our brains tell us about what's out there are extremely compelling, even when they are completely wrong. In this sense, the memories in our heads have the power to mislead us into perceiving things that are patently false—even when we know full well that we are being misled.

Prediction and Commonality

You might be thinking: If everything is an illusion our brains construct, then why do we all generally agree on what we're perceiving? We generally agree on things for two reasons. First, all of us have the same sensory equipment. If that equipment is working properly, then we're all getting the same sensory feed. Second, we're all immersed in environments that share countless similarities, and our times spent in these environments have become abstracted into memories of the world and how it works. These memories help you know, for example, that sandwiches go in your mouth and not your ears. We have these memories in common, and therefore, we generally tend to perceive things the same way.

We're able to use our memories of experiences to help us share the world we inhabit together because our world is predictable. Other animals that share our sensory equipment and also have shared experiences with us have brains that make the same sorts of predictions about the world as we do. This is why your dog jumps to catch a tennis ball when you lob it at him and your goldfish, which has quite different equipment and experiences, doesn't.

How do we know that experience in common environments matters? Consider the Kanizsa triangle. It's a symmetrical black-and-white figure that consists of three shapes, each of which looks like a pizza pie with a missing slice. In between each pair of pies is a pair of short, intersecting lines that meet at a 60° angle. The raw sensations coming to your eyes are simply three black pies and three black sets of lines. It's nothing but sensory garbage, but our brains work to give it meaning. It turns what it's seeing into a fully outlined equilateral triangle with one point facing downward, covered by a second, un-outlined triangle with one point facing upward. The illusion is so strong that it feels as if we can grab the top triangle.



However, there are no triangles in the picture. We need only the suggestion of one to "see" one. This is the story our brains tell us because they have little to no experience in everyday life with pie shapes and lines arranged symmetrically but are used to seeing triangles. Thus, they fill in the blanks this way.

That's a mistake, of course. Generally, however, your brain's tendency to consult your memories to make split-second decisions about what you're perceiving with only incomplete information is extremely valuable for you, both individually and collectively. For example, that grayish saucer floating closer to you in the surf is not a giant floating mushroom but a jellyfish. In this way, your brain constantly turns memories into seemingly automatic predictions about the world.

Memory, Association, and Expectations

If you're still questioning whether it's your memory that's guiding these decisions, consider the perceptions of people from different cultures, such as the Zulu of South Africa. The Zulu grow up and live in villages made up of round huts arranged in circles. Therefore, they don't often, if ever, see built things with straight lines, such as the streets, railroad tracks, and buildings you're used to. As a result, the Ponzo illusion doesn't as easily kick

in for them. That is, they're likely to judge the top and bottom line as the same exact size—something many of us can't do even when we know we're dead wrong. This shows that different people will interpret the same thing differently depending on their prior knowledge.

We do the same kind of thing with color. It turns out that color, like everything else, is a prediction our brains make for us based on associations stored in our memories. It sees an apple and predicts red. They make these predictions even when the color of a thing changes. When you look out at the part of your lawn that's in the shade of a giant oak tree, you see that part of your lawn as green because lawns are green, but it's rather gray.

This tendency to see what should be, rather than what is, helps us get by. If we relied on only the exact information coming in—in this example, only the precise wavelengths of light—we'd be constantly fooled. We might think that the shadow cast on our lawn by our tree is dead grass or a giant hole, for instance, but our brains account for these sorts of changes. Rather than consider only the precise wavelengths of light coming in, they make guesses about color based on the cues around it and our prior experiences and guess that the grass is still green. We make these sorts of guesses constantly.

The power of expectations extends to countless aspects of our lives. It even explains the placebo effect. If you take a sugar pill that you believe reduces pain, you will feel less pain. Why? Such a belief causes your brain to release endorphins, which triggers some relief from pain. There are often measurable changes in heart rate and blood pressure. If you get that sugar pill in familiar brand-name packaging, you get more pain relief than you do with plain packaging. People will report experiencing the side effects of whatever drug they think they are receiving.

The unnerving thing about all of this is that most of the time, we have no way of knowing which experiences are guiding our perceptions. Your brain makes a great deal of inferences that influence how you experience the world but doesn't have the decency to tell you when it's making an inference.

Now you know that all memories start with the raw data of our sensations. You wouldn't have a memory of stubbing your toe if you hadn't felt the pain in your toe or seen that the offending object was your couch. However, it's more than that. You wouldn't have a memory of stubbing your toe on the couch unless you first had an idea of what a couch and a toe are. Even though it feels as if your perceptions automatically turn themselves into a memory that accurately and fully reflects reality, you now know that memories can be wrong at their inception.

4

Attention: You Remember What You Notice

Your brain lets you experience far less of the world than you think you do, and you can remember only what you experience. Although it feels as if you see, hear, and smell everything you experience, the truth is that you are quite often shockingly unaware of almost everything going on around you, particularly when you're paying attention to something else. In this lecture, you'll explore how powerful expectations are in what you experience. You'll also learn how you don't experience—and consequently don't remember—as much of the world as you think you do because of the limits of your attention.

Experience, Attention, and Memory

Attention is the glue between our experiences and our memory. If we're not paying attention to something, then it simply does not exist, at least not for us. If it doesn't exist for us, we can't remember it. In addition, we often confuse forgetting with attention. When you say you forgot where you put your phone, you haven't forgotten. Rather, you weren't paying attention to where you put your phone down, and when you find it, you often don't remember putting it there. It never made it into your memory in the first place.

At any moment, we attend to only a tiny portion of the sensory information that's all around us. If our brains didn't work this way, the world would be a jumbled onslaught of constant perceptions; thus, our brains focus on the sensations that are the most important for our current goals and throw away the rest. Attention not only filters information coming in from the outer world but also filters our inner thoughts. However, the cost of paying attention to anything is being blind to everything else. That is, where you direct your attention determines your reality, and everything else simply does not exist, at least not for you.

Inattentional Blindness

A video made by psychologists Daniel Simons and Christopher Chabris demonstrates how blind we are to things in our field of vision. It shows two teams of people moving in a circle and passing basketballs back and forth. One team is wearing white shirts and the other black. At the start of the video, viewers are asked to count how many times the players wearing white passed the ball. A few seconds into the film, a person dressed in a whole-body gorilla suit walks into the middle of the circle, faces the camera, and stops to beat their chest. The gorilla is in plain sight for about 10 seconds of the 25-second clip, but about half of the people who watch the video fail to see the gorilla—even if they never take their eyes off the screen. If shown the video a second time, without the direction to count basketball passes, everyone always sees the gorilla.

How could people not see a gorilla walk in the middle of a game of catch? It's an error of perception that results from lack of attention called inattentional blindness. When we're paying close attention to a particular aspect of our world, we tend not to perceive unexpected objects or events, even when they're extremely salient, potentially important, and appearing exactly where we're looking.

Therefore, expectations matter. Our brains construct reality for us by making predictions about what they expect to perceive in any given situation. These expectations are derived from our experiences in the world. Your brain hasn't experienced a gorilla during any prior ball play. Consequently, it doesn't expect to see a gorilla in a game of catch, and thus, it doesn't see it even when it's right there in front of you. Inattentional blindness happens all the time in everyday life.

An experience-driven attention system ordinarily doesn't cause problems. However, inattentional blindness can have devastating effects. At any given moment, we think that we see everything in front of us, which can lead to incautious or overconfident decisions that cause accidents. For example, the majority of motorcycle accidents are collisions with other vehicles. People are looking for cars and trucks because those are common, and they fail to see motorcycles because they don't expect to. The same kind of thing often happens with bicycles and pedestrians.

Change Blindness and Automaticity

Imagine this scenario: You're walking across a college campus, and a man holding a map asks you for directions. While you're talking, two workers holding a giant door rudely walk in between you and the man. Once they pass, you finish giving directions. Do you think you'd notice if the original person was replaced by a new person as the workers carried the door through? What if the original and new person had different clothes, differed in height, and had noticeably different voices? You'd have to be oblivious to miss the change, right? That's exactly what more than 95% of people thought when asked if they would notice. Remarkably, when psychologists ran this experiment in real life, only about half of the people noticed they were talking to someone different.

This sort of error, where we don't notice changes, is called change blindness. To detect this sort of change, people need to focus their attention on the exact aspects of the experience that change. However, generally, we don't attend to anything at that level of detail. We process most of our experiences at an incredibly superficial level, which leads us to remember the general gist of most of our experiences but not the specific details.

The lesson here is that attention is needed to see change, which is why you might not notice your partner's new haircut when they first greet you after coming back from the barber. Of course, expectations are at play here, too. If your partner hasn't told you they're getting a haircut that day, you don't expect to see it, and thus, you don't look for it.

There's an interesting class of experiences where we can expect our lack of attention to interfere with our memory. This is especially problematic because we have these experiences on a routine basis, but it's the routine that's the problem. Numerous experiments have demonstrated that, with practice, all kinds of tasks that are initially extremely effortful and attention-demanding become essentially automatic, which means they require little to no attention. Operating on automatic gives us the cognitive freedom to focus on other things as we carry out what once was an attention-consuming task. Imagine if tying your shoes required as much concentration and effort as it did the first time you tried it.

Despite being a neat trick of our attention system, automaticity comes at a cost—the virtual absence of memory for activities that were performed while on automatic. You're simply not paying attention to what's going on around you; hence, you remember nothing of it. This kind of amnesia for the automatic confounds us on a regular basis, yet we can hardly function without automaticity. How would we contemplate life while riding a bike, stir a pot while reading cooking directions, or strum a guitar while singing? It's an essential but flawed function.

