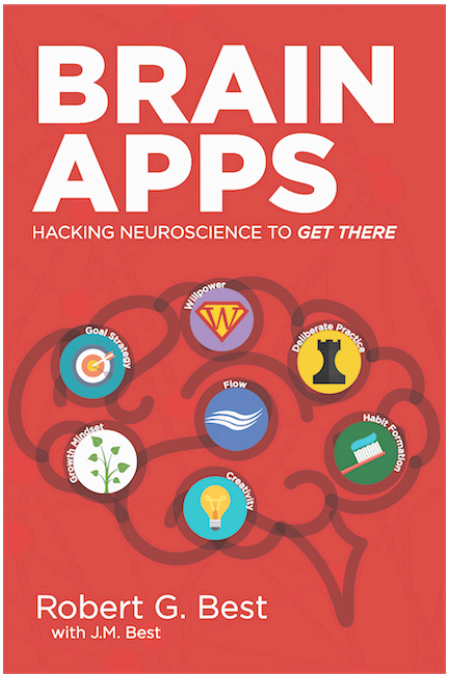

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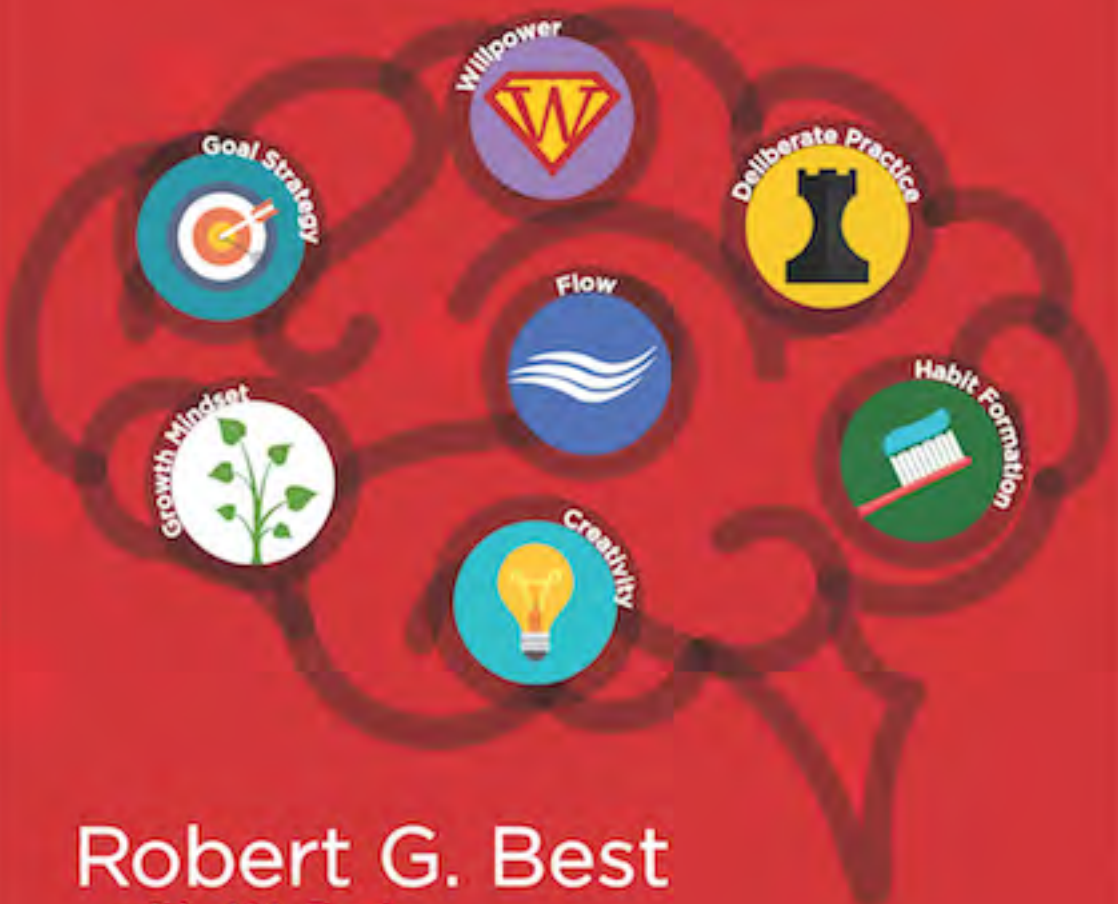
Brain Apps: Hacking Neuroscience To Get There

by Robert G. Best and J.M. Best

BRAIN APPS

HACKING NEUROSCIENCE TO *GET THERE*



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with J.M. Best

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Contents

Chapter 5
Habit Formation App

So far we've stoked the fires in the *pit of practice* and fanned the flames of our Rage to Master. Now it's time to convert our deliberate practice regimen into a full-fledged brain app, or habit. (We'll be using those terms interchangeably from here on out.)

Apps are what make your smart phone smart, and in much the same way, brain apps are what allow you to take better advantage of your brain's potential. Practice is crucial in creating new habits.

By now, you understand the basic process: practice builds repetition, which myelinates connections, which in turn, form habit. Habit is really nothing more than myelinated neural code put into action. But, of course, knowing how something works is not the same as actually doing it.

Brain Apps in Action

An estimated 47% of your daily behavior is driven by habit, bits of neural code that your reflexive System 1 uses to save analytical System 2 from expending unnecessary energy.[226] From flipping on a light switch to driving a car, you've built a whole series of brain apps that you rely on to function. And those simple bits of neural code can be stacked on top of each other to create more elaborate behaviors. The formation of those behaviors is difficult to detect because they generally run below your conscious awareness, but it's still happening all the time.

Psychologist B.F. Skinner famously illustrated this point when he taught a rat to react to the Star-Spangled Banner by hoisting a miniature American flag and saluting with its front leg.[227] The rat clearly did not attach meaning to these gestures; Skinner had taught the rat a series

of actions, which, when combined, created the impression that the rat was actually hoisting and saluting with intention. The rat had simply learned, through repetition and reward, to respond to certain cues.

Once a behavior becomes automatic, much of what we do is in a sense rat-like; we don't actually *think* about it, we just perform on cue.

For instance, it's unlikely you set out to watch TV for the typical three to five hours each night[228] and then actively practiced and perfected the technique until you mastered sitting in front of a glowing screen. Still, through repetitive action, your reflexive System 1, in essence, was busy practicing and building that TV app. It works the same way for Internet browsing, too.

If you stack your Internet app on top of another app, say evening snacking, we can start to see how the power of unintended habit programming has a dramatic effect on both our watching and our waistlines.

Habit Stacking

Habit stacking is the combination of several habits that trigger each other or are triggered at the same time. Although excessive snacking may be undesirable and can have consequences to our over-all well-being, other examples can have a far greater impact on our lives.

Imagine what happens if you've built habit stacks out of a variety of fixed mindset positions. If you've habituated operating out of a position of fear, and at the same time, you have a habit of shutting out critical input from others, you can see how habit stacks can quite literarily stack the odds of success against you. Then, when things don't turn out well, it feels as though there are unseen forces working to bring you down. This, of course, is correct; it's just that those forces are coming from within.

Studying habits work provides us with some important opportunities. First, we can trace behaviors back to the source and better evaluate their meaning. Second, we can consciously rewire neural code to offset the flaws and glitches in our current brain apps. It gives us a better chance

of becoming, as Pulitzer Prize-winning author David Foster Wallace once put it, "the lords of our tiny skull-sized kingdoms."[229]

Many of our habit stacks have built up slowly over our entire lifetime. This is because our operating code is being written, overwritten and amended every hour that we're awake—and in a very real sense, during memory consolidation while we're sleeping. From simple to elaborate patterns, we live by internal rules that often drive predictable, habituated behavior.

Again, it's important to remember that if you recognize your own behavior, you can take a far more active role in consciously constructing your own code.

When Your Habit Stacks Are Turned Against You

There are plenty of great sci-fi stories about sinister people manipulating the brains of everyday folk for their own nefarious purposes. Of course, that's science fiction, but what if some other entity, evil or not, also had the ability to hack your brain's habit code? It's not as far-fetched as you might think.

It all starts with metadata, an enormous repository of collected information about, for instance, common buying behaviors. Retailers and marketers are constantly scooping up such metadata, looking at how you've bought things in the past to predict how you will make such decisions in the future. Here we have an excellent example of how marketers are leveraging your habit stacks for their own monetary gain.

As *New York Times* writer Charles Duhigg recounts, one particularly savvy statistician named Andrew Pole provided that kind of leverage for the chain store Target,[230] with somewhat eerie results.

Target, it seems, had figured out the value of the childbirth cycle. From disposable diapers to strollers to organic baby food, it turns out that from a retailer's point of view, gaining the brand loyalty of a new mom really is like hitting the mother lode. With Pole's number crunching, Target ran "predictive analytics." By tracking purchase history of items like unscented lotion and prenatal vitamins, which tend to follow

certain distinct patterns, Target was able to make very good guesses about which shoppers were pregnant, down to the stage of pregnancy.

Armed with this intelligence, Target would, well— *target* the future mom. Where one might assume everyone on your block was getting the same sales flyer, in fact the company was sending some pregnant women specialized coupons and flyers with ads based on their current and future baby needs. This gave the mass merchandiser a leg up on the competition for the hearts and minds of expectant mothers. "We knew that if we could identify them in their second trimester, there's a good chance we could capture them for years," Pole told Duhigg.[231]

Duhigg notes that Target was also working another habit angle, based on the research of Alan Andreasen. In the 1980's, UCLA professor Alan Andreasen ran a study to examine people's purchasing habits regarding everyday products like toothpaste, soap and toilet paper.[232]

Andreasen's research showed that once a consumer's routine solidified into unconscious autopilot, shoppers were pretty much locked into buying a given brand. This, of course, was good news to stores like Target, provided they could establish that habit in the first place.

But there was another powerful piece of learning that came out of Andreasen's research. He found that when people underwent major transitions—a death in the family, moving, a new job, marriage, divorce, or, yes, having a baby—these adjustment periods made regular routines much more malleable. Changing someone's habit became more possible.

This was why Target was interested in catching consumers during key life events like pregnancy, when established buying patterns at non-Target retailers could be switched in their favor.

The company was on a roll until they unwittingly began to send coupons for baby-related products to a high school girl. Outraged, her father cornered the manager of his local Target store. But several days later, the father made an apologetic phone call to the manager after his daughter confessed that she was indeed pregnant. By chronicling her

purchases, Target had awkwardly shoehorned itself into a momentous event in one shopper's life—and in so doing, demonstrated another truth in business: the law of unintended consequences.

Of course, adjusting a group's habits can be beneficial in a variety of ways. When former U.S. Treasury Secretary Paul O'Neil was CEO of Alcoa, he helped the struggling company return to prominence on the Dow Jones Exchange by improving safety-related workplace routines. It led to a cultural shift in the organization and a renewed financial vitality. One of the factors that helped Coach Tony Dungy take the formerly terrible NFL Colts to the Super Bowl included focusing on habits and carefully altering his team's reaction to "on-field cues."[233]

And according to Duhigg, it's not just mass merchandisers, companies and professional sports teams that are leveraging habit. President Obama had a 'habit specialist' on his campaign team to help analyze voting patterns and trigger new ones.