Prospective Memory Errors

Prospective memory errors—incredibly common errors caused by attention lapses—are forgetting to do things in the future, such as picking up dog food on the way home. What makes prospective memory errors particularly challenging is that making them can reflect on your credibility or character in ways that retrospective memory errors do not. Retrospective memory errors involve forgetting things that happened in the past, where you might simply complain about your bad memory. Forget to do something in the future, and you're seen as unreliable or insensitive.

People are right not to blame prospective memory errors on having a bad memory. Usually, these errors come about when the event designed to trigger a memory of the intended action fails to do so, as our attention is deployed

elsewhere. We make these sorts of errors because we often tell ourselves that surely we'll remember in the future at the right time—but at the right time, other things have captured our attention, and the intended task is off our radar. We have so much confidence in our prospective memory that we rarely generate concrete cues to help us remember later.

In summary, although we don't experience, or remember, as much of the world as we think we do because of the limits of our attention, our brains are doing us a favor here. Our sensory organs are constantly bombarded with waves of stimuli in an avalanche of sensations that far exceeds our capacity to make sense of. If we were to take it all in, we'd be relentlessly overwhelmed in perpetuum. The limited nature of our attention allows us to concentrate on what we need to or want to in that moment without being distracted by everything going on around us constantly. Two people experiencing the exact same thing could be taking in entirely different information at the same time and end up with different memories of the same event or conversation due to differences in attention.

5

False Memory: Remembering What Didn't Happen

Everything you see, hear, and feel is not reality but rather a story your brain creates for you, in the moment, about what you're experiencing. Sometimes, the story is faulty; sometimes, it misses things it shouldn't. You can't trust your memories either. Your memory system doesn't simply hand you the past the same way every time. Rather, your recollections of experiences are reconstructed anew every time you attempt to recall them. Sometimes, your brain grabs the wrong information, such as your own knowledge, beliefs, or biases. Other times, it splices in new information altogether. When your brain makes these mistakes, you become prone to reconstructing aspects of the past wrong—a phenomenon that you will explore from different angles, starting in this lecture.

False Memories

Imagine that someone asks you to listen to a list of words and then, after 5 minutes, try to remember them. Imagine hearing the following words: *bed*, *rest*, *awake*, *tired*, *dream*, *pajamas*, *nap*, *blanket*, *relax*, *dose*, *slumber*, *peace*, *snore*, *yawn*, *drowsy*, *snooze*.

Now wait 5 minutes and try to recall them all.

If you're like most people, you didn't remember all 15 words. Most get a few words from the beginning of the list, a few from the end, and less than half from the middle—on average, seven or eight words. The interval between when you heard the words and were asked to remember them was brief. Presumably, no one was distracting you during the task, nor were you under any duress. Yet, despite these optimal conditions, you couldn't even remember 15 words you heard moments earlier.

This exercise clearly demonstrates the limits to how much you can remember but also how we remember what we do. Look at the list of words again. Is the word *sleep* in it? About 40% of people who take this test recall hearing the word *sleep*. If you're one of those people, you're probably as confident that you heard the word *sleep* as you are about any of the other words you reported, but it's a false memory.

The list was engineered to bring about this error, known as the Deese-Roediger-McDermott (DRM) task. Here's how it works: Each of the words on the list is strongly associated with the word *sleep*. You've already seen that memory works by linking things in memory by association, and therefore, your brain made associations among the incoming words and built up a theme that connected them all. That theme was sleep. When working to retrieve the words, your brain also retrieved this theme and mistakenly recalled *sleep* as a word on the list.

The DRM task reveals a couple of important things about memory. The first is that it uses more than only the material it retains from any given experience to reconstruct what happened. Rather, it rebuilds the past by blending the remnants of experience it retrieves from storage along with what it knows about the world generally. The second thing concerns our ability to

discern which pieces of our memories are based on experience and which are fabrications based on associations and knowledge. The DRM task tells us that we will not necessarily know the difference.

Usually, calling on knowledge when reconstructing the past is an efficient strategy. Our memory's tendency to associate incoming information with what we already know benefits us in a myriad of ways. It helps us discern what's important about our experiences. Association also provides us with retrieval cues, but memory by association can fool us. Lawyers are perhaps best known for taking advantage of this tendency. You've seen this on TV crime dramas when they tell the jury a carefully worded story that leads to a certain conclusion but never state that conclusion—then, the jury misremembers the inference they've made as true.

Verbal Overshadowing

Talking about our memories is one of the most common ways we create false recollections for ourselves. The moment we share a memory with someone, we've already changed it. To share a memory, we have to turn it into words. We have to transform sensory input into verbal information. Every time we take images, sights, sounds, smells, or tastes and convert them into language, we will lose some information because words can only capture so much. Therefore, we downsize, and these new shrunken creations impair our ability to accurately and completely remember what happened. This process is known as verbal overshadowing.

However, when we put a memory into words, not only do we lose details but we also generate a second new memory—that of our verbal description. Thus, anytime we tell someone about an experience, we end up with two competing memories: one of the actual experience and one of our description of the experience. The problem is that memory for our description often takes precedence over our original memory because it's more recent and more readily comes to mind. Therefore, we tend to think our description is what happened.

Despite the loss of information that comes from talking about a memory, such trimming serves us well. Let's say that yesterday you passed a station wagon

carrying 13 dalmatians and driven by a woman dressed as Cruella De Vil. The moment you tell someone what you saw, you lose the details. Your act of categorizing the animals as dalmatians treats them as the same, regardless of differences in size, spot patterns, and patches, and labeling the driver as a character makes her other features fall away. Now, all you remember is dalmatians and Cruella De Vil.

By glossing over the details, your brain has demonstrated its efficiency. It's put the memory into a manageable and shareable form. It has significantly reduced the amount of time and effort you need to communicate (and store) that experience. However, we do more than simplify when we share our memories. Sometimes, we tack on extra, and sometimes, we distort. Perfect accuracy is not the usual goal of memory sharing.

Retelling the Past

We share our memories to entertain, build social connections, boost our self-esteem, regulate our own emotions, or plan the future. Memory can serve these goals even when our recollections do not exactly represent the past. In fact, at times, we benefit from some degree of unfaithfulness. For example, sometimes, adjustments to memory based on new knowledge or changed appraisals of the past help us maintain a healthy self-conception or decrease emotional distress.

We also tune our retellings of the past to fit our audience. We're likely to retell certain stories differently to our kids, our friends, and our mom. These tunings, however, have implications for what we can later remember. Anytime we revamp the past—unwittingly or deliberately—we make ourselves likely to later remember in line with our revised versions rather than the original. This is known as the saying-is-believing effect. The more we share an amendment, the more likely we are to believe our own distortions. Our brains easily confuse familiarity with memory because familiarity can feel like memory.

In everyday life, we rarely, if ever, get any corrective feedback on false memories that everyone agrees on or that no one spots. We call these collective errors reality. However, in many contexts, our tendencies to unwittingly tell good stories can get us in all kinds of trouble.

For example, Hillary Clinton, while giving a speech during her 2008 presidential campaign, described risking her life under sniper fire when exiting a plane during a visit to Bosnia in 1996. *The Washington Post* fact-checked the story and discovered that it was not factual; therefore, everyone thought Clinton had been caught in a lie. However, there's another explanation that comes from understanding the fallibility of memory. Clinton had shared this story many times and told it differently on occasion. Had she exaggerated the truth at some point and come to believe that her new story was accurate?

Just like the vividness of our visual perception makes us think we're seeing reality and getting it all in, when we get vivid reconstructions of the past, they feel real and can fool us. Once we've shifted our memories, we don't remember or even know that we've done that. Thus, we have the illusion that we remember things as they happened. This is why confidence is no measure of accuracy. You can be 100% confident that you heard or saw or experienced something yet be 100% wrong.

Therefore, knowledge can shape memory at its inception, and prerequisite knowledge is important for building coherent memories. Our experiences are unambiguous and understandable because it's not our first rodeo. We also rely on our knowledge to downsize our experiences and turn them into manageable, useful, shareable representations. However, because our knowledge base becomes activated anytime we experience an event, that knowledge can become indistinguishable from experience. We can mistakenly believe that our inferences or abstractions happened. Usually this is not an issue, but it can be in certain contexts, such as the legal system, where false memories can ruin lives.

It is extremely difficult to have a clear memory and concede that it might be untrue. We can hear and see our memories and reexperience pieces of them in our heads. This can give us a compelling sense of truth about our memories. The thing is, though, that this also happens for memories that are not true. Doubting memories is an incredibly odd experience. However, in the same way you "see" triangles that aren't there in illusions, you can also remember things that never happened.

6

How Biases Distort What We Remember

When you know the outcome of an event, you sometimes feel as if you've always known it would happen. Thus, your brain automatically and unconsciously reconstructs the past to make it consistent with what you know in the present. These sorts of retrospective distortions to memory—ones based on your own current knowledge, beliefs, and feelings—are driven by memory biases. They can sucker you into editing or even entirely rewriting your previous experiences, unknowingly and unconsciously, in line with what you now know, believe, or feel. This leaves you with a skewed rendering of experiences that says more about how you feel now than about what happened then. In this lecture, you'll work through a range of biases that systematically color your memories of the past.