Habit Time

You might have heard that it takes 21 days to build a habit.

Psychologist Jeremy Dean, author of *Making Habits, Breaking Habits*, says that there is only one problem with 21 days as the habit gold standard.[234] It's less of a statistic and more of an urban myth.

Dean believes the myth originated with plastic surgeon Maxwell Maltz, M.D. who in 1960 wrote the best seller *Psycho-Cybernetics*.[235] The book sold 30 million copies and generated a lot of memorable quotes. One of those oft-repeated quotes is that habits take 21 days to stick. This was supposedly based on Maltz's observations from his medical practice that amputees and facelift patients both took about 21 days to habituate to their new identities.

In his book's preface, Maltz elaborates on this idea:

> "People must live in a new house for about three weeks before it begins to 'seem like home'. These, and many other commonly observed phenomena tend to show that it requires a minimum

> of about 21 days for an old mental image to dissolve and a new one to jell."[236]

The bottom line, however, is that Maltz's observations were not based on any formal scientific study.

For a more scientific approach to understanding what a habit timeline looks like, we turn to University College London. Researchers ran a habit acquisition study with 96 people over 84 days.[237] The participants logged into a website when they had reached a level of 'automaticity,' meaning their behavior had become routine. The amount of time it took to acquire a habit fluctuated quite a bit based on the difficulty of the behavior they were trying to master.

Drinking a glass of water after breakfast took only about 20 days to habituate, surprisingly close to Maltz's observation. But the average habit, across all study participants, took about 66 days to lock down. More difficult and challenging habits, based on extrapolation (since the study only ran for 84 days) worked out to be closer to 254 days or more.

Understanding Habit

Three features define a habit. First, when we are running habit code, our reflexive System 1 has taken over and we are operating in autopilot, like when we're driving a car or typing. For the most part, we initiate a habit without deliberation and the habit generally operates below our awareness.

Second, because we are operating out of System 1 automation mode, emotion researcher Nico Frijda says that habitual behavior tends to be largely devoid of emotion.[238]

No experience is as powerful as the first time you encounter it. Most habituated experiences, performed again and again over a period of time, diminish in impact and lose some of their poignancy. So even things like sex, drugs, rock and roll, or the stress associated with hearing police sirens can lose emotional gravitas.

The tamping down of excitement allows the brain to burn less glucose. Thus we could say on the plus side, habits are more energy efficient. On the negative side, the humdrum repetition of habits means they can become stale and boring. And as we've seen with the Target example, under the right conditions, habits are susceptible to change.

Lastly, we tend to initiate habits under the same set of reoccurring circumstances, much like Russian researcher Pavlov proved in his experiment with dogs.[239] When conditioned to hear a bell before feeding, Pavlov's dogs began to salivate in anticipation of the food. Humans operate in a similar fashion; our habits are strongly rooted in, and triggered by environmental context.

Unintentional Programming

From the time of your birth, your parents were bombarding you with repetitive messaging, everything from "Eat your peas" to "Do your homework." Messaging is the very essence of being a parent. And that external messaging is a partial key to whom you grow up to be. But what about the internal messaging: how does that happen?

The mass of 200 million interwoven fibers linking your brain's left and right hemisphere is known as your corpus callosum.[240] This high-speed communication bridge ensures the two hemispheres work in sync with each other, neurons connecting parts that handle vision, hearing, spacial reasoning, and thought. As you experience the world, your brain is constantly learning and adjusting in an effort to maximize fuel efficiency and keep you alive.

Interestingly, these neural adjustments happen behind the curtain; for the most part, we are unaware of them. Rewiring tends to follow patterns. As we've discussed, the basal ganglia converts repetitive patterns into little bits of myelinated neural code to ensure that a particular brain application lives on in your unconscious.[241] This frees up your working memory from trying to remember to execute a particular task like flossing.

However, your basal ganglia doesn't have a horse in the race as far as your mental or physical health is concerned. It takes no side in whether

the habituation it programs is good or bad. Balancing your checkbook every weekend, practicing the piano five hours a week, hitting the bars every Saturday night —all feels the same to your basal ganglia. It turns autopilot on whenever you give it enough repetition.

Of course, the same is true if you start walking after dinner in the evening. The brain makes little distinction between healthy endeavors and the unhealthy ones. When it finds a pattern, it's like a bear finding a picnic basket: the feast is on.

What's interesting is that so much of what we habituate is unintentional. For example, there is a pretty high likelihood that tonight when you sit down for dinner (provided that you eat at home), you will sit in the same chair you sat in the night before. Of course, there's no intrinsic value to that specific chair. It's likely there are at least a couple more chairs nearby that look exactly the same.

But over time, your habit-driven brain has programmed that shortcut to free you from dithering each evening about chair choice. And now, brain app firmly installed, if someone plops down in your chair of choice, you might remind them rather indignantly, "Hey, that's my chair!"

Given our ability to create neural programming, you'd think we'd take huge advantage of our brain's flexibility and program the thing to the hilt. Unfortunately, there is one big hurdle necessary to hacking your own brain's habit formation.

Neural code, as we've learned, often takes at least two months to build. In today's fast-paced world, two months of repeatedly practicing something feels like an eternity. More advanced brain apps, like learning Chinese, can take many months of repetition. Intentionally building consequential brain apps is generally hard work. We tend to be more comfortable running the same apps, the ones we've already programmed.

For this reason, many of us find ourselves doing the same routines over and over again. We repeatedly eat the same foods, wear the same clothes, hang out with the same friends and do pretty much the same

activities with those friends. It takes real physical and mental effort to radically depart from our daily routines. Take something as simple as brushing your teeth. Try brushing with your opposite hand—not only does it feel strange, but you'll find yourself quickly reverting back to the way you normally brush. Even simple routines are powerful reminders of the brain's reliance on existing habit code.

Wiring Brain Apps

Behavior Scientist BJ Fogg has developed a useful approach to changing your routine. He told us that when it comes to building habits, the key is to start small: very small.

The idea is to knock down the barrier to entry by making those first steps toward building a new habit so easy it's almost impossible not to do them.

Here's an example BJ Fogg uses: you probably brush your teeth every day. (No doubt, with the same hand.) But chances are pretty good you don't floss. Only about 40% of Americans regularly floss, according to the American Dental Association.[242]

Still, presumably everyone wants to avoid gum disease, and although the data is inconclusive,[243] some health professionals think there's a link between gum disease and heart disease.[244] They believe the mouth is one of the easiest ways bacteria can be invade your blood supply. If you get an infection, if you get gingivitis, that bacteria can find its way into your bloodstream—which is bad news for your whole system.

The theory says that flossing is one of the surest strategies known to reduce bacteria's access to your bloodstream. It shores up the gum line, creating a seal around your teeth that keeps the bacteria out. If you're worried about heart disease or the health of your blood supply, flossing is one app you definitely want to build.

Now, suppose you recognize the value of flossing but seldom do it. Your basal ganglia has already built a habit for brushing your teeth, so it makes sense to use brushing as your trigger, or anchor mechanism.

Start by putting your floss right beside your toothbrush to remind yourself what comes next.

After you brush your teeth, floss. But here's the catch: start out flossing only one tooth. Make the barrier to entry so comically small that you can't begin to psyche yourself out about it and pass the buck to Future-Self. After you've reached your first day's goal of just one flossed tooth, take credit for it; let yourself feel good about the progress you've made. Literally praise yourself out loud. As amusing as this might sound, by so doing your brain will be giving you a little shot of dopamine, the feel-good drug that helps reinforce new brain apps.

The next day, follow the same routine, again flossing a single tooth. It's important to give yourself time to make the act of flossing a habit. If you raise the bar to a mouthful of teeth at the beginning, you'll weaken the habit acquisition program and jeopardize the entire flossing enterprise. On the other hand, once you solidly establish that single tooth habit, you'll find yourself gradually adding more teeth into the program. Build up your regimen tooth by tooth, and eventually you'll be flossing all your pearly whites. Following this simple process, motivating yourself through verbal reward, allows you to cultivate what Fogg calls the "Tiny Habit Method." After about 66 days, the tiny habit will grow into a fully programmed, automatic brain app.

It's easy to get excited about a new goal and expect positive improvements to happen almost immediately. When we are impatient and don't appreciate the value in delayed gratification, we get discouraged. If morale flags, we're more likely to rely on Future-Self for making a potential change. Start small, and you can get Current-Self in on the action.

Beyond the smallness of the steps, you also make things easier on yourself if you can trigger the new behavior with something you've already habituated—it creates one more layer in a habit stack. Otherwise, you might legitimately intend to floss, only to forget about it until you're doing something else, like driving down the highway, making flossing, like texting, both difficult and inadvisable.

Tiny Hacks

When we spoke to B.J. Fogg, he offered the following advice:

1. Take advantage of neural programming you've already created by piggybacking on an existing habit. Your existing habit becomes the trigger for your new desired action.

2. Keep the motivation rolling by letting yourself feel good after you've successfully completed the desired action.

3. Start small–really small, like with the flossing example.

Fogg also said that the beauty of the Tiny Habits Method is how easily habits can grow into something more. "If you have a habit of putting on your walking shoes, eventually you'll have a habit of walking thirty minutes a day. The metaphor I use a lot is to think of it as a small plant, a little seed that you're planting... a little seed will grow to an expected size, as long as you keep it nurtured. And you can't force it to grow, without causing it harm. You keep it nurtured and you allow it to expand on its own."

Getting Started

Let's suppose that you're ready to build a new brain app. You've decided to start writing a weekly blog about your passion, travel. To reach that goal you're going to follow the **SMARTR** model from Chapter Two, which means there's some pre-preparation involved. First, you're going to have to hone your writing chops.

To that end, like Mark Twain before you, you're going to need to write an awful lot and get accustomed to hitting a daily word count. You understand that the growth will be exponential and it won't happen overnight. You're also aware that, again like Twain, you might not be an accurate judge of your own writing quality so you've joined a writing group to ensure a good feedback loop.

Being the clever person you are, you've ratcheted up your willpower ahead of time by making sure you're exercising, eating right and getting enough sleep.

In order to gain the necessary practice time for your travel blog, you've cancelled your TV cable subscription and moved your computer to the former TV area.

Why move your computer? You're taking advantage of habituated context clues. When you walk into that room after dinner as you normally do, now you'll piggyback on your old TV watching trigger to build your new writing app.

Fogg told us it's critical to work out the first step in your new routine.

> "What is the starter step in writing that blog? Is it opening up [the website platform] Wordpress? Is it taking out a notebook? And you would work to make that an automatic behavior."
>
> "For other types of habits," he continued, "you would scale it back to something very small. Not a starter step, but you would actually maybe write one sentence, and that would be the tiny habit. But I think, with regular blogging, the right thing is to bring it back to a starter step, not a tiny version. A tiny version would be writing one sentence, a starter step is opening up Wordpress."

Let's imagine that you've kicked off your habit by opening Wordpress. Understanding the power of feeling good in boosting your dopamine levels, you're already celebrating by dancing around the room. But you're not done yet. As a visual reminder, you've bought a big calendar on which you intend to put a red X on every day that you write for the next two months in order to both track your progress and as an incentive to keep the momentum chain going.

In fact, you're so serious about making the travel blog happen that you've gone one step further: you've enlisted a trusted friend to request regular updates on your progress, thereby making it much tougher for you to back out. Telling a friend was a pretty good idea, because

research shows that with a support network you're much more likely to hit your goal.[245]

You've seemingly planned for everything except for one thing — the dreaded *extinction burst*.[246]

Extinction Bursts

You might be surprised to find that your analytical System 2 is up against an internal conspirator bent on thwarting your writing goal in favor of reinstating TV watching. The nemesis is your own primitive reptilian brain. This region, evolutionarily the precursor to your more advanced prefrontal cortex, has some habit wrecking shenanigans up its figurative sleeve.

The shenanigan in question is an extinction burst. Your reptilian brain cleverly waits to spring the trap only when you are specifically in the very final stage of habit change, your TV habit all but pushed aside by your new writing habit. An extinction burst is much like a Hail Mary play in football, in which desperation drives an all-or-nothing strategy for success. Your reptilian brain makes a final push to reestablish and save your TV habit from extinction.

It goes something like this: suddenly, you get a deep craving to watch an episode of *NCIS* instead of putting in your nightly word count. The X's on your calendar can attest to the fact that you've maintained your writing willpower up until that moment. But the urge to watch TV seems both ridiculous and undeniable. You begin to wonder how long it will take to get your cable service back on and you frantically search your smartphone for the number to call.

Feeling a level of weird desperation, you even find yourself contemplating inviting yourself over to your neighbors to poach a little TV. What's so strange about all this is that this TV desire seemed to drop into your thoughts full-blown and out of the blue, taunting you like the sirens in the Odyssey.[247]

You can thank your reptilian brain for ramping up the *NCIS* craving to almost unbearable level. This same extinction burst phenomena might

explain why dieters succumb to binging behavior after they've been so diligent in their efforts to kick their sugar addiction.

Why would part of your brain thwart your intention?

Perhaps because your TV watching behavior has become so deeply ingrained and so hardwired through Hebbs rule, that your more primitive brain region misidentifies the habit as something vital to your very survival and sends out the signal to hold on at all costs.

Although watching television is, from a rational point of view, clearly not key to your continued existence, still your reflexive System 1's job is to follows orders; it's not there to evaluate the merits of the programming. Like the electric company during a power outage, the priority is to simply bring everybody's power back on line.

The theory goes that extinction bursts may operate similarly to certain allergies. Some allergies occur when your immune system misidentifies an allergen as an unwanted invader, ramping up histamines in the system to fight it off.

Since the brain's job can be viewed primarily as keeping you alive, the brain errs on the side of caution. Occasional misidentification is a small price to pay if overall the brain's survival strategy has proven effective, as it has in the past. However, extinction bursts are dangerous, largely because they hit without warning and can overwhelm all of your good intentions.

Odysseus solved his fear of succumbing to the tempting siren song by having his shipmates lash him to the mast of his ship. That might have worked for the legendary Greek hero, but ship masts aren't always easy to find, especially when it comes to the dessert aisle of your grocery store or the whispers of your favorite unwatched TV show. One strategy to avoid extinction bursts is to thoroughly invest in the habit process and understand how each mechanism is connected so that you can maximize your effort when wiring up your next brain app.

The Wiring Process

Behavioral change models are plentiful, but for our purposes, we'll rely on B.J. Fogg's system, the Fogg Behavior Model, or FBM.

Fogg writes, "The FBM asserts that for a person to perform a target behavior, he or she must (1) be sufficiently motivated, (2) have the ability to perform the behavior, and (3) be triggered to perform the behavior. These three factors must occur at the same moment, else the behavior will not happen."[248]

Suppose you want to kick your level of exercise up a notch. A trusted friend has told you about a great exercise facility close to your house. Included in its introductory offer is a customized strength and stamina assessment, along with a personal exercise plan. This program normally carries a $100 charge. To sweeten the deal, it's offering a 50% discount on a year membership, provided you sign up in the next five days.

You understand the power of loss aversion, that is to say, the brain bias we all carry that weighs the pain of a potential loss twice as strongly as the joy of a potential gain. In other words, skipping that deal feels worse than spending the money on membership.

Loss aversion is a potent force; it's what helped build Las Vegas into a world-renowned gambling mecca. Gamblers who are down thousands of dollars keep pushing for a win, because it feels so bad to walk away from the table with less money than they had at the start. We all know how this story ends.

And even though you understand the manipulative aspect behind the gym's offer, you still find yourself being pulled in by it. The promotion's expiration date becomes a powerful motivational trigger. In fact, when you stop by the gym for a preview, you notice they've reinforced this special "once-in-a lifetime offer" with a giant digital clock that's ticking down toward the end of the promotion time window like Time Square on New Year's eve. (Nice loss aversion touch, marketing team.)

The gym still has two hurdles to jump before they gain you as a member. The first is your motivation to sign up—your own perceived readiness to begin exercising. The second is your ability to pay.

Fogg points out that we can think about motivation and ability as each existing on a sliding scale. After the initial trigger, if both motivation and ability are high, there's a good chance you'll cross the decision threshold and sign up.

If neither motivation nor ability is high, it's unlikely you'll sign up. If motivation is high but your ability is low–for example, if you don't have a lot of spare cash and your credit is maxed out–you will likely skip the offer. It won't matter if the gym drops the membership rate another 25% as an enticement; all the motivation in the world can't overcome your empty bank account.

This is an important rule to understand: increased motivation alone isn't enough to change your behavior and wire for a new brain app. This is why motivational speakers can get an audience really fired up, and seemingly motivated, without spurring any lasting changes. If you lack the ability to follow through on the call to action, the money, and time you spent on the motivational seminar becomes a sunk cost.

However, if you clearly have the ability to follow through on the call to action, a tiny dash of motivation might be all you really need.

Imagine that you're at a carnival and you have a chance to win a new outdoor gas grill in a basketball-shooting contest. To win the grill, you need to sink five free throws in a row. Assuming you were a shooting ace back in high school, you might consider trying your hand at the contest, even though you don't really need a new gas grill. In this case, ability might trump motivation.

If we review the description of luck from Chapter One—being in the right place, at the right time, under the right circumstances—we begin to see a parallel. In the case of luck, the three aforementioned conditions happen naturally without directed human intervention and are therefore not subject to one's control.

When it comes to orchestrating change, triggers, motivation and ability do fall largely under your control. This is why the oft quoted saying "the harder I work, the luckier I get," is technically inaccurate, but illustrates a deeper truth. Hard work can't generate luck, but it can allow you to create a situation for yourself in which it is easier to succeed.

As we've seen, motivation and ability move on a sliding scale, but nothing can happen without a trigger, the cue or switch that fires up the necessary neural circuitry. Fogg says, "Successful triggers have three characteristics. First, we notice the trigger. Second, we associate the trigger with a target behavior. Third, the trigger happens when we are both motivated and able to perform the behavior."[249]

Triggers can come in all shapes and sizes. I might trust an alarm clock to get me up in the morning to go jogging. I might rely on the pangs in my stomach to remind me it's time to eat lunch. A tone on my smartphone might trigger me to check my email, or tooth brushing might be an existing trigger I can habit stack to build my new flossing app.

Not all triggers last. If I put a yellow Post-it note on the refrigerator to remind me to practice piano, it might be effective at first, but after a while, the note fades into the refrigerator scenery and I no longer give it import. This, Fogg says, is why a reminder is not the same as a trigger.

The best triggers require some kind of physical action and are linked with the actual task at hand. The buzz of an email alert is a good example of a trigger that is directly associated with a next step: checking your messages.

When wiring for brain apps, your goal is to create physical trigger associations. Putting an alarm clock on top of your running shoes, when your shoes are on the other side of your bedroom, means that when the morning alarm sounds, you're forced to get out of bed to turn off the alarm. At that point, the alarm serves as both timing trigger and cue that your running shoes are patiently waiting for you to hit the pavement. Setting up this scenario the night before makes it hard to escape the less-than-subtle double trigger effect.

Timing is key. Poorly timed triggers not only have little impact, but they can prove to be irritating. Fogg cites spam and pop up ads as relatively ineffectual Internet triggers. When they show up on the screen without warning, they seldom serve as a call to action, unless their call to action was designed to annoy you.

However, studying the Fogg model, it becomes increasingly clear how Amazon's 1-Click technology—the ability to order, pay for and download a book with a single click—has proven to be so effective. That button is an instant trigger for buying, aimed at people with the motivation to be browsing for that item in the first place, and as far as ability goes, what could be simpler than a single press of a finger? Companies like Amazon are leveraging the habit behavior into their selling scheme. Whether you think of it this way or not, with each successful click, they are actively complicit in triggering the rewiring of your brain.

Fogg breaks trigger mechanisms down into three types: sparks, facilitators and signals.

Spark Triggers

Spark triggers are highly emotional prompts that pull at your heartstrings to summon up feelings of hope, fear, guilt, or empathy. Their goal is to significantly ramp up your motivation.

Seeing a video of a starving child in a third-world nation is a spark designed to evoke empathy in order to maximize your motivation for charitable giving. A PBS pledge drive is a spark to trigger guilt if you continually watch their programming for free. (They usually couple this with some kind of sweetener or reward, like a CD set or book, to add a positive appeal as well.) Insurance companies often use images of disasters to trigger the fear of losing your belongings and increase your motivation for taking out a homeowner's policy.

Facilitator Triggers

Facilitator triggers are designed to take advantage of high motivation when the ability to carry out the call to action is in question. Facilitator triggers lower the ability hurdle by simplifying a process. Amazon's

1-Click technology is a facilitator trigger, making ordering a book almost effortless.

When your health insurance company mails you a bill that comes with a pre-labeled return envelope for simpler payment, they are hoping to simplify the process and get their money sooner.

Signal Triggers

Signal triggers aren't set up to motivate or lessen the ability required. Their goal is to signal that it's time to initiate a specific behavior. The ding on a microwave tells you to open the microwave door. An alarm clock serves as a common signal trigger. When motivation and ability are already high, adding a signal trigger is both necessary and an effective way to launch a new brain app.

With the advent of smartphones, triggers are taking on a far more significant role. The sudden immediacy of the Internet offers new opportunity to modify one's behavior. Before we were all carrying smartphones, much of the wiring or learning phase required physical access to certain resources—books, lectures, and domain experts. Today, we can easily watch a tutorial on a myriad of subjects by some of the greatest authorities in the world.

Smartphones also provide us with countless useful programs, allowing us to create and perfectly time our own triggers. The opportunity to take advantage of technology and wire your own bevy of brain apps has never been greater.

Simplicity Profile

Fogg writes that five elements often come into play when we consider the ability/simplicity factor of building a habit. He likens the five elements to links in a chain: each link must be intact in order for the chain to support the habit change and therefore, the new brain app.

Fogg's research shows your ability/simplicity chain is usually made up of the following links: time, money, physical effort, brain cycles, and non-routine. He calls this your simplicity profile.