Hindsight and Availability Bias

Give a group of people a somewhat challenging test. Each question should have two options, such as: "Are spring peepers flowers or frogs?" Then, ask them to give a probability that one answer is correct. Later, give them the same test again and ask them to recall the exact same answer they gave the first time around. People generally are good at this—except if you tell them the correct answer the second time they see the test. After you tell them the correct answer, ask them to remind you what probability assessment they gave before. Most people can't do it. Knowing the correct answer disrupts their ability to remember what they said earlier. They wrongly recall giving the correct answer a higher probability of being right than they truly did. Once we know the right answer, our memories can't let it go.

Hindsight bias is so potent that even when you tell people about it and explicitly warn them not to be influenced by seeing the right answer, they still are. They can't help themselves. It's as if the moment we know the outcome, it feels as if we always knew it. You find hindsight bias at work in the courtroom. The prosecution introduces information from a seemingly incriminating text message. The defense objects. The judge rules it inadmissible and tells the jury to disregard it, but most jurors can't. Studies of mock jurors show that once incriminating information enters their memories—even if they are told to ignore it—most can't help but feel that they knew all along the defendant was guilty.

Another type of memory bias is availability bias—where we tend to rely on memories that are most easily recalled to make decisions or judgments. This bias usually serves us well, but it can also can get us into trouble. It can lead us to make bad decisions because those memories that most easily come to mind are not necessarily representative of fact. This is why many of us are more wary of flying than driving: We can more readily recall stories of deadly plane crashes than automobile accidents. However, your odds of dying in a car crash are 1 in 5,000, whereas your odds of dying in a plane crash are 1 in 11 million.

Availability bias is also why things such as gas stations, car dealerships, and hardware stores often are clustered together. You're thinking you need to get gas. You don't remember the names of any of the three gas stations on the

same corner, but you recall where to go get gas. Each gas station then has a one-in-three shot at your business, which is much better than the chances of gas stations you don't visit because their locations don't readily come to mind.

Egocentric and Stereotype Bias

With egocentric bias, we're likely to put more faith into our own recollections of events than those of others, especially for those memories that readily come to mind and do so with vivid, compelling details. We don't have direct access to these qualities of other people's recollections, but we do to ours. This can lead us to dig in and insist that we must be right.

Then there's stereotype bias. Our brains naturally categorize people on a broad range of attributes and characteristics, such as age, race, religion, occupation, and social class. These categories, or stereotypes, can be useful because it would require too much effort to size up every new person we meet from the ground up. They can help us understand how to interact with someone new by making guesses about their category.

However, when unfavorable attributes or negative characterizations become folded into a stereotype, you've set the stage for stereotype bias. This can happen when we hold a negative stereotype about a certain group that causes us to make negative prejudgments about someone whom we believe to be part of that group. This is how a handy cognitive shortcut can lead to harmful prejudice. Stereotypes can also can cause people to misremember information to make it conform to their stereotypes.

The use of stereotypes in connection with race is, of course, especially fraught. We are notoriously bad at distinguishing between people of races different from our own. This is known as the other-race bias. If you've ever confused two people of the same race because you couldn't distinguish between their individual features enough to tell them apart, then you've noticed this bias in yourself. The other-race bias has dire effects in our criminal justice system. Eyewitnesses are more likely to misidentify someone of another race than someone of their own race.

How can we account for this effect? By how we remember faces. It turns out that we think more categorically about people in other races than our own. When we take in an other-race face, the shortcut we do is basically notice that it has racial markers that are different from our own and tune out the rest. Thus, it's not that we can't notice the other details of cross-race faces; it's that we don't.

Can we prevent or minimize the other-race effect? Yes, because it's learned, not inborn. It appears to develop during a sensitive period in infancy. If infants regularly see and interact with people of other races before the age of nine months, the other-race effect doesn't emerge. It appears as if exposure to people of other races in adulthood can help. It turns out that White people who are fans of professional basketball—where Black players typically make up 70% or more of a team—show no other-race effect when asked to distinguish between Black people.

Consistency and Change Bias

We often assume that that our beliefs, feelings, and attitudes about the world don't change much over time. Consequently, when we reconstruct our pasts, we are prone to fitting them to our current thinking. We invoke consistency bias because we aren't good at remembering what we felt or believed in the past. Therefore, we infer our current beliefs, feelings, and attitudes from our current states. Unless there is good reason to believe we've changed, we're likely to take our current views and assume we felt the same way in the past.

Sometimes, however, there's good reason to believe that we have, or at least should have, changed over time. Such a belief can trigger change bias. We can find evidence for the workings of consistency and change biases in romantic relationships. Consider dating couples who were asked in separate sessions conducted two months apart to rate their partner on various attributes such as honestly, kindness, and intelligence—and also on how much they liked and loved their partners. When people's evaluations of their partners became more negative over time, they mis-recalled their initial impressions as more negative than they truly were. In contrast, those who said they liked or loved their partner more in the second session misremembered having felt more liking and love in the past than they reported.

Sometimes, we invoke consistency and change biases to reduce cognitive dissonance—the psychological discomfort we feel from experiencing conflicting thoughts and feelings. Therefore, a newly single person who believes he should be happier single than tied down but is struggling to find happiness may reduce cognitive dissonance by remembering himself as much unhappier when he was in a relationship a year ago than he would have reported if you had asked him a year ago to assess his happiness.

Another type of memory bias, peak-end bias, relates to what happened at the peak of your experience and how it ended. In the 1990s, Nobel Prize–winning psychologist Daniel Kahneman and colleagues asked people about their memories of colonoscopies. This is back when colonoscopies were extremely painful, when you were awake for the whole thing. As the procedure was ongoing, the researchers had people report on their pain level every 60 seconds on a scale of 1 to 10. There was a tremendous range in terms of the length of the procedures and much variability in the amount of pain felt.

However, none of this affected people's answers when later asked how much it hurt or how bad the whole experience was. What determined their answers was the peak amount of pain and how much it hurt right at the end. Even when Kahneman and his colleagues experimentally extended the procedure—thereby increasing the duration of pain—but lessened the amount of pain at the end, people rated that experience as better. That is, people preferred a longer-lasting colonoscopy as long as the pain was reduced at the end.

The power of consistency bias to lead us to reconstruct our pasts in line with our current thinking teaches us a larger lesson: How we synthesize our pasts is, at least to some extent, determined by our present. Thus, if you're in a spot in life that you don't like, you're likely to see everything before as an explanation for why you're in your current spot. However, if you do the work and get yourself to a spot that you're grateful for and gratified with, then you're likely to reconstruct troublesome aspects of your past in ways that you can deal with better. Knowing about consistency bias gives us the power to use our present to reverse engineer our pasts.

In addition, having learned about the potency of peak-end bias to shape our retrospective evaluations of any given experience, you could plan to end a vacation on a high note or capture the peak through a tangible artifact of the best day (for example, a photograph or journal entry). This will give you a concrete cue to use later to bring back your memory of that day. It's even better if you can create a cue that unambiguously triggers the goodness of that experience so that none of the biases you've seen here stand a chance of sucking you into rewriting that day.

7

The Repressed Memory Wars

Your memories tell a living, shifting story about your past, and your reports of your experiences can be false. In addition, a belief in repressed memories remains well entrenched in clinical contexts and the general population. In this lecture, you'll explore a complicated but important (and still ongoing) debate between two camps of professionals who differ on their views on the validity of repressed memories. On the one side are mostly research psychologists who argue that there is no credible scientific evidence that repressed memories exist. On the other side are mostly practicing clinicians who believe that repressed memories are real.

Freud and Repression

The idea of repression has its roots in Sigmund Freud's psychoanalytic theory. At the heart of this concept is the notion that traumatic experiences can be so overwhelming that we use defense mechanisms to cope with them. Repression, according to Freud, involves the automatic and unconscious detachment or "dissociation" of the trauma from other memories. The traumatic experience becomes buried in the unconscious, where it remains inaccessible and unknown to its owners and frozen in a pristine, unmodifiable form.

Freud also argued that repressed memories make themselves known to their owners by leaking out in the form of physical and mental dysfunction. To heal, one must work to recover the repressed memory in a safe psychological environment. When a traumatic memory is recovered, thought Freud, it resurfaces as an unmodified whole, and symptoms disappear.

However, this runs counter to everything we know about memory. Decades of research on how traumatic experiences are stored and retrieved in memory provide no evidence that trauma can become inaccessible and unknown to its owners or that it is stored as an intact and unchangeable whole. Furthermore, traumatic events tend to be well remembered—sometimes too well remembered. This is exactly what happens in the case of posttraumatic stress disorder, where recurrent and intrusive traumatic memories is the core symptom and can go on to influence a lifetime of perceptions, emotions, and behaviors. Even Freud himself, in his later work, repudiated the idea of repression.

False Memory Research and Repressed Childhood Trauma

More so than any other memory researcher, psychologist Elizabeth Loftus's program of work has helped us understand the phenomenon of false memories—how people can be made to remember things that never happened. In her studies, she realized the power of external information to convey ideas that can contaminate memory. The inaccuracies in memory produced by simple post-event suggestions are known as the misinformation effect.

When we call on a memory, we have to assemble it from disparate pieces of information in our heads. Some of that information is remnants of what truly happened. However, our brains sometimes mistakenly grab associated bits of information residing in memory. Sometimes, we also confuse what we're remembering from an actual experience and what we're reconstructing from knowledge, beliefs, and feelings. We also have trouble parsing out what we've picked up elsewhere, after the experience has ended.