Time

Building a brain app requires consistently using Chapter Two's time blocking process to set aside the necessary time for the task. On first blush, this might seem like simply making time to deliberately practice, but it also includes marshaling all of the resources needed, and/or setting up the circumstances to make the deliberate practice possible in the first place. This would include making sure a trigger is in place to initiate the process.

If my goal is to build a morning jogging brain app, I need to set the alarm ahead of time. As we discussed, I might consider placing the alarm on top of my running gear to double trigger my jogging activity. But I'll also want to already have all my running gear together and ready to go. This might mean I'll need to do a load of laundry the night before, and maybe clean the mud off my shoes from yesterday's morning run ahead of time.

It also might mean I'll need to pre-assemble the ingredients for my morning smoothie to allow enough time to jog. The bottom line: building a brain app requires planning ahead, and understanding what resources you'll need to have in place before you can begin your practice regimen. All of this must be factored in and measured against your time constraints.

This pre-planning phase is critical. If you're unable to overcome the inertia in the beginning, your brain will be perfectly willing to let you rollover, push the snooze button, and rely on Future-Self to start tomorrow.

Money/Resources

No matter what field you're hoping to master, securing the right resources is a necessity. Whether it's art supplies, sports equipment, software, musical instruments, books, a coach, or even a chess set, nearly every domain requires some form of additional resources to achieve your goal.

When we met with Chess Grandmaster Susan Polgar at SPICE headquarters, she stressed that one of the exciting things about chess as a pursuit, besides developing the mind, was the low monetary barrier to entry. Chess sets are not expensive, and these days, rather than assembling a massive chess library, aspiring players can view databases with past matches online.

Physical Effort

Fogg points out that the habits requiring significant physical effort can be tougher to achieve. Based on what we know about the brain, its miserly control of glucose, and its tendency toward stasis, this makes perfect sense.

This is where willpower maintenance pays off—never is that trifecta of exercise, nutrition and sleep more important. In Chapter Three, we saw that the Stanford basketball team performed better by lengthening their sleep cycles to combat the drain from extreme physical exertion.

This is also why, when undertaking a physically demanding goal, it's important to understand the exponential and logarithmic aspects of the growth curve and appreciate the power of delayed gratification as you force yourself to expend more energy. Olympic swimmer Michael Phelps, who was notorious for his grueling workouts, capitalized on his rage to master, his coach's creative inventiveness and an astonishing 8000 to 10,000 calories[250] a day to fuel his workout passion in his steady quest for Olympic gold.

Brain Cycles

The amount of mental energy necessary to pursue expertise varies from domain to domain. If not carefully managed, some domains might prove to be overly taxing. Physical and/or mental burnout can lead you to drop a pursuit temporarily or for good.

One of the rock stars of the 17th century's scientific revolution was Sir Isaac Newton. Physicist and mathematician, he is perhaps best remembered for his law of gravitation. As a voracious scholar, his growth mindset caused him to push back against the then geocentric

view of the universe and Aristotelian philosophy common at top universities of the time, including his alma mater, Cambridge. Newton was legendary for pouring himself into his work, and juggling a wide variety of academic pursuits at the same time, all the while keeping up a rapid-fire correspondence with some of the greatest thinkers of his era.

Although the basis of his mental stress is not clear, in 1678, he did experience what's commonly described as 'a complete nervous breakdown.' As a result, he withdrew from academia for the next six years, and his correspondence dropped off to a trickle. He eventually returned to his scientific pursuits.

David Bromberg, the multi-instrumentalist who toured extensively and played on many iconic recordings with artists like Bob Dylan, Willie Nelson, and Jerry Garcia, famously burned out and gave up playing publicly for some time, releasing no new music between 1990 and 2007. Again, this is where there is a benefit to investing heavily in willpower maintenance and a clearly articulated plan.

In Chapter Seven we'll explore how meditation can become a cornerstone for keeping your own stress at bay, and willpower at a maximum, as you endeavor toward your long-term goal.

Non-Routine

Relying on habit conserves brain glucose, and of course, initiating new behaviors burns high amounts of it. We can understand why this problem is at the crux of creating a new brain app.

Fogg also says that when you're trying to establish a new habit, you should always be careful to factor this time into your existing routine. Otherwise, when new behaviors intrude on your pre-established schedule, habit acquisition can become difficult.

If you haven't exercised in 15 years and you decide to create a new running habit, it's important to start out with a 'mini step,' such as beginning a walking routine for a couple of weeks before you attempt any jogging. It's also important to figure out how running is going to fit into your day. As discussed, Fogg's research shows that if you gentle

your way into a habit, you're far more likely to succeed. The whole idea behind new behavior is setting up the right kind of trigger and then nurturing your motivation and ability with small successfully completed increments.

Going out, buying a pair of running shoes and pushing yourself through a 10k run that afternoon is more than likely to leave you extremely sore, a little defeated and far less devoted to the next 66 days of improvement. Radically attempting to break into a daily routine, even if that routine was largely built on sedentary behavior, carries consequences.

Fogg sums it up this way:

> "Each person has a different simplicity profile. Some people have more time, some people have more money, and some people can invest brain cycles, while others cannot. These factors vary by the individual, but also vary by the context—In studying simplicity, I've found this to be important: Simplicity is a function of a person's scarcest resource, at the moment a behavior is triggered."[252]

In other words, you need to understand the nature of each link in your simplicity profile, and the whole chain is only as strong as its weakest link.

Tiny Habit Method Goes Big

We've built the case for tiny habits and behavioral change on an individual basis, but what happens when a population exponentially multiplies tiny habits? Just how powerful can a habit stack be when you involve an entire dorm floor of college kids?

In the past year alone, Americans used and discarded about 50 billion plastic water bottles. The recycling rate for those same plastic bottles is about 23%. This means that last year, roughly 38 billion water bottles were dumped into landfills or ended up as general litter.[253]

In the face of this growing problem, Elkay Corporation, a U.S company best known for drinking fountains, developed the EZH2O fountain,

which doubled as a water bottle filling station. This allows people to reuse their own refillable bottles, thus cutting down on waste.

As a savvy company, Elkay saw an opportunity to make money and be a little greener at the same time. The big question their engineers had was, will people actually change their habits and take advantage of the eco-friendly option? When the engineers finished their filling station design, they decided to add a counter readout on the machine to show users how many plastic bottles they were saving with each fill up.

Once the full expense of research and development are factored in, it's not uncommon for prototype models to scale back from the original concept. "At one point, we almost cut the counter from the specification due to cost," Franco Savoni, VP of Product Marketing and Engineering at Elkay told us. However, the counter stayed in, and here's what happened: in college dormitories across the U.S. where the EZH2O was installed, students got really excited about the bottle counters. They could instantly see a tangible result each time they refilled their own bottle—and they could watch those results stack up.

It took almost no effort, saved them a few bucks a bottle, and provided instant gratification that they were doing something good for society and the planet. Watching the bottle counter turn over each time meant they were, in effect, getting gold stars—small, constant, emotionally satisfying dopamine reinforcers, creating the all important 'tiny wins,' at the heart of Fogg's behavioral model. Fogg makes the point that "emotions create habits."

To up that reward factor, these days students at both University of Michigan and University of Minnesota even organize contests: which dorm floor can save the most bottles and get that counter the highest?

As of this writing, Savoni reports that Elkay has delivered hundreds of thousands of EZH2O units.[254] You can find them in gyms, airports, offices and of course, on college campuses. That's a whole lot of tiny habits built on Fogg's formula of simple trigger, easy ability and small wins to drive motivation.

Fogg says that creating tiny habits is really a design issue. If you're trying to build ecologically friendly machines, or become the next great guitar wizard, or get your travel blog up and running, make sure you've got the basic questions covered. Who, what, when, where, how and why?

In our travel blog example, you would ask yourself specifically who's going to do the writing, what are you going to write about, when and where are you going to write, how are you going to write it, and why does it matter? The more precise you are about your habit intention, the more likely you'll succeed, whether you're writing a travel piece about the Vasa Museum in Stockholm, Sweden, or attempting to make a small dent in cleaning up the planet.

The Role of Emotions

The concept of building a 'mini habit' is not difficult to understand, but there are variables complicating habituation. One is the role of human emotions.

In his book *Self Comes to Mind*, Professor Antonio Damasio describes emotions as complex, largely automatic neural programs of action.[255] He writes that emotions can be triggered by real-time events, events of the past, or related images. They tap into various brain regions, including the areas concerning language, movement, and reasoning. This, in turn, sets off a chain of chemical reactions. So you can understand basic emotions as habit code that has come preprogrammed and pre-installed in your brain at birth.

Certain kinds of emotions tend to activate specific brain regions, producing a kind of lock and key effect. For instance, frightening events unlock the primitive amygdala and trigger additional chemicals associated with fear. When two regions are affected at the same time, it can create a composite or mixed emotion, such as melancholy sweetness or nostalgia.

Feelings are the body's readout of what's happening internally, combined with your moment-by-moment state of mind. As Damasio says:

> "Feelings are the consequence of the ultimate emotional process: the composite perception of all that has gone on during emotions—the actions, the ideas, the style with which ideas flow—fast or slow, stuck on an image, or rapidly trading one for another."[256]

During an emotional state, our rapid body readouts allow us to weigh the likelihood of reward and punishment, all in an attempt to predict what might happen next and what we'll do about it. Basic emotions like fear, anger, sadness, and disgust can be understood as a more nuanced approach to the evolutionary choices of fight, flight, or freeze.

Damasio adds that the brain's emotional process follows the same strategy as our body's immune system. When a swarm of outside invaders show up, our white blood cells dispatch an equal number of antibodies. These cells lock onto the surface shapes of the trespassers in an attempt to neutralize them.

Similarly, when you find yourself in an alarming situation, the amygdala dispatches commands to the hypothalamus and the brain stem, increasing your heart rate, blood pressure, respiration pattern, gut contraction, blood vessel contraction, cortisol release, and a metabolic ramp down of digestion, culminating in a contraction of the facial muscles we have learned to interpret as a frightened expression.

In primitive times, depending on the context of the situation, you might freeze in place, where you'd begin to breathe shallowly—important if you're trying to remain motionless in order to elude a predator. On the other hand, you might make a run for it, resulting in an increased heart rate to drive blood into your legs. And your cognitive resources would be redistributed; interest in things like food or sex would temporarily fall by the wayside.

All of this takes a giant toll on your energy reserves. It's costly—especially if it turns out to be a false alarm. Like a dimmer switch, the basic emotions give us graduated options. Instead of entering full on combat mode when an encounter goes poorly, you may choose to simply show your disgust toward that individual, thereby saving precious glucose and decreasing the chance of getting knocked on the head.

Damasio suggests that basic emotions are unlearned, automated, and predictably stable programs resulting from natural selection and genetic predisposition. Although you can choose to 'act' bravely, no amount of stoicism can undo the fear you're 'feeling' on a basic physiological level. This helps explain why people who have performed heroic actions frequently shy away from describing themselves as courageous. Although their outward behavior was brave, they remember feeling profound terror.