Why do our memories have so much trouble determining what was experienced? It might help to think of your memory system as a storyteller working on a tight deadline—on the order of milliseconds. With the pressure to get you your story so quickly, mistakes will be made. Your memory splices in what's handy, what most easily comes to mind.

However, can we create a memory of an entire event that never happened? In the 1990s, there were claims of repressed memories and stories of adults recovering traumatic childhood memories everywhere. For instance, former Miss America Marilyn Van Derbur said she recovered childhood memories of her father's sexual abuse.

All of these memories had something in common: They were all recovered during the course of therapy for something other than childhood trauma. People were entering therapy for common problems, such as mood swings, low self-esteem, eating disorders, and relationship difficulties, and were coming out with new memories of childhood sexual abuse and other trauma, without physical evidence or corroboration from others.

The Debate on the Validity of Repressed Memory

Why was this happening? A handful of popular books written by clinicians, with titles such as *Secret Survivors*, were largely to blame. These books proffered long checklists of symptoms they told readers were "indicators of childhood sexual abuse"—even if one had no memories of being sexually abused as a child—because those memories could be repressed. Therapists

then used the "memory recovery techniques" laid out in these books to treat clients and search for repressed memories. They sprinkled in some knowledge they'd learned about their clients' personal lives to help the process along. They also often sent clients to survivors' groups, with the idea that hearing others share their memories of abuse may exhume their own.

Droves of people started to believe they had recovered memories of childhood trauma, mostly sexual abuse. At the same time, memory researchers began to worry that recovered memory therapy might be creating new memories of things that never happened rather than resurrecting old memories of real experiences. To find out, Loftus and others took the methods used in recovered memory therapy into the lab.

In one study, Loftus and her team asked volunteers to try to remember four events from their childhoods. Unknown to the participants, only three of them happened. The fourth event involved a made-up scenario of getting lost in a shopping mall as a child. To cue recall, participants were given details that they were told were learned from a family member, similar to how recovered memory therapists used familiar places and people to try to liberate repressed memories. For the mall event, participants were told about being lost, scared, and crying and then rescued and reunited with family. Over a quarter of the participants constructed memories of getting lost in a mall as a child. Loftus and camp then upped the ante and engineered false memories of more upsetting and weighty events, such as choking.

The researchers had hit on a recipe for engineering false memories: To start, have someone trusted—here, a family member; in therapy, one's therapist—plant a seed that something might have happened during childhood. Then, merely ask people to think out loud on the details. Such thinking and sharing can make an idea become familiar and an image grow in vividness. The people and places suggested in the seed activate real memories that start to become associated with the imagined scenario.

These demonstrations didn't sway the repressed-memory believers. They argued that Loftus's recipe was not creating false memories but instead successfully recovering repressed ones. However, memory researchers then engineered false memories for events that could never have happened in reality and therefore could not be the result of recovery.

Loftus's studies demonstrate the real risk that recovered memory therapy techniques can create false memories. In addition, the social pressure in Loftus's studies likely paled in comparison to what happens in a therapist's office, where a suffering client is urged on for months or even years by an authority figure who tells them "remembering" will relieve their symptoms. The tide eventually turned when client after client came to doubt the veracity of their new memories and retracted their allegations of childhood trauma.

Source Misattribution and Group Corroboration

Most false memories are created incidentally during everyday interactions. For example, with source misattribution, one's memory might be right but the source wrong. We make such source errors all the time, such as your memory of a joke you think your boss told you when it was your mom. We make such mistakes because we do not store our memories with a label specifying their origins. Rather, we judge their source at retrieval by evaluating certain characteristics of what comes to mind.

When memories are recalled in vivid detail, we tend to judge them as firsthand experiences. When they're less vivid, they don't feel "experienced," and thus, we attribute them to non-experienced sources, such as the TV. Therefore, even when we try to rely on our recollections only, we still can misappropriate others' memories, believing they are our own.

Our source misattributions often reflect an egocentric bias. That is, we more often misattribute things said or done by others to things we've said or done ourselves. Source misattributions can have real-world consequences. For instance, they are at the heart of a spate of recent high-profile cases in music copyright law in which artists have been accused of stealing music. However, what's likely going on is cryptomnesia: a type of misattribution where you have a thought—or, in these cases, a song—that you produce from memory, but you mistakenly identify its source as your own creative processes.

Should we also worry about media exposure creating false memories? *Slate* magazine fabricated a photo of President Bush relaxing at his ranch in Crawford, Texas, with baseball player Roger Clemens during Hurricane Katrina and asked its readers if they remembered the photo. Even though Bush was at the White House at that time and Clemens never visited Bush's ranch, 15% of respondents recalled seeing the photo, and an additional 16% recalled the event happening but couldn't remember seeing the photo. What's more, people were more likely to say they remembered a doctored photo when it was in line with their political ideology: Liberals were more likely to remember seeing Bush on vacation with Clemens during the Katrina disaster.

This pattern harks back to the role of beliefs in remembering. When we encounter false information consistent with our beliefs or attitudes, our memories are especially prone to being misled by it—even our recollections of what we saw with our own eyes. This also opens the door for some to prey on our political biases to manipulate our memories of world events.

Social media is particularly fertile ground for us to develop false memories. That's the power of groups. Many people can corroborate each other's memories, and corroboration will strengthen a memory for anything, potentially resulting in false collective memories. The research and theories considered so far show that remembering is a process that commonly occurs in collaboration with others, where tellers and listeners co-construct a rendering of experience. Moreover, individual memories are an amalgam of firsthand information; internal knowledge, beliefs, and biases; and new content derived from others.

Therefore, any analogy has to work with the idea that individuals do not process personal experience in a standalone manner. The evidence of the influence of others on remembering suggests that memory is a collaborative enterprise. In this regard, memory's content is usually close to reality but not entirely accurate. Sometimes, it includes utterly false, if not fantastic, information, and information in it can change over time. The original creator can go in there and modify its content—but so can others.

8

Things You'll Forget and Why

Most people don't immediately see any value in forgetting. When you're unable to retrieve information or you lose it entirely, it seems that your memory system has failed you. You regularly feel the negative consequences of forgetting in your life. By contrast, successful forgetting typically goes unnoticed, but it happens constantly. It is a consequence of your mind's default factory settings. When you look at forgetting the right way, you'll see that it's not a failure of your memory system but an adaptive feature. In this lecture, you'll work through the valuable—and indeed vital—functions of forgetting and how to deal with the downside of it.

What Does It Mean to Forget?

Forgetting is not an all-or-nothing process in which a memory is either completely absent or entirely present. Just because you can't access a certain memory at a given moment doesn't mean it doesn't exist. It simply means that you can't get it right now. In the future, under different circumstances, it may become accessible again. There also are multiple ways we can "forget," many of which have to do with attention.

At the moment of experience, our attention indulges in some details over others. The same thing happens when we're operating on automatic. This is why you'll search frantically for the glasses you pushed up on the top of your head moments before. You do this automatically, and so it doesn't require your attention. This type of memory failure is especially likely when our attention is divided among multiple tasks and, thus, none of it sticks.

For those experiences that make it into memory, there are still a range of ways they can be forgotten. Forgetting can happen as the result of decay, as details fade and retrieving the right remnants of experience becomes increasingly difficult, if not impossible. Forgetting also happens because of interference, which occurs when experiences that happened either before or after the information you're trying to recall interfere with retrieval.

There are two different kinds of interference: proactive and retroactive. During proactive interference, old memories interfere with the recall of new memories, such as when you can't retrieve a new password because the old one keeps coming to mind. By contrast, during retroactive interference, new memories interfere with the recall of old memories, such as when you can't recall the names of former students because the names of current ones get in the way.

Ineffective retrieval cues can also be a cause for forgetting. The memory is there in storage; you simply can't come up with the right cues to trigger it. Lack of effective retrieval cues is also why we often forget things we're supposed to do in the future, such as forgetting to take the casserole out of the oven in 20 minutes.

Lastly, a process called blocking can cause us to forget. This is known as the tip-of-the-tongue phenomenon. This happens when we're trying to retrieve something and the memory feels right there, yet we can't access it because the cues we're using trigger associations that get in the way of accessing the memory we need.

The Functions of Forgetting—Cognitive Efficiency

Forgetting benefits us in three broad ways. To start, it helps make our cognition efficient and orderly. When we search for memories, we tend to get recent memories because they are more accessible and easily retrieved than remote memories, which are less readily recalled and thus more likely to have been forgotten. This tendency is useful because our most recent memories tend to be the ones most relevant to our present-day lives.

Context also plays a role in giving us those memories that are most relevant or useful in the present moment. We can recall extremely remote things, even from our childhoods, but such retrieval is often triggered by strong contextual cues. Forgetting remote memories is helpful because usually we don't need or want them, in the present, to come to mind. They would only get in the way. When the context is gone, so is easy access to the memory. Only the present context matters. Thus, this process makes the memories we'll most readily retrieve in tune with the present context and causes us to forget those that are not currently relevant.

There's also a second way that forgetting makes us more cognitively efficient. As we use our memories to understand the present and make predictions about the future, remembering every detail of every experience wouldn't be helpful because it would prevent us from generalizing the details to new situations. To help use our past experiences in the future, our brain washes out the details of specific episodes and retains the gist so that we can apply the memory to novel situations, not only those that exactly match what happened.

Our brains abstract across our experiences to form generalized memories for concepts and episodes that can be flexibly applied to novel situations. Otherwise, to make decisions or reason, we'd have to juggle infinite details across multiple similar instances. That would be too overwhelming and too static of a solution to work in the complex and constantly changing environment we live in.

The Functions of Forgetting—Emotional Health and Sense of Self

The second major benefit of forgetting is that it guards our emotional health and sense of self. Consequently, the experience intrudes less into our thoughts, and when it does, what seeps in carries much less of an emotional toll than the day it occurred.

Forgetting helps us regulate our emotional state. Since memories elicit emotions, it seems like we'd want to remember more positive than negative experiences, thereby ushering in positive emotions more often than negative ones. Most people do exactly this: We selectively forget negative experiences. Even though we remember highly negative events more vividly than positive ones, most of us remember two times as many positive experiences as negative. Remembering positive past experiences not only brings about positive emotions in the present but also inoculates us against negative emotions by helping us forget competing negative experiences. That is, retrieval of positive experiences interferes with the retrieval of undesirable negative memories. Remembering good times blocks the way for bad times to come to mind. The less bad times are recalled over time, the more likely they are to fade.

This doesn't mean that all negative memories should be forgotten. Some such memories help us avoid future negative events. However, not everyone is equally adept at selectively forgetting the negative. In fact, difficulty squashing negative memories is associated with maladaptive behaviors, such as rumination and worry, and the diagnosis of mental health conditions, such as depression and posttraumatic stress disorder (PTSD), where the full force of the memory network that triggered the condition can be reactivated, provoking a heightened and incapacitating emotional response.

Forgetting also protects our sense of self. Our view of ourselves is largely dependent on our personal memories. They form the foundation of our identities. They shape what we think we experienced and, consequently, what we think we are capable of in the future. We revise our memories of the past in a way that pulls us toward a stable self-concept. When our memories don't match our self-representations, we not only modify our memories but also forget parts of them. These two processes work in tandem to minimize challenges to our self-concepts. Forgetting assists at retrieval by advantaging those memories that are consistent with our views of ourselves while disadvantaging competing memories that are at odds with our identities. Then, those memories that we don't recall—the ones that challenge our self-narratives—become increasingly inaccessible over time.

Forgetting, Creativity, and Reminders

The third and final benefit of forgetting is that it fosters creativity by letting go of old memories and creating a space for new representations to form. For instance, if you're shown a coffee mug, you're likely to recognize it as a cup that holds coffee. However, other than this most common function, what else could you use it for? Forget that a mug holds coffee, and you can come up with a planter or a candle holder.

Getting stuck on what's known, or a mental fixation, happens when you try to solve a problem the same way again and again. Consider the candle problem: You're given a candle, a box of thumbtacks, and a book of matches and asked to attach the lit candle to the wall. Most people try to solve the problem by attaching the candle to the wall with the tacks or gluing the candle to the wall by melting it. However, the real solution is to use the box as a candle holder. Tack that box to the wall and put the candle in the box. However, few people get this right. Why? Because the box is seen as the thing that holds tacks. Most people are too fixated on this function of the box to see it any other way. This is exactly why our ability to forget can get us to new, innovative solutions. It allows us to look at problems and create solutions unencumbered by existing representations.

A good memory isn't one that never forgets. A good memory is one that retrieves the right memories at the right time—and doesn't retrieve memories that are burdensome or irrelevant to your present lives. This is why you shouldn't be worried if you walk into a room and you forget why. Of course, forgetting something important can be disastrous. However, the key is simple: Remind yourself. Set a buzzer or other device that will jog your memory at the right time.

This also applies to the rest of life. All of the anxiety that's been generated about memory has made people feel like they're cheating if they create to-do lists, use sticky notes, or put reminders in their phones. However, knowing what our memories can and can't do, this is good practice. Outsource these jobs. Your brain can't handle them. Conversely, toughing it through the cognitive anguish of coming up with it on your own won't keep your memory system strong.

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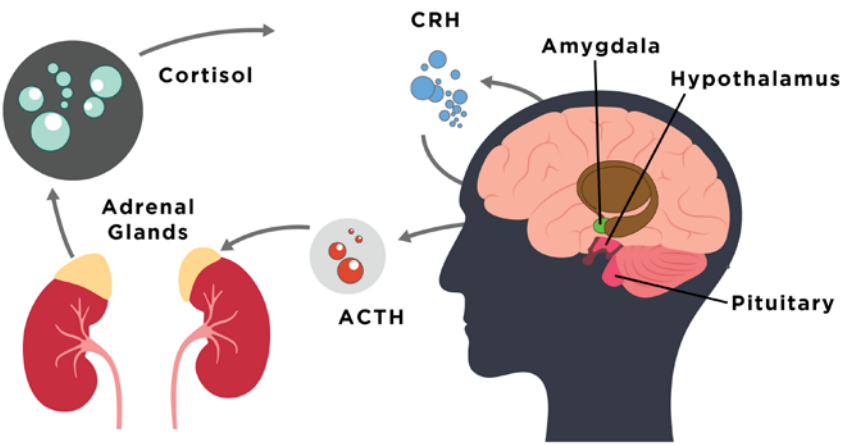
Memories of Emotional Experiences

Do you remember where you were, what you were doing, and who you were with when the terrorist attacks occurred on September 11, 2001? Each detail of such a highly emotional experience seems permanently etched into your memory in vivid color. Memories of emotional events of personal or national significance are known as flashbulb memories, reflecting the idea that you capture every detail of emotionally significant events in the instant they happen and retain them in a way that lets you forever look back at them with photo-like perfection. In this lecture, you'll learn how such an intuition is wrong. Despite your memories of emotionally significant experiences often being vivid and lasting, they're not necessarily accurate. They are subject to change as time goes by. In fact, under some conditions, memory of emotional events is highly susceptible to distortion.

Memory and Emotional Events

When we experience high levels of emotion or stress, our brains have a security system that functions to keep us safe by preparing us for action when it senses a threat—the hypothalamic-pituitary-adrenal (HPA) axis. When an experience trips our emotional alarm, our hypothalamus—a collection of neurons deep in our brains that controls many of our basic drives—triggers the pituitary gland. This stimulates the adrenal glands above our kidneys. The adrenals then release stress hormones, making us feel alert, focused, energized, and ready to go.

Even though the sorts of experiences that activate the HPA axis can be extremely fast, such as a punch in the gut, the stress response has both immediate and longer-lasting effects. In the immediate moment, the increase in focus enables us to deploy greater attention to what's going on around us. The chemicals released at the onset of stress also keep our brain in a more activated state for some time beyond the event itself. This extended activation is important because it helps us consolidate or stabilize our memories of emotional events. This makes them not only more enduring but also more readily brought to mind later.



The amygdala, an almond-shaped structure on both sides of our brain that facilitates activation of the HPA axis, processes and codes the emotional aspects of our experiences. It paints the bland aspects of our memories, such as time, places, people, and things, with emotional color, giving them their vividness. It also shades our memories of negative emotion most vividly. Emotionally positive experiences tend to be represented less vibrantly in our heads. Holding on to memories of emotional events, particularly when they're negative, has value. For example, remembering experiences that evoked fear can protect us from making bad decisions that could get us injured or killed.

We also play a role in making our memories for emotional events persist. We tend to use these memories more than our memories for ordinary events. That is, we more often think about, ruminate on, and recount to others our most emotional experiences. Every time we use or activate a memory, we make it more enduring and more likely to be brought to mind again in the future.

However, none of this enhancement means that our emotional memories are immune to change. Despite this, our confidence in the accuracy of our memories for emotionally significant events is often as high when they're right as when they're wrong. In addition, the disparity between how accurate our memories are and how accurate we think they are operates at maximum strength for emotional memories. Memories for emotional events are coded in vivid detail. It's this vividness that gives us confidence, but when an experience trips our emotional alarm, vividness is no longer a reliable marker of accuracy.

This is, in part, because of the power of mental imagery. Mental images are highly memorable. However, they can bring about memory errors precisely because they are quick to generate and readily retrieved. For instance, when we think about an emotional flashbulb event we heard or read about but didn't see, our brains conjure up mental images of what it must have looked like. Then, later, the ease with which these made-up images come to mind makes them feel familiar and makes us prone to mistake them as genuine memories of experience.

Errors can also seep into our emotional memories because the heightened attention that arousal brings is not universal—it doesn't apply to everything around us. In fact, it's narrow. It gives us a soda-straw view of the world that closes in on the most central and emotionally arousing information. Consequently, we remember this subset of our experiences well. However, this benefit comes with a cost: We trade vivid memory of central details for poor memory of peripheral details.

Emotional Arousal and Memory Amplification

If emotion can enhance memory, might turning up arousal to the max give us flawless memory, safe from decay or interference? Although mild to moderate arousal can enhance memory, when stressors become too large or prolonged, memory fails. Under these conditions, our attention is prone to shift from the experience itself to attempts to regulate emotion, endure the experience, or even survive. Such an extremely narrow focus results in terrible memory for what is happening.

Field studies show that not only can high arousal hurt memory, but it can also leave people highly susceptible to misinformation. Not only are our memories of highly emotional events vulnerable to substantial error, but also even highly mentally disciplined individuals are susceptible to the distorting effects of misinformation. In fact, distortions of extremely arousing events follow a particular pattern: People tend to remember more trauma over time, a phenomenon known as memory amplification. This effect has been demonstrated in diverse samples, including military personnel who have endured combat and witnesses to a school shooting.