It's not a matter of being born with a fearless personality. Firefighters, Navy Seals, and many others undergo intense training to learn how to successfully function through their natural fright and override inborn emotional programming.

Such is the power of intentional habit code. Brain apps allow us to tamp down certain emotions in order to make it successfully through life and death situations as well as piano recitals, company speeches, chess tournaments, and trumpet solos.

Knowing how to override a primitive emotion like fear, a common component of fixed mindset, might have come in pretty handy if you were the CEO's of Blackberry a few years ago.

Motivation

Hope, fear, pleasure, pain, acceptance or rejection—these are key emotions that can come into play with habit change. Because a discussion of emotion can carry so many connotations, B.J. Fogg uses the term "core motivators" to hone in on greater specificity in his behavior model.

When you're attempting some new project like writing a travel blog, you can both be motivated by the hope of thousands of readers, or by the fear that no one will read it. Fogg says you can maintain hope through "success momentum." That is, you can start by working toward—and celebrating—very small wins. This works because the brain has trouble assigning proportionality and will often judge a small success as equally important to a larger one.

In other words, you can knowingly exploit your brain's proportionality bias for your own gain. Remember when you used to get gold stars on your fourth grade spelling quizzes? Taking time to feel good about minor successes still has impact today. Enough small wins can keep you motivated and create a domino effect, where one successful tiny habit can trigger another tiny habit and lead to a powerful and useful habit stack.

Pleasure and pain as emotional readouts are well understood. As we've discussed, pleasurable outcomes and small wins are much more likely to keep us on the habit path. Another way to leverage the emotion of pleasure is to build a reward component into your new habit structure.

Physiologically, rewards help ensure myelination of desired neural connections. Our sensory systems are primed to avoid pain; accidentally touching a red-hot burner on a range top doesn't require a lot of repetition to create a habit of avoidance. The desire to avoid physical pain associated with alcohol and drug abuse is a key element in many addiction recovery plans.

Some habit acquisition is relatively painless. Some is so effortless that we can form habits without even noticing. Still, some involves discomfort—maybe not as severe as burning your fingers, but a noticeable level of mental or physical stress. It's unlikely you have hours and hours of idle time on your hands, which you've spent staring off into middle distance, saving the space for a future habit.

Every new behavior that you seek to create will likely dislodge a pre-existing one. The disruption will not be restricted to your daily schedule. There will also be emotional disruption in which you'll experience new feelings as a result of change. Being aware of, and properly dealing with, both your new feelings and changes in schedule will ensure your habit gets off to a good start.

It's difficult to maintain a steadfast and uncompromising allegiance to an exacting set of behaviors day in and day out. Although we operate and rely on a significant amount of pre-programmed neural code, we are not automatons. As humans, we are infinitely fallible.

Fogg cautions against feeling guilty when you stray from your newly minted habit routine. If you miss doing a tiny habit once in a while, don't beat yourself up over it. If you find yourself feeling guilty and your misses are more than occasional, consider reexamining your habit anchors. He says "if you want to do a habit ten times a day, find an anchor that occurs ten times a day."[257] It's about trial and error, figuring out what anchored behavior you can piggyback on as your trigger.

Fogg says to make sure you take time to celebrate the completion of each tiny habit repetition. It might seem silly at face value, but celebration allows you to leverage pleasure as a way of enhancing habit wiring. Emotional responses heighten and amplify your feelings, which reinforce memory. Fogg's research is clear: the people who celebrate tiny habits are more successful at building them.

Habit Implementation

There are two common ways to think about gearing up for a new habit. One way is to imagine a positive outcome, a fantasy, like standing on the stage, receiving an Oscar for Best Travel Blog Writer as the crowd rises to their feet in standing ovation. The other way is to ponder what about your current situation makes you unhappy and what the solution to your problem might look like.

New York University Professor of Psychology Gabriele Oettingen decided to test these ideas to see which one was more useful. She ran an experiment in which she divided her subjects into three groups and gave them the same problem to solve. The first group was told to start by indulging themselves, fantasizing about having solved the problem. The second group was told to dwell on the negative consequences of not solving the problem.

The third group, however, was told to do both: to envision the satisfaction of solving the problem, and the disappointment at failing to solve the problem.

It turned out that when expectations of success were high, the third group performed best. However, when expectations of success were

very low, this same group invested less in planning and backed away from taking responsibility for the outcome.

Oettingen theorized that, as is often the case in business and life, people tend to do a cost-benefit analysis of potential outcomes and gear their actions accordingly. We only invest when we think any idea or a goal has true viability. It appears that we also operate under this same principle when deciding how much energy to devote to building a new brain app.

Motivation is a necessary force, spurring you toward any goal. Countless books and articles tout the benefit of positive thinking as a catalyst, but in Oettingen's book *Rethinking Positive Thinking*, she argues that positive thinking only takes you so far.[258] It's true that fantasizing about achieving a goal can lower blood pressure, compelling us into a state sometimes associated with the desirable effects of meditation. That's because, bottom line, there's a little Walter Mitty in all of us; daydreaming feels good.

Oettingen says, unfortunately, daydreaming can be counterproductive. You feel less urgency to act, because on some level, you've already experienced a fantasized positive outcome. Fantasize too much, and you can find your motivation slipping and reliance on Future-Self growing.

This isn't to say we should eliminate wishful thinking altogether. Oettingen writes that it can be a useful tool, provided you add a few more steps to the habit building process. To increase your chances of success, she's even created a mnemonic device: **WOOP.**

W stands for wishful thinking, which, as we've explained, is a useful starting point. Before you start building a new habit, you want to get excited about what your new habit could mean for you. Fantasizing a desired outcome can be important, but it's only the first step.

O is for outcomes. Oettingen says that, for a well-defined goal, think beyond vague dreams of excellence. The greater the specificity, the easier it will be to develop a concrete plan for wiring a new habit. Dreaming about becoming a long-distance runner is one thing. Aiming to qualify for the Boston Marathon on April 20th 2020—and thus

following Hal Higdon's Ultimate Training Guide to hit a time of 3 hours and 40 minutes as a woman age 35-39—is quite another.[259,260]

The next **O** stands for obstacles. Here is the all-important reality check. By anticipating and examining obstacles, you can get a jump on overcoming issues before they arise.

Oettingen makes it clear that this is not simply about looking at environmental impediments that you might encounter, but more importantly, this is about examining your own *mental* obstacles. These include your heuristics, beliefs and the emotional components that drive your behaviors and mindset.

Chapter Four introduced us to Masaaki Imai and the concept of Kaizen. Central to Kaizen is the idea of solving problems by focusing with laser-like intensity on the root cause. This is precisely what Oettigen is suggesting; move past circumstantial barriers and focus on your own emotional drivers.

Are you acting or not acting out of fear, or shyness or embarrassment, insecurity, or something else, perhaps an overriding fixed mindset, or an outdated heuristic? Oettingen suggests this is the real opportunity to rewire. You need to recognize the root of the particular mental obstacle that's keeping you trapped in your current way of thinking. This requires a careful and thoughtful deep dive into holdover effects of past experiences and understanding how they continue to shape your decisions.

Taken together, the **WOO** of **WOOP** brings us to what Oettingen calls "mental contrasting"— examining the entire scope of the problem, all potential gains and impediments, with a special emphasis on emotional underpinnings and then crafting a *plan* to overcome your obstacle.

This is where the **P** in **WOOP** comes from. Oettingen calls the plan an "implementation intention." A key ingredient to the implementation intention is an if-then statement: 'If I'm afraid to speak in public, then I'll join Toastmasters and learn how to overcome my glossophobia.' The if-then statement reflects both the obstacle and the practical solution.

Oettingen says the real power of Mental Contrasting is examining the mental obstacles that are holding you back and then devising a detailed plan for success.

Pre-rehearsed if-then statements act as defensive plays to combat the urges to procrastinate and delegate to Future-Self. 'If I don't feel like jogging this morning, then I'll crank some hip hop for a few minutes to get myself pumped up before I hit the pavement.' Or: 'If I don't feel like jogging, then I'll start out walking until I build a little momentum and then I'll start my run'.

As you draft your implementation intentions, there are a few things you'll want to remember. Don't link them to times of day—for example, 'If it's 6 a.m., then I'll start jogging'. This has a limiting effect; when the clock ticks to 6:01 am, it's too easy to give yourself permission to lie back and grab a couple more Zs.

If-then statements sync well with BJ Fogg's Tiny Habit Method: 'If I brush my teeth, then I'll floss immediately afterwards'. In addition to keeping you on track when your motivation starts to flag, if-then statements formalize and help lock down exactly what the next action should entail.

It's also possible to piggyback multiple "then" statements on the back of one "if": 'If I enter the weight lifting room in the gym, then I'll do leg lifts, bench presses, and pull-ups'. Or they can be very specific to a practice pattern: 'If I begin doing pull-ups, then I'll take my time and concentrate for five seconds on each contraction to build up my bicep strength'.

Implementation intentions are a great example of seemingly small but potent incremental shifts. They are like micro catalysts to tiny habits. Often, we teeter on the edge of commitment, where the slightest breeze can push us into the ever-waiting arms of Future-Self. Implementation intentions act as a mooring, keeping us secure and steadfast in our habit commitment.

How effective are implementation intentions?

Across 94 studies with over 8,000 subjects in pursuit of a wide variety of habits, implementation intentions outperformed other habit motivation strategies.[261] This might be due to the strong cause and effect linkage implicit in the technique. The 'if' portion of the statement acts as a powerful trigger and the 'then' portion directs a specific action. As we've seen repeatedly, specificity of both trigger and call to action plays an oversized role when you're attempting to implement any goal strategy.

In a 2008 implementation study, researchers looked at 107 table tennis players from German league play: 76 men and 31 women, with an average age of 34.[262] The subjects were split into three groups. The first group served as the control group; they were told to play their matches as they normally would.

The second group was coached to "play each ball with upmost concentration and effort in order to win the match."[263] The third group was instructed to pick out some of the negative thoughts that regularly popped into their heads during match play and shield against these reoccurring mental obstacles by creating appropriate if-then statements.

Group three identified 18 negative thought states that occurred regularly during match play, including feeling anger, exhaustion, and distraction. Subjects in this third group constructed implementation intentions before their next match, like 'if I feel angry, then I will work on relaxing myself', or 'If I feel demotivated, then I'll push myself even harder', or 'If I am playing too cautiously then I'll play with more abandon'. In the next set of matches, group three utilized it's newly created implementation intentions.

After the matches were played, the players' observations reviewed, the coach's critique done, and the scores posted, not surprisingly, group three (the implementation intention group) turned out to have more wins.

The study identified two more bonuses to an implementation intention approach. First, even if you don't have preplanned if-then statements at the ready, they can be formed on the fly once you identify the nature of your mental obstacle. And second, because implementation intentions are so straightforward, it doesn't take a lot of cognitive energy to create them and put them to use.

Implementing if-then statements allows you to plug the dike before emotions can swamp your intention. And it doesn't matter what level of mastery you've achieved in your particular domain; the negative tapes that play in your head turn out to be extremely common.