Memory amplification is important because it comes with consequences beyond memory: The more amplification people show, the more likely they are to report reexperiencing symptoms associated with PTSD, such as recurrent and intrusive thoughts, flashbacks, and nightmares of the trauma. Why would people who have experienced trauma remember more trauma with time? Shouldn't normal forgetting kick in? Yes, but what's likely going on is a failure in people's source monitoring.

Memories of traumatic events are highly likely to be reactivated, often in a deliberate manner. Each time, we risk exposing ourselves to details that were not part of our original experience. Traumatic memories are also frequently reactivated in unintentional ways through intrusive thoughts or memories that can take the form of images. Sometimes, these spontaneous memories will reflect genuinely experienced aspects of the traumatic event, but they may be memories of images generated from others' stories or the news. Either way, recollections of related images can, over time, come to feel as familiar as those of the original experience, increasing the likelihood that we misjudged them as genuine recollections of the past.

Conditioning Trauma and Fear

The stress response that happens when we experience danger can not only enhance memory but also cause trauma. Our stress response is generic. It isn't designed to make us fear any one thing or set of things, which means that we can come to fear anything. This flexibility is incredibly adaptive. That does make it useful because the experiences likely to activate our stress response system today, such as a gunshot, didn't exist when this system evolved. However, this flexibility can also cause us to fear ordinary, safe situations. It can cause trauma because of the ease with which memories for stressful events can become attached to our fear response.

A well-known psychological finding is that of Ivan Pavlov, who, through research on dogs, helped to identify the process of classical conditioning. Give a dog food, it salivates. Ring a bell, and the dog doesn't salivate. However, pair the ringing of bell with food enough times, and the dog will come to salivate in response to the bell. This is how fear and trauma can be formed, except, unlike Pavlov's dogs, you don't need many pairings. You can get what's called one-trial learning. This fast learning serves to minimize the number of times we get ourselves into danger. We only need one broken femur from a fall down an uneven set of stairs to never again forget to walk carefully down that set of stairs.

However, the system can go wrong: One highly emotional experience, say, one bad breakup, and you've got an intense reaction in the moment it happens. However, now, the memory of this experience is wired in as a fear. The next time you try to commit to a romantic partner, all of the bad comes rushing back, and you're filled with panic. Despite this, we can unform fears by knowing a few things about memory.

The first step involves sharing the original memory, again and again, in a safe setting. This will progressively weaken its connection to the stress response. The first time people share a traumatic memory aloud, there's often a tremendous stress response—sometimes even greater than what the original event elicited. However, over time and with repeated retellings, the amplitude of the stress response progressively wanes until the memory becomes a boring, ordinary story, overriding the chronic stress response linked to it.

However, repeated retelling is not enough by itself to entirely alleviate a trauma. You also need to associate a new, positive memory or story to that previously fearful event. This is because when it comes to our stress response, story is everything. What we feel when the stress response is activated is nonnegotiable: Our heart pounds, our breath quickens, our muscles clench, and our armpits sweat. What is negotiable is the story we attach to why we're feeling what we're feeling.

Say you're in a bad accident biking to work. Not only do you no longer want to bike, you also don't want to go into work or even go anywhere. Repeatedly retelling the memory of this experience in therapy would work to reduce your stress response. That's step one. Step two is creating a new story, a positive story—not only that you bike to work but that you also enjoy the time alone to relax and recenter—and linking this positive story back to your memory of the previously traumatic experience.

Now, you're not only replacing a bad story with a good story, but you're also holding in mind these good stories through the next triggering experience. The linking of the positive story back onto the prior traumatic memory is key because this new story becomes attached to the old memory. This the previous fear response far less likely to occur and more likely to remain extinguished.

The lesson here is the power of story. We've seen how our brain tells us stories about what's out there in the world and what happened in the past. Much of this is automatic and out of our hands. However, we can deliberately use story to override reflex. We can grab the story reins and take control of how we react to things that evoke discomfort, fear, and even debilitation.

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Changing Your Memories on Purpose

Constructing our own versions of the truth, even when they're wrong, can be useful. For example, we revise the past when we've behaved unscrupulously to help us feel better about ourselves. Such distortions in memory are unintentional and happen without us intervening, driven by our own biases, beliefs, and goals—a natural by-product of the way our brains rebuild or reconstruct our past experiences in the present. In this lecture, you will explore the following question: What if we deliberately massaged our memories to remember things differently from how they truly happened?

Modifying Memory for Positive Improvement

Scientists who study false memory can provoke us into remembering things that never even happened—not only false details but also entire events. The purpose of these false memories is to better understand how well or poorly people remember stressful experiences or how much we can rely on our memories of traumatic experiences. Recently, however, some scientists have begun to ask whether the memory-modifying techniques they've discovered to implant false memories could be used to improve our lives.

To tackle this question, researchers asked a group of people to complete a personality questionnaire and a food history inventory. A week later, they invited everyone back and told them that their survey information had been fed into a supercomputer that had generated a personalized profile of their early childhood food experiences. This, of course, was a lie. The profile was merely a vehicle to suggest to some people false information about a past experience with ice cream. Specifically, some people were told that the supercomputer had determined that, as children, they had gotten ill eating strawberry ice cream.

Finally, everyone was asked to complete the food inventory history again and a food preference questionnaire. In comparison to control participants who received no false information about ice cream, nearly half of the people who believed the false feedback later reported less willingness to eat strawberry ice cream at a party and less general preference for strawberry ice cream. These findings show that with a simple one-time suggestion, you can turn people away from a food as delightful as ice cream.

False Memory and Behavioral Change

Thus far, the only thing that researchers have measured is people's self-reported intentions—that is, how willing they'd be to eat the food at a hypothetical party or buy it at a hypothetical grocery store. However, can implanted false memories change not only what people say they'll do but also what they do?

The answer is yes. It seems that the simple "you got ill eating X food as a child" suggestion can cause people to eat less of that food compared to those who didn't get the suggestion. It's been shown to affect behavior at least four months after hearing the suggestion. Findings such as these demonstrate the power that deliberately procured false memories can have on our behaviors. However, do they mean that we can address health problems such as obesity with false memory therapy?

On paper, it seems like they might hold some promise for those interested in changing their eating behavior. However, it may not be so easy to get people to believe suggestions about their pasts that they know are not true. This is exactly why false memory researchers have to sell a cover story to their study participants before presenting them with untruths. In addition, a therapist can't ethically deceive their own patients on purpose, even if it's for their own good. Regardless of how you feel about the ethics of false memory techniques, putting these procedures into practice would be tricky at best, perilous at worst.

False Memory and Physical Pain

Evidence is emerging that other types of implanted false memories can have interesting consequences. One area where there is growing evidence is with physical pain. Pain isn't always bad, and it can show many important things, such as that our hand is too close to the fire. However, there's other kinds of pain that we'd likely be better off without, such as the constant pain that can happen with advanced stomach cancer.

We already know from our everyday lives that the experience of pain can be modulated by a range of factors and that our state of mind can affect our perception of pain. Our current levels of pain can also influence our memory of past pain. If we're in a great deal of pain in the present, we tend to recall the past as being more painful than it was. If we're having a good day pain-wise, we tend to remember the past as less painful than it was.

To test the idea of whether others can toy with our memory for pain, researchers asked people to hold their hand in a bucket of borderline-freezing water for 90 seconds. This is a frequently used experimental pain induction technique

known as a cold pressor test. Following the cold pressor test, people were asked to rate how much pain, distress, and positive and negative affect they felt on a 100-point scale. Later, people were reminded of their pain rating and asked to elaborate on why they rated their pain the way they did. Some people were told that they had rated their pain 20 points less than they in fact did. Interestingly, most didn't notice. People who had been misinformed about their pain rating recalled feeling less distress, less negative affect, and more positive affect and were more willing to repeat the study tasks again in a future experiment.

Findings like these show that our willingness to repeat painful experiences depends more on our memory for our affective reaction during the event than our actual experienced pain. This could be good news in medical settings. Mild suggestions could perhaps be used to increase compliance for routine yet painful medical procedures. Suggest to people that they experienced less pain than they did, and they may be more willing to seek out medical care in the future.

Emotional Pain and Reducing Trauma

The drug propranolol, a beta-blocker, has been used since the late 1980s or so to treat acute anxiety. It blocks the activation of the amygdala, which is important to our memories of stressful experiences because it's the brain structure that gives them their emotional color. Without the amygdala, we simply have facts without feeling. If you reactivate the traumatic memory (or fear) but turn off the amygdala, when this memory goes back into storage, it has lost its emotional color. The process of retrieval puts the memory temporarily into a plastic or flexible state that makes it, at that moment, susceptible to modification. This is how all misinformation studies work—by exploiting the moment of plasticity of recalled memories.

With regard to emotional pain, therefore, it's reasonable to ask whether propranolol might blunt the fear response enough so that one's memory for negative experiences doesn't cause trauma. However, how do you study this exactly? Extremely distressing events, at times, happen naturally to some of us. What if we go to people at the site of a stressful experience and try to blunt the fear response as the memory is being consolidated or stabilized in their brains?

This is exactly what Harvard University psychiatrist Roger Pitman did. He and his colleagues found people admitted to an emergency room for traumatic injuries, such as car accidents and assaults, and recorded interviews with them about what they experienced. Then, within 6 hours after the event, they began a 10-day course of either propranolol or a placebo. After 3 months, people who were given the drug experienced significantly reduced PTSD symptoms over those who weren't. Specifically, people were asked to listen to their recorded interviews. None of the people who had been given propranolol showed strong responses to their recordings. By contrast, most of the people who were given the placebo were noticeably shaken by hearing their narratives, experiencing physiological symptoms of PTSD.

These findings feel particularly promising for survivors of trauma. They hint at the benefits of giving propranolol to soldiers traumatized by combat or victims of assault, rape, bombings, or burns. However, there are also limitations. Pitman's participants were given propranolol within hours after the event. What about people whose trauma is further in the past?

Every time we recall a memory, the reconstructive nature of that process makes the memory pliable again—letting it be strengthened, weakened, or otherwise altered. Researchers asked people suffering from chronic PTSD to describe their traumas in detail, to activate the memory and put it into a temporarily malleable state. At the same time, these patients were given either propranolol or a placebo. It turns out that both groups retained the factual details of the event equally well, but the propranolol group showed a significant decrease in physiological PTSD symptoms. These data illustrate that that propranolol can mute the distress caused by traumatic memories while sparing the facts.

Researchers have begun to use this sort of therapy not only with those with PTSD but also with the romantically brokenhearted—particularly those who have gone through infidelity or some other form of deception and are stuck obsessively reliving their painful betrayals in their minds. Like those with PTSD, many heartbroken sufferers feel relief after popping a propranolol (or six over a 6-week period) and reading aloud the memory of their betrayal each time. The memories aren't gone, but their intensity is reduced to a level where they no longer trigger symptoms. This type of therapy is now known as reconsolidation therapy.

In addition to treating victims of trauma, propranolol might be helpful in the treatment of issues such as phobias and addictions or in liberating people from debilitating grief or performance anxiety. However, what if we could erase those distressing memories altogether? This possibility is creeping closer to reality.

Our bodies need to continually recreate a protein called protein kinase M zeta (PKMzeta) to keep information stored in memory. Without it, we'd forget. A drug known as zeta inhibitory peptide (ZIP) neutralizes PKMzeta, and researchers have used it to erase all sorts of memories—locations, motor skills, fear, and physical pain—in rats. Has it been used in humans? Not yet. ZIP wipes out all memories in the part of the brain it enters, not only the recollections you want to erase. That said, there are ways to block the production of PKMzeta. Thus, one day, we may be able to activate a certain memory in a patient while giving them a drug that inhibits the production of PKMzeta so that that memory returns to storage in a weaker form or even completely fades.

However, whether this would work, or should be applied, in humans is very much in the "if" stage. Obliterating an entire memory with a drug might be something we want to be careful about. The same goes with techniques for deliberately modifying memories of the past with verbal suggestions. Since our memories of our pasts make up who we are, if we wipe a few out, we could change our personality or threaten our selfhood.

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Memory, Evidence, and the Law

In the legal system, misremembering can have dire consequences, particularly in cases involving young witnesses. Understanding the conditions under which young children's memories are vulnerable to the false suggestions of others is important. In many of the criminal offenses of which young children are victims, children are the only witnesses, and their memory is the only evidence against defendants. In this lecture, you'll explore how young children's memories can be influenced by others and the implications of these findings for understanding why and how others can lead victims, eyewitnesses, and suspects of all ages to remember past wrongs.

Confirmation Bias

A stream of research exists that focuses on how others can unknowingly shape children's memories to fit with their own beliefs about what happened. This occurs most often in cases involving allegations of sexual abuse, when adults believe that a child has been molested—based on their own suspicions—and mold their conversations with children to elicit statements about the past that confirm that belief. This belief can be incredibly powerful. It can cloud adults' judgment and drive them to make suggestions in line with that belief. They ignore denials of abuse or interpret them as evidence that the child is withholding the truth because they're too afraid to tell. If the child continues to deny, adults ramp up the pressure until the child acquiesces. The problem is that adults' beliefs can be wrong. Such questioning can produce false memories in children that can be devastating.

Why would an adult pressure a child so aggressively? Because they have fallen prey to confirmation bias—the tendency to seek, interpret, and sometimes inadvertently create evidence that confirms their beliefs and to ignore or reinterpret contradictory evidence. This bias often gets triggered in complicated, unclear, or emotionally charged situations, such as suspected child sexual abuse.

Consider, for example, the infamous case of preschool teacher Margaret Kelly Michaels, who was convicted of sexual abuse against her students at the Wee Care Day Nursery in Maplewood, New Jersey. After Michaels spent 5 years in prison, her case was overturned. According to the ruling, the record of interviews showed that all allegations of abuse were made only after the children had been repeatedly and relentlessly questioned by police interviewers who believed that Michaels was guilty. Confirmation bias was at play from the get-go.

Concerns about forms of suggestive questioning in the Wee Care case and similar cases in the 1980s and 1990s led developmental scientists to design studies exploring how the questioning strategies used in these cases might influence children's testimony. The overriding theme that emerged from this work is that when interviewers hold preexisting beliefs about what happened, they are prone to communicate their beliefs to children via particular questioning techniques that can lead to the children relaying false memories in an extremely compelling and detailed manner.

Prompted by these findings, researchers developed empirically based forensic interview protocols that encourage interviewers to use open-ended prompts to maximize the amount of information children provide in their own words and to avoid suggestive questioning techniques. These protocols effectively minimize errors in forensic interviews, but they don't solve the problem that most allegations of child sexual abuse first arise during interactions with a non-offending parent, usually the mother. Parents, like interviewers, are prone to developing beliefs about what happened before they question their children. This can create false allegations even before any formal interview takes place and, worse yet, can bias the interviewer's beliefs and line of questioning.

The Forensic Arena

Research has demonstrated that a single subtle suggestion to parents can intrude into children's later reports and inspire the invention of new details—that is, details that were never suggested by parents but rather generated by the children themselves. This latter finding is important because some legal professionals argue that you can tell when a child has been influenced by an adult because they parrot the adults' suggestions verbatim. Research findings demonstrate that this argument is baseless.

In addition, it's a natural tendency of parents to fill in the blanks in their children's remembering with what they believe happened. They supply new details, offer their own interpretations, ask forced-choice questions, and provide their own speculations—confirmation bias at work. In everyday exchanges, these tactics are usually harmless, if not helpful, in guiding young children's contributions during conversations about the past. However, in the forensic arena, they can have grave consequences.

Why would a parent come to develop a belief that abuse occurred if it never happened? Countless websites, books, and articles offer lists of "indicators" of child sexual abuse that are remarkably long and include behaviors such as bed-wetting, thumb-sucking, sleeping difficulties, and stomachaches. These lists may make intuitive sense to parents who see worrisome behaviors in their children. However, there is no clinical or scientific evidence that any behavior or any set of behaviors is specific to child sexual abuse. The same behaviors are seen in non-abused children for all kinds of reasons.

There was a child sexual abuse case in Indonesia in 2015 with all of these earmarks of children who had been pressured into false testimony and had formed false memories, but the alleged perpetrators confessed. Does that mean they were guilty? Unfortunately, false confessions occur more often than you might think. Why would someone do this? Essentially for the same reason non-abused children can end up making false claims of abuse: They're questioned by someone who has a preexisting belief and doesn't stop until that belief is confirmed. Specifically, police with a strong but false belief in someone's guilt can lead that person to confess and to lose their liberty and even their life, even if they're absolutely innocent.

Interrogation Technique and Internalized False Confessions

Police are prone to developing a belief in guilt based on someone's demeanor. When they do, they approach the interrogation as a tool to secure a confession, not a means to get to the truth. However, ample research has shown no connection between any specific behaviors and guilt. When you look at real interrogations, you quicky see that the interrogators fall back on a set of coercive techniques they've been trained to use that make it less stressful to confess than deny.

When a suspect immediately denies the crime, typically, what a detective will do is call that person a liar. The suspect will repeatedly be accused; the detectives will insist on hearing the details, and they'll ignore all denials. This process will proceed relentlessly. In these interviews, detectives may ask loaded questions that presume the suspect's guilt. Note, too, that in the United States, police can lawfully lie to suspects about evidence, and the courts have not put any boundaries on it: You can tell major lies, you can lie repeatedly, and you can lie to children.

What can happen at this point—when you tell an innocent person that you have all this overwhelming evidence against them—is that you trap them. An innocent person will confess because they feel they have no other choice. It's rational to confess under these circumstances. If you're innocent and believe in a just world, you're likely to think that justice will prevail and the truth will come out in the end.

The problem is that once somebody confesses, people believe the confession is true. They don't appreciate the power of a situation to overwhelm people into a false confession. Nobody trusts a recantation as much as they do a confession, especially if the confession contains facts that are accurate with regard to the crime and not public knowledge. If you go back and look at DNA-exonerated people who falsely confessed, you see that this is exactly what happens in the vast majority of these cases. How could this be? The police also know these facts and often show crime photos or share other evidence during an interrogation, resulting in these details finding their way into innocent people's confessions.

In some of these situations, a suspect deliberately makes a confession to get out of the situation, but they still know they're innocent. The metric of this is that they recant as soon as the pressure of the situation is lifted. However, in other situations, the interrogation affects people's memories—much in the same way that recovered memory therapy does. Think about it this way: Detectives may be lying to you about the evidence, but they present details. You visualize what it must have looked like, but you have no memory of the crime. This fractures your reality. Presented with such overwhelming evidence, you start to believe that it must be true. Source confusion kicks in. Soon, everything about the story feels like a memory, and therefore, you believe it is one.