Even world class scientists, artists, and athletes encounter reoccurring negative monologs. The strategy to offset these negative feedback loops doesn't have to be sophisticated. The key is to recognize negative mental feedback and counter with the proper if-then statement before your analytical System 2 begins its all too common process of second-guessing your behavior.

Habit Tracking

Consistency and simplicity are two keys to keep in mind when attempting to maintain and track new habits. For consistency, we'll turn to an unlikely source: a piece of lore surrounding comedian Jerry Seinfeld.

Love it or hate it, Seinfeld's sitcom "about nothing" reportedly managed to earn him a cool $267 million in 1998 alone, according to writer James Clear,[264] turning him into a comedic icon.

For instance, perhaps you've heard of the Seinfeld Productivity Program?

Clear quotes software developer and aspiring comedian Brad Isaac about a chance encounter in a comedy club, wherein Isaac had a chance to ask advice from the comedy legend and future animated bee himself:

> "He said the way to be a better comic was to create better jokes and the way to create better jokes was to write every day.
>
> "He told me to get a big wall calendar that has a whole year on one page and hang it on a prominent wall. The next step was to get a big red magic marker. He said for each day that I do my task of writing; I get to put a big red X over that day.
>
> "'After a few days you'll have a chain. Just keep at it and the chain will grow longer every day. You'll like seeing that chain, especially when you get a few weeks under your belt. Your only job is to not break the chain.'"

It's an appealing story. There is just one problem. It never happened.

As James Clear himself acknowledges, Seinfeld denied the incident in a 2014 Reddit thread. "This is hilarious to me," Seinfeld wrote, "that somehow I am getting credit for making an X on a calendar with the Seinfeld productivity program. It's the dumbest non-idea that was not mine, but somehow I'm getting credit for it."[265]

In fairness to those still telling the tale, it's not the first time a well-known idea has been misattributed.

Besides, neither detail necessarily means that the method itself is without merit. It is true that persistence is a major key to success and it is important to commit to a regular deliberate practice schedule, especially in the early incubation period of a brain app.

This brings us to the second idea: simplicity. The simpler the plan for staying the course, the less brain glucose is expended. As we've seen in previous chapters, the brain tends to be downright miserly with its fuel. This is where the principle of Occam's Razor comes in.

Occam's Razor is a philosophical rule of thumb. Sir William Hamilton coined the term in the 19th century, cashing in on the celebrity status of 14th century scholar, logician, theologian and friar William Occam.[266] The friar was long dead, and thus not in a position to explain that he didn't have much to do with his supposed Razor. Occam's Razor

suggests whenever you're constructing a mathematical solution, you should reduce your chance of error by eliminating any redundancies. Crudely put, the simplest solution is the best.

The idea of a law of economy or parsimony is not new. "We consider it a good principle to explain the phenomena by the simplest hypothesis possible," said Egyptian astronomer Ptolemy around 1800 years ago.[267] This concept is present in the works of Aristotle and Thomas Aquinas, as well as many other legends of philosophy.

In the end, it shouldn't really matter where an idea or strategy comes from as long as the content and intention is fair and sound. If your goal is to create quality brain apps, you might consider the amalgamation of two ideas, consistency and simplicity— we've taken the liberty of calling "Seinfeld's Razor," as a reminder to maintain and measure your practice regimen. We've already alluded to this earlier.

Try putting an X on the calendar for every day you manage to hang in there on your new habit goal. Remember, a little positive affirmation will help reinforce the links of your habit chain.

Depending on the brain app you're trying to build, the timing will vary, but on average, 66 days of X's will be a substantial down payment on a new piece of intentional programming that can move you one step closer to your long-term goal.

Chapter Key Points: Hacking Your Habit App

- Almost half of our everyday activity is driven by pre-programmed neural wiring commonly know as habit.

- Some of these brain apps came wired at birth and some are wired unintentionally through repetition.

- Heuristics are a mental shortcut, a framework for making decisions. If you want to understand yourself better, identify and examine your heuristics.

- BJ Fogg's Tiny Habit Method involves taking the time to identify the right behavioral trigger, and piggybacking on an existing habit to create a powerful habit stack.

- Keep in mind that momentum is built out of tiny wins.

- Consider your simplicity profile, understanding your strengths and weaknesses with regards to time, money/resources, physical effort, brain cycles, and the effects of non-routine.

- When you're stymied by a lack of progress, remember psychologist Gabriele Oettingen's mental contrasting model. Use her system of **WOOP**—**W**ish, **O**utcome, **O**bstacle and **P**lan—to examine your current mindset.

- To prepare yourself against Future-Self and the dreaded Extinction Burst, take some time before you embark on a challenge to devise some if-then statements.

Chapter 6
Creativity App

We now know the essentials of what it takes to build a brain app. To take you to the next level, you'll need to harness your creativity. You might think of creativity as the realm of artists and musicians, but the truth is, mastering nearly any skill requires you to think independently and find novel solutions to problems as they arise in pursuit of your long-term goal.

Not only does creative problem solving allow you to avoid *stagnation swamp*, but it's fundamental to boosting application strength, which compounds your chances of success.

So just how does creativity work? Only recently has neuroscience begun to answer that question. I say "begun to answer" because understanding creativity is still very much a moving target. Let's start with what we do know, by unpacking some common misconceptions.

Left Brain/Right Brain

By now, you're familiar with the idea that there are two hemispheres in your brain connected by a corpus callosum. Undoubtedly, you've also heard that the left hemisphere is responsible for analytical thinking, while your right hemisphere is the home of creativity.

It's probably less likely you've heard of Michael Gazzaniga. However, he is one of the founding fathers of cognitive neuroscience. Early in his career, he teamed up with famous brain pioneer Roger Sperry. Sperry shared the 1981 Nobel Prize, with David Hunter Hubel and Torsten Nils Wiesel, for their work in split-brain research.[268]

Gazzaniga's own split-brain work involved patients in treatment for severe epilepsy who underwent operations severing the bridge between their brain hemispheres.[269] Cutting this corpus callosum was an attempt to isolate and contain the epilepsy so it couldn't spread to both sides of the brain. His studies led to the discovery of what's called the functional lateralization of the brain: how the two hemispheres can operate independently and still communicate with each other.

In the mid-sixties, the media seized on these findings and ran with them, morphing the data into a still-familiar narrative of the artistic, creative right brain and the methodical, analytical left brain. But although you can find some degree of specialty, there's also a tremendous amount of overlap and redundancy between the hemispheres. The right brain versus left-brain model is at best, a tremendous oversimplification and at worse, just plain wrong.

In the days since Gazzaniga's groundbreaking lateralization research,[270] numerous fMRI studies have searched for the locus of creativity. However, creative thought requires the interplay of so many different systems that trying to find where creativity happens in the brain is a little like visiting an automobile factory in the hopes of pinpointing the exact spot where cars are created. Should we look to the assembly line, or paint line, parts department, engineering department, or front office? The truth is, it's all of those places working in conjunction with each other.

It takes multiple neural networks to develop an original thought. Unfortunately for our purposes, this means there isn't a single roadmap to creativity, just as there is no single way to get to Chicago. Instead, there are many transportation modes and numerous routes.

Another complication in any study of creativity: by its very nature, it can be difficult to measure. How do you take something so subjective and convert it into clean, numerical data? Various people have tried, with decidedly mixed results.

Creativity is, at least for now, a partially hidden enterprise because parts of our brain are not yet accessible to scientific scrutiny. We have made gains, but the ability to replicate creativity remains elusive.

This is why it's impossible to excel at trumpet exactly like Dave Guy or at chess exactly like Susan Polgar. Doing so would require you to have lived their identical lives, down to the nano-second, with every bit of their realized experience and genetic coding unchanged. By that, I mean you would actually have to be them; even cloning wouldn't work because of a little variable in human brains called transposons.

Transposons

A transposon is a fragment of DNA that inserts itself into another cell. Research suggests that about half our DNA sequence is made up of these fragments, these interlopers.

In the cells of, say, your lungs, heart, or kidneys, transposons have no real effect. They don't behave like viruses, which sneak into cells and multiply like crazy. They're more like very mellow hitchhikers; once they've found their way in, they're usually content to fall asleep and enjoy the ride.

The exception is the brain. Once transposons get inside neurons, they can alter the very nature of the cell. It's like a troupe of improv actors that show up unexpectedly at your birthday party; suddenly, you're at a very different party. Transposons can influence a neuron's firing sequence, turn it off or on, or even reconfigure the operating code of the whole chemical-electrical switch.

This means they can change the entire identity and purpose of a neuron. And like any good improv actor, they can shift into a variety of roles and characters.

Kelly Clancy reports that it's a Darwinian parable playing out on a cellular level,[271] producing "a kind of evolution in miniature."

The result? Even among twins, no two brains are exactly alike. Identical twins begin with identical DNA, but the arrival of those improvising transposons makes neural activity wholly unique. And since transposons aren't passed down, your brain is truly a once-in-a-lifetime show.

If all this sounds a little, well, scary (rogue DNA wreaks havoc on unsuspecting brain!), think of it this way: transposons, in essence, help to make each of us the completely unique creative individuals we are, from Dave Guy to Susan Polgar to you.

IQ and Creativity

For a long time, conventional wisdom held that if you wanted to compare one person's mental powers to another's, you didn't need to look any further than their respective IQ scores. So, were the Fords, Edisons and Jobs at a creative advantage because of superior IQ? What is the relationship between creativity and IQ? The modern day Intelligence Quotient test, more commonly known as the IQ test, analyzes your applied knowledge of math, as well as verbal and spatial recognition skills. At the end of the test, your final score is reflected by a number between 1 and 200, with 100 being average.

We can trace the American fixation on IQ back to the beginning of our involvement in World War One. The U.S. War Department was searching for ways to identify who would be best suited for which jobs, from foot soldiers to officers. For help, the military turned to psychologists like Lewis Terman of Stanford University.

Terman had tweaked an intelligence test devised by the famed French psychologist Alfred Binet to create a new version, called the Stanford-Binet Intelligence Scales.[272] Binet initially promoted his model as a tool for classifying developmentally disabled children, but the U.S. military was so impressed with Terman's version, they hired him and six others to create the "Army Alpha", an assessment test which was administered to 1.7 million GIs.[273]

At the time, there was no other widely circulated intelligence test to use as a benchmark, so it's hard to measure the test's net effect. However, the allies went on to win the war, and after the war, Terman went on to screen children for signs of "genius level" IQ.

Several years later, Terman used these screening results to kick off a study aimed at understanding the wide-ranging effects of "genius." (Eventually, the study would abandon the emotionally charged—and

difficult to quantify—label "genius" in favor of "gifted.") He began in 1921 at Stanford. Terman looked at 1,500 boys and girls, attempting to track factors like developmental progress, their interests when playing, their medical condition, how much they read, and how many books were available to them at home.[274] Then he continued to periodically check in with those same subjects throughout their lives.

An early example of a longitudinal study, it's also the longest running of its kind and still continuing today, to be concluded at the death of its final subject.[275]

This work eventually begat Terman's multivolume *Genetic Studies of Genius*,[276] considered a seminal document in American psychology. (That's not to say that Terman's scholarship all holds up by today's standards. In testing across cultural and racial groups, he jumped to a number of sloppy, prejudiced conclusions.)