These sorts of false confessions, where innocent people come to believe they committed the crime, are known as internalized false confessions. These sorts of confessions can take the form of full-blown narratives made up of not only details suggested or seen through the process of interrogation but also fabrications that go beyond these details but nonetheless are consistent with the crime. These sorts of confessions also often contain physical reenactments, hand-drawn maps, apologies, and expressions of remorse.

Questioning the Criminal Justice System

Ample experimental evidence shows that lineup administrators who know who the suspect is in a case may inadvertently convey this knowledge to eyewitnesses. Compared to administrators who don't know who the suspect is, they are more likely to ask witnesses about the suspect than about the other people in the lineup. They are also more likely to smile when eyewitnesses are looking at the suspect rather than at another person in the lineup. These behaviors are often inadvertent, and neither eyewitnesses nor administrators usually know they're happening. Nonetheless, they influence eyewitnesses' decisions by making them more likely to choose the suspect.

In addition, witnesses may receive confirmatory feedback from administrators following their identification of the suspect. Research has repeatedly demonstrated that simple confirming statements have powerful effects on

eyewitnesses' testimony. Not only do they inflate eyewitnesses' confidence in the accuracy of their identification, but they can also lead them to wrongly remember having been that confident all along.

This evidence likely goes against everything you believe—or want to believe—about the criminal justice system. However, our judicial system mistakenly seems to prioritize imprisoning someone—anyone—for a crime over imprisoning the guilty party. Further, when an innocent person is convicted, it leaves the criminal free to strike again. If you look at the DNA hits on actual perpetrators who are left to go free, you see stunningly high numbers of further offenses: homicides, sexual assaults, and other crimes that never would have happened had we gotten it right the first time.

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The Virtues of Misremembering

Memory works in unexpected and often downright counterintuitive ways. Your memories sometimes omit things that clearly happened. They sometimes serve up recollections that don't square with the facts of what you previously experienced. Sometimes, they manufacture events that never even happened at all. In this lecture, you will explore why this might be the case. There's no question that your memories are important to you, and most of the important features of living things have evolved to serve a useful purpose. From this perspective, what purpose is served by an oddly quirky memory that's only partly accurate?

Memory as a Reconstructive Process

Memory is a reconstructive process. It's never a matter of simply accessing, retrieving, and playing back a static record of a stored slice of the past. Rather, we reconstruct our pasts by piecing together the remnants of experience available to us in the moment of recollection. Every reconstruction is shaped by a range of factors, including the search cues we use; our present knowledge, attitudes, and goals; and our current state of mind or mood. Because each of these factors is dynamic and ever-changing, we'll remember the past today differently, if ever so slightly, from how we remembered it yesterday and differently from how we'll remember it tomorrow.

It's this reconstructive process that can lead us to make an array of memory errors, ranging from mistakenly believing we've experienced events we did not to generating detailed memories for experiences that never happened to anyone ever. There are also a myriad of routes to getting it wrong. For example, the cues we put in might pull up bad information. Our own biases or beliefs can twist the way we rebuild the past, and we may generate guesses, inferences, or images that we misremember as actual experiences.

Our memory system has a deep history. The earliest versions of it first appeared in animals hundreds of millions of years ago, and it has been tweaked across evolutionary time until it became the system that operates inside us today. It's possible that our memory errors are a bug rather than a feature. However, considering how heavily we rely on memory every waking moment and how constantly memory errors shape and reshape our lives, that seems highly unlikely.

Three Functions of Autobiographical Memory

Memory magically frees us from our present and makes it possible for us to relive, resee, and refeel our pasts. Although the process of memory reconstruction can sometimes shape our pasts in ways that can't be true, it

turns out that these nontruths can, at times, be functional. In fact, they can have great value. Generally, autobiographical memory is thought to serve three different categories of functions: self, directive, and social functions.

The first class of functions concerns the self. Our memories of our personal past shape our sense of who we are. Starting at a young age, parents teach children how to use their personal memories to construct a continuous sense of self and share their own memories. Our memories of the past also help promote self-change, especially when we get ourselves in a bad spot. In addition, we use our memories to regulate our own moods or emotions. For instance, we can recall positive memories to boost positive and quell negative emotions. Parents also encourage children to use their memories of the past to manage their own emotions. We can teach children to look for insights into other people's emotions by reflecting on their own pasts.

The second class of functions of autobiographical memory is directive. We use our memories of the past to help us solve problems in the present or to inform our future behavior. We do this by generating memories of the past that can help us decide what to do. The future works out fine when the right memories come back at the right time to help us make the right decision. When we retrieve the wrong memories, we will fail to predict the future. That's when things go awry.

A third function of autobiographical memory is its social value. Sharing our memories with others builds interpersonal connections. When we exchange pieces of our past with someone new, they learn about us, and we learn about them. Sharing the past, especially our shared pasts, with those we know well helps us maintain and even strengthen our bonds with one another. Relaying our personal past can also help us develop empathy with each other.

What this brief analysis tells you is that memory is for much more than providing an accurate record of the past. The real gauge of successful remembering is not accuracy; rather, it's the extent to which memory has met self-image needs, informed present or future plans, or nurtured our relationships. At times, this means remembering the past wrong. False memories can serve our current selves, our planning, and our social needs.

The Value of Memory Errors

Considering the self function, how can our memory system's flexibility be of value to our personal identity? One example of this phenomenon is our tendency or bias to recall our past selves as inferior to our present selves, even when our past selves objectively were not inferior. By depreciating our former selves, we appraise our current selves more favorably, giving us the feeling of improvement even if there was none or in the face of actual decline. This fosters optimism about the future. Someone with an exact memory of the past might not be inclined to work hard to better themselves over time if their memories don't adjust their past status downward and make them feel improvement.

For example, consistency bias can affect our judgments of pain, biasing us to recall our past levels of pain more in line with our current levels rather than accurately. We do this because we tend to infer our past beliefs, feelings, and attitudes from our present states given that the present more readily comes to mind than the past. This shortcut, even though it can lead to false memories, can help our sense of self. Consistency bias can make us forget that we previously held a particular view once we no longer agree with it. In certain situations, if you didn't adjust your memory of your past self to fit your present self by forgetting your previous views, you might suffer a destabilizing effect on your identity. To some extent, our self is artificial because we can never get an unbiased depiction of who we truly are (or truly were). However, if our recall were perfect, our memories would never be able to add in a little fiction to make ourselves feel better.

With regard to the directive function of our memory errors, it seems that the problem-solving and planning functions of memory require accurate recall. However, if we could call up only intact event replays, they'd be useless. Life's experiences rarely occur as direct replications of prior episodes. If we had to base our current actions on establishing a precise match to detailed earlier circumstances, we'd be in trouble. The only way we can use the past to direct our current and future behavior is to flexibly apply aspects of our past to our present and future.

Having the dynamic capacity to reconstruct our memories not only allows us to reexperience our pasts; it also endows us with the flexibility to imagine possible futures. Our world is constantly changing. The exact same moment

will never repeat itself. Thus, to the extent that our memories serve a directive function, frozen representations of the past will never help us in the present or future. Our ability to continuously alter our pasts is vital for us to adapt to our shape-shifting worlds.

With regard to the social function of misremembering, most social settings encourage some degree of inaccuracy. Accounts of the past with exaggerated or even fabricated details can be more engaging to conversational partners than exactly veridical reports. We also know that there are socially driven distortions that serve to nurture interpersonal bonds. For instance, when we remember the past together with others, the group negotiates a collective version of experience. Consequently, individual memories are revised to become progressively alike among group members. The shared representation of the past that you all have created leads to a common history (or shared reality) that reinforces group cohesiveness.

We also do the same at larger group levels. For instance, when asked about the United States' invasion of Iraq, more Americans than Australians or Germans falsely remembered there being evidence that Iraq had acquired weapons of mass destruction, perhaps to justify their country's actions. Whether or not that's a net positive, it strengthens our cohesive national identity. We also tend to generate richer and more detailed memories when we remember within familiar groups, such as friends and family, than when remembering alone. This happens because when individuals repeatedly experience and remember events together, they develop a collaborative system for encoding, storing, and retrieving shared events. The result is memories that contain more and different information than if each individual were remembering alone.

Closing Thoughts

The common belief when memory doesn't directly mirror reality is that something has gone wrong. However, memory is sensitive to context and designed to purposefully veer away from the truth when that serves important goals—self, directive, and social goals. From this vantage, memory may be operating perfectly properly when it provides a false report if that

misrepresentation benefits the rememberer in the context in which the memory is being used. There's a myriad of ways that our misrepresentations can benefit us, our social groups, and society at large.

The lesson here is that quite often, something adaptive is going on when our memories distort reality. Therefore, what we need is a pivot in our thinking about memory. We need to move toward a view of memory that acknowledges its representational ability but that also more fully values its flexibility—a view that recognizes the aspects of memory that we call error as keys to understanding our memories, ourselves, and our well-being.

This perspective also requires a redefinition of what a memory error is. A memory error occurs not only when recall doesn't match reality but also when a person recalls something in a way that does not serve them well in the current moment, which may or may not be the same thing. From this vantage, both highly accurate and constructive memories can be "wrong." Thus, the new yardstick of error is whether the memory serves the rememberer.