However, he did debunk then-common misconceptions about high-IQ children: his research did not show them to be physically frail or socially maladjusted. In an era where parents often held their children back a grade to prevent their child from being the youngest in their class, Terman found that being the youngest in a class was, in fact, a predictor of a high IQ.

For our purposes, Terman's most interesting result concerns creativity.

To the extent it could be measured, Terman found that the 1,500 high IQ study subjects did make an above-average number of societal contributions in creative fields. This, on the face of it, would suggest that a high IQ delivers a key creative boost. However, in a separate study, sociologist Pitirim Sorokin showed that a random group of children from equivalent socio-economic backgrounds would do just as well.[277]

In other words, Sorokin's work suggested that a high IQ score was not itself a predictor of creative success; rather, children growing up with above-average access to certain resources—books, piano lessons, etc., and the undivided attention of a parent or parents who didn't need to work multiple jobs—had advantages over the population at large.

Terman's study arguably had other shortcomings. Luis Alvarez, a San Francisco native who later became a Nobel laureate in physics,[278] did not meet Terman's definition of genius as a child and wasn't included in the study. William Shockley, who was a 12-year-old Palo Alto resident in 1922, also failed to make the 'genius' cut, even though he would go on to share a Nobel Prize in physics with John Bardeen and Walter Houser for the invention of the transistor.[279]

Interestingly, Shockley credited his team's success, not with their collective IQs, but with a trial-and-error approach he described as "creative-failure methodology."[280] It was more a matter of perseverance than pixie dust. "A basic truth that the history of the creation of the transistor reveals," he wrote, "is that the foundations of transistor electronics were created by making errors and following hunches that failed to give what was expected."[281]

Due to his role in commercializing the transistor, Shockley is now considered to be one of the founding fathers of Silicon Valley.[282] (Another founding father, coincidently, was Lewis Terman's own son, Fredrick.[283])

Of the children in Terman's study who did exhibit 'genius' level IQs, roughly a third of both the men and women did not graduate from college. Faced with the data, even Terman had to admit: "We have seen that intellect and achievement are far from perfectly correlated."[284] This sentiment is echoed by many other studies; abnormally high IQ is no guarantee of academic success or high creative output.[285]

It's been suggested that Terman's research supports what's called the Threshold Theory, which states that an IQ of 120 is enough to achieve "creative genius".[286] Anything above that point doesn't seem to make much of a difference. Since the average IQ is measured at 100, this would suggest that creativity is well within the reach of a large number of people, given hard work, focus, and a certain dose of luck.

But in 1983, the story got more complicated. Howard Gardner published his groundbreaking book *Frame of Mind*[287] and turned the notion of IQ upside down.

Gardner argued that the standard IQ test doesn't give us nearly the whole picture of intelligence. How can one number possibly give us any useful information about something as complex as a human mind? He suggested we were missing a whole boatload of emotionally driven indicators, which had a profound effect on our intellectual process. Collectively, these additional factors were first called Emotional Intelligence by researchers Peter Salovey and John D. Mayer.[288] The idea became more widely known with Daniel Goleman's international bestseller *Emotional Intelligence: Why it can matter more than IQ*.[289]

Gardner says that we navigate the world and weigh our decisions using all manner of domain knowledge that exists outside the confines of test parameters, along with emotional drivers, including mind frame, self-awareness, relationship management and self management.

So if standard IQ tests don't tell the whole story, and high IQ isn't a solid predictor for creativity, what about tests that are specifically designed to measure creativity?

Divergent Thinking

As we've noted, scientists trying to get to the core of creativity encounter a very basic problem at the outset. Unlike, say, size, or time keeping, creativity is extremely difficult to measure and test. It's even difficult to define.

Frequently, people searching for a creativity metric focus on what's called "divergent thinking". This is the ability to come up with a large number of solutions to a given problem. It's the 'no wrong answers' school of brainstorming. Divergent thinking is all about casting the widest possible net, and then gauging success from overall net size.

There are arguably some benefits to this approach. Since divergent thinking concerns itself with the sheer amount of ideas generated, measuring it is as simple as counting.

What do these experiments look like? Imagine that you're handed a paper cup and asked to think of as many uses for that cup as you can. A person with a knack for divergent thinking would be off and running:

a drinking vessel, a flycatcher, a drain stop, a place to store crayons, a hat, and so on. One of the standard divergent testing questions is, "How many uses can you devise for a brick?"[290]

This approach lets scientists easily assign scores to large groups of test subjects, generating huge amounts of easy-to-interpret data. Assuming, of course, that divergent thinking is a useful lens for examining creativity in the first place. If you've ever walked out of a 'no wrong answers' brainstorming session feeling unsatisfied, you may already grasp the controversy at play here.

Some scientists dismiss the relevance of divergent thinking, arguing that, at the very least, it's not a useful way to assess a person's creativity. Sure, it's easy to compare one person's score to another, but it's difficult to prove that high scorers in the test environment are more creative in real-life situations.

For one thing, divergent thinking tests don't seem to have any correlation with a person's future creativity. Some high scorers might just be really good at playing the divergent game, in the same way that you might be a regular J.P. Morgan when it comes to Monopoly, but that alone doesn't qualify you to run a real-life corporation.

There isn't much evidence that finding many uses for a brick on any given day translates into any creative advantage later in life. And outside of a testing facility, most of the time, solutions only count as solutions if they're actually useful. In other words, a paper cup would make a terrible hat.

In addition, most people would agree that when we judge a person's creative output, quality trumps quantity. Originality or novelty is considered an essential part of the mix. Judging a person's creativity only by their number of ideas is like saying that romance novel writer Nora Roberts, who has published a massive amount of books—over 200—is a more creative writer than legendary poet and author Maya Angelou.

Furthermore, creativity seems to be domain specific with a direct correlation to domain knowledge and not a generalized trait that applies

across the board, as divergent thinking tests would suggest.[291]

To add another wrinkle, University of Iowa neuroscientist Nancy C. Andreasen suggests that the human race might owe far more of its creative achievements to convergent thinking, the direct opposite of the divergent approach.

Convergent thinking doesn't concern itself with finding a lot of answers, but with winnowing down to the single best solution. "A process," she notes in an article in *The Atlantic*, "that led to Newton's recognition of the physical formulae underlying gravity, and Einstein's recognition that $E=mc^2$."[292] But nobody is clamoring to test for convergent thinking. It's tough to know just how to tally it.

It appears that creativity isn't lightning bolts hurled down by Zeus. And it doesn't seem to flow from brick ideation or from the netherworlds of our individual DNA as represented by super high IQ.

Top Down Process

What does it look like when your brain grapples with a creative problem?

Let's turn back to psychologist Daniel Kahneman. Kahneman says problem solving engages System 2 as part of a top-down analytical process, which involves your prefrontal cortex, the home of executive control. System 2 comes online when you deliberately focus on a problem, applying conscious thought to it. Your prefrontal cortex begins to run through a checklist of possibilities, searching out appropriate matching patterns or solutions. And where does your brain look for those answers? In the library of past experiences we call memory.

With the sum of your accumulated knowledge as a guide, the top-down creative mode allows you to form a specific hypothesis and test it. The scientific method is an example of this approach.

Neuroscientist Arne Dietrich says the beauty of this kind of empirical process allowed the NASA engineers to bring the crippled Apollo 13 spacecraft's astronauts home safely, allowed Bach to compose hundreds of cantatas, and Thomas Edison to methodically test all of the many

possibilities that led to the incandescent bulb.[293]

If it all works out, you find an appropriate solution. Sometimes, as with the case of Edison and the incandescent light bulb, the process can drag on for an exhausting 14 months of experimentation.[294]

Scaffolding

Although some problems can be difficult to solve, the brain's ability to project into the future and run multiple simulations means we can fast forward possible outcomes and avoid potential dead ends. We can imagine an eventual outcome or long-term goal and work toward it.

The best-selling novelist and Academy Award-winning screenwriter John Irving says in the introduction of his book, *A Prayer for Owen Meany*, that his habit is to write the last sentence of a new novel first.[295] Some neuroscientists call this *scaffolding:* a problem-solving strategy in which you identify the end point and then fill in the missing steps, making sure the steps sync with the final goal.[296]

This can be a real advantage. A known or hypothesized conclusion makes it easier to connect starting point A to endpoint B. It also allows for task sets, which are the pre-identified parameters for what will and won't be included in the search. Again, this has the effect of narrowing the search and creating more focus on the necessary steps for achieving a logical end goal.

The downside with this kind of creative processing is that narrowing your search parameters ahead of time can shut out some unusual, surprising solutions.

Take, for example, clostridium difficile, the gut disease commonly known as C. diff. This contagion can cause maladies ranging from unpleasant digestive problems and diarrhea to life-threatening symptoms like severe inflammation of the colon. Worse, in recent years, particularly in hospitals, it's become a growing problem, both in frequency and severity.[297]

A successful treatment for eliminating C. diff is to transplant a fecal sample from a healthy individual into the infected patient's gut. That's right, I said "fecal sample". The antibodies from the transplanted fecal matter settle into the patient's gut biome, multiply, and then overpower and wipe out the C. diff bacterium.

One of the problems with the novelty of fecal transplant is the idea of ingesting someone else's feces, no matter the delivery method. It's probably not the first treatment that comes to mind when you're trying to combat a gut disease. Employing a typical top-down process to combat C. diff would likely eliminate this approach from consideration. This is where analytical, creative problem solving can, unfortunately, blind you to counterintuitive solutions.

Luckily, your brain has a backup plan.

Bottom Up Process

This brings us to the second kind of problem solving, the one associated with your unconscious thinking process: epiphanies. It's what many people consider to be the gold standard for true creativity.

The process starts when your more rational, top-down, conscious thinking System 2 struggles with a question it can't seem to solve. With possibilities exhausted, you start to lose focus. Your attention shifts. Your executive control system bows out, handing over the problem to an unconscious neural network, which turns to memory and the associative matching task. It's like an architect who, out of ideas, kicks a problem down to the site foreman, saying, 'See what your guys can do with this design issue.'

However, with your unconscious brain region heading up the search, there is no longer any direction or intervention from the executive control center of your prefrontal cortex. Task sets loosen. Associations connect less powerfully and more randomly. This might sound like it would hamper the whole search enterprise, but without the scrutiny and self-criticism of top-down control, the bottom-up process is allowed to operate unimpeded. Wilder, more unexpected answers begin to surface.[298]

In these kinds of situations, random associations are not only free to form but allowed to take root, and it only takes a few to create a new ad slogan, a novel solution to C. diff, or a new concept in architectural design.

It's important to keep in mind that epiphanies are not some bold strike of thought lightning. They represent a whole lot of toil taking place in the brain's basement, by a host of unrecognized worker neurons who struggle away at discarded problems for minutes, hours, days or even weeks at a time without the analytic tools of executive control. Sometimes, even your unconscious can't solve the problem, but sometimes, we are tickled by the answer.

While your prefrontal cortex is on hiatus, should you chance to encounter some new stimulus—like a tub of water you displace by plopping into it—you, like ancient Greek mathematician Archimedes,[299] might spot new associations bubbling up unexpectedly.

I'm talking about that "Eureka!" moment when associative circuits eventually connect, and the hard work that's been going on in the basement of long-term memory is spotlighted in your working memory. That newly-minted idea, having made it to consciousness, can now bask in the glow of the light of day. You're struck with what feels like a momentary insight. If you're Archimedes, you discover a new principle, which turns out to be a central tenant of physics about how fluid mechanics operate.

Today, using fMRI technology, neuroscientists can watch the 'Aha' revelation unfold on a cellular level. Neurons begin to cluster and activity speeds up, eventually giving way to a burst of energy not unlike a mini fireworks show. All this can be witnessed by the fMRI technician about eight seconds before the subject is aware of their impending moment of truth.[300]

So what are insights?

Insights are not merely the rediscovery of misplaced data, like suddenly remembering where your car keys are. They are combinations or reinterpretations of information in the basement of your associative

memory at work, creating something entirely different or new. They are the embodiment of what it means to 'think outside the box.'

Take this classic riddle:

> A father and his son are in a car accident. The father dies at the scene and the son is rushed to the hospital. At the hospital, the surgeon takes one look at the boy and says, "I can't operate on this child, he's my son."[301]

How can this be?

This 1970's era brainteaser played on the fact that some readers will automatically assume the surgeon is male. (These days, with an increased awareness of adoption and blended families, there are arguably several solutions to this riddle. However, the original intended answer is that the surgeon is the boy's mother.)

Suppose you are one of those people who is unable to find an explanation right away. It's true your prefrontal cortex might be stumped. Unbeknownst to you, even though some lingering gender bias has brought your prefrontal cortex to an impasse, unconscious neural circuits are triggered as a back-up plan to find the answer. This allows your conscious mind to head off in some new direction.

In that case, all this association business continues below your awareness. When the solution finally floats, fully formed, into your working memory, it feels as if it came out of nowhere, an epiphany. (Epiphany comes from the Greek *epiphainein,* which means to 'reveal.')[302]

Only the conscious brain region has language. This is probably a good thing, because if your unconscious brain region could talk, it might very well demand a thank you for all of its hard work, or at the very least an "I told you so.

Mind Wandering

The ability of reflexive System 1 to perform a mundane task while your mind essentially goes into improvisational mode has a name: mind wandering. What we call mind wandering is actually your freewheeling unconscious engine hard at work, checking out random associations for a winner.

Most people think they mind wander about 10% of the time. Researchers at UC Santa Barbara put that figure closer to 30%. When engaged in well-rehearsed tasks, like driving a car on a wide-open highway, it's estimated that mind wandering can be as high as 70%.[303]

Behavioral psychologist Susan Weinschenk[304] makes the important distinction between mind wandering and daydreaming. According to Weinschenk, daydreaming involves an aspect of fantasy, like imagining you've been asked to headline in the next Star Wars movie, or that you've just won the lottery.

Mind wandering occurs when your brain is engaged in a habituated activity, like driving, and at the same time you're wrestling with some other problem. Mind wandering, according to researchers at UC Santa Barbara, is tied to the associative connections of creativity. Weinschenk notes that the ability to perform a rote task while mind wandering and, more specifically, to switch on this mental meandering at will is "the hallmark of the most creative people."[305]

Thought Experiments

There are numerous stories of great thinkers engaging in some very productive mind wandering forays.

When Einstein was in his early teens, he received a gift from a family friend: a series of illustrated science books with the catchy title of *Naturwissenschaftliche Volksbucher* ("People's Books on Natural Science"), by Aaron Bernstein.[306] In *Einstein: His Life and Universe*, Walter Isaacson quotes Einstein as having later described it as "a work which I read with breathless attention."[307]

In the first volume of Bernstein's popular science series, he asked the reader to imagine a bullet shot through the window of a fast-moving train. Bernstein postulated that anyone examining the bullet's exit on the opposite side of the train would conclude the bullet must have been shot at an angle.

Bernstein's point was that, because the earth is hurtling through space, light would exhibit the same refracting properties going through a telescope lens as the bullet passing through the train windows. And that this outcome would always be the same regardless how fast the source of the light was traveling.

Bernstein wrote, "Since each kind of light proves to be exactly of the same speed, the law of the speed of light can well be called the most general of all nature's laws." (I think we can all agree Einstein went on to do a pretty good job chasing down this idea.)

In a later volume, Bernstein had his readers imagine the effects of traveling through space as a passenger on a wave of light. At sixteen, the young science nerd Einstein was fascinated by these creative challenges. In retrospect, we can see the seeds of Einstein's famous 'thought experiments,' where he meditated on complicated physics problems through striking visualization.

This was partly out of necessity, given the limitations of turn-of-the century technologies. It was difficult to conduct literal experiments in the burgeoning field of physics prior to nuclear accelerators. Today, manipulating a solar system under lab conditions still remains a tall order for even the brightest and most determined physicist.

Taking advantage of the basal ganglia's ability to run simulations, and the brain's inherent visual strengths (Thirty percent of brain activity appears to be devoted to decoding images[308]), Einstein eventually found himself applying Bernstein's approach to some of the toughest physics problems of his day.

In essence, this allowed Einstein to watch a movie version of the physics problem as it played out in his head. And the beauty of this technique was that he had the power to edit, readjust, and rerun the footage over

and over as he sought to uncover the underlying principles of space and time. Before the days of particle accelerators and NASA telescopes, Einstein was already making use of the best tools nature had to offer.

There was, however, one small problem: his thought experiments might go off without a hitch inside his own mind, but he still had to demonstrate the results to the greater scientific community.

To prove one of the tenets of his Theory of General Relativity—that light bends when it passes near a very heavy body—Einstein eschewed the lab for a more creative solution: a total solar eclipse. When the moon passes in front of the sun, the moon shields some of the sun's intensity, allowing us to observe distant stars, and to measure their light for refraction. Luckily for Einstein, in May of 1919, English astronomer Arthur Eddington agreed to travel to the Island of Principe off the west coast of Africa to take telescopic photographs of stars during an upcoming eclipse.[309]

From Einstein's point of view, Eddington's task couldn't have been more simple: to demonstrate that starlight would be bent by the warped space around the sun's mass. In reality, given the weather conditions, Eddington risked his life and was barely able to snag the needed photographic evidence. But Eddington got the shots, and his subsequent calculations proved Einstein's theory and helped turn him into the scientific rock star he still is today, nearly 100 years later.

Mind wandering, or what Einstein self-described above as 'combinatory play,'[310] is essentially putting your mind in a relaxed mode where executive control and working memory restraints are loosened, but not completely undone. This allows you to access somewhat more random connections while still operating within reason. In this regard, mind wandering can be thought of as combinational, a hybrid of both top down and bottom up processing, both part of analytical System 2.[311]

Whether you're working top down or bottom up, you're harnessing your solution mechanism. Creative problem solving, even for an Einstein, is not some magical technique wholly different from the way the human brain solves any kind of problem.

There is no secret sauce involved in creative solutions. If you want to improve the number of creative solutions you produce, you must invest time in the process. You'll need to build a brain app to practice, habituate and improve problem solving. And all of this will mean ratcheting up your associative domain knowledge.

Domain Knowledge

What is the most practical method for generating fresh new ideas? Despite our slowly growing understanding of the neural processes governing creativity, that question haunts every scientist, writer, artist, filmmaker, athlete and inventor, or anyone serious about upping their creative chops.

Much has been written about the connection between creativity and what's called the default network, the mental mechanisms associated with mind wandering and daydreaming we introduced in Chapter Two. This might be because there is something inherently alluring about the idea of epiphany, that bolt-out-of-the-blue inspiration seen as the mind fruit of spontaneous genius.

What doesn't get as much airtime is the role of domain knowledge in creativity—that is, the breadth and depth of your familiarity with a given field, including the contents of your associative memory and the sum total of your practice regimen.

One of the best-known epiphany stories occurred around 1666 when Sir Isaac Newton was allegedly conked on the head by a falling apple, thus triggering a revelation on the nature of gravity. Here's some slightly lesser-known context: by 1666, Newton was a master of Euclidean geometry, algebra, and Cartesian coordinates. He'd already invented calculus, which he needed so he could measure planetary orbits.[312]

"In other words," writes Nancy C. Andreasen in 'Secrets of the Creative Brain,' "Newton's formulation of the concept of gravity took more than 20 years and included multiple components: preparation, incubation, inspiration..."[313]

Newton might not have been the first person to be beaned on the skull by an apple. But it's possible he was the first person whose entire career had prepared him to fully grasp the principles behind his 'apple moment.'

Similarly, Einstein's famous thought experiments were more than idle fancies; they were grounded in his expertise in physics. There's a reason Darwin's breakthroughs came in biology and not, say, dance. It's the same reason rock icon Prince was able to bring us his mega hit "Purple Rain" in 1984 at the age of 26 when he mixed pop, rock, and gospel. Prince, the son of a musician, had been playing piano and composing since he was seven years old.[314]

There's no way around it: your best bet for creative achievement is doing your homework. Having an enormous library of information and expertise helps build out the novel connections between ideas that we call creativity. It doesn't guarantee that great works will necessarily follow, but for those of us who enjoy the experience of trying to bring something new into the world, it appears that stocking and constantly restocking your brain's memory library is a prerequisite.

So was Steve Jobs really a creative genius? The visionary techno-wizard of Palo Alto whose own 'apple moment', came with a wave of his hand, summoning from thin air the Mac, iPhone, iPod, and iPad? Or, instead, was he an extraordinary designer, and marketer in a field he was passionate about, who surrounded himself with like-minded experts, and lived out Daniel Kahneman's formula for success (hard work + luck)?

This rewrite on the classic headline, 'Genius has epiphany,' may not sell as many papers or computers. A bolt from the blue is much catchier than a bolt from decades of careful groundwork. But in the end, a lack of pixie dust doesn't diminish what Newton, or any other domain master, has brought us.

Copy, Transform and Combine

In his four-part documentary series "Everything is a Remix," Kirby Ferguson has something to say about the nature of creativity and it

doesn't involve pixie dust. "Creativity isn't magic," says Ferguson. "It happens by applying ordinary tools of thought to existing materials."[315]

His central premise is that ideas don't originate in a vacuum. Instead, most creators, from George Lucas to DJ Danger Mouse, borrow and adapt their ideas from other sources.[316]

Artists, inventors, and serious thinkers immerse themselves in their chosen subject, Ferguson explains. Often, the early learning phase involves outright copying others—an effective way of practicing and developing one's abilities. Ferguson reminds us that Richard Pryor's earliest standup was an obvious riff on Bill Cosby's work.[317] Similarly, Bob Dylan began his career as something akin to a Woody Guthrie impersonator. Once would-be creators have assembled a deep domain knowledge and refined their skills, they can start to make their work their own.

Ferguson sums up the process with a simple formula: copy, transform, and combine. Creative people pick up on, or copy, aspects of other material that interest them. Next, the creator elaborates on this idea, tinkering with it and altering it until it is often distinctly different from the original. This element is then combined with other copied and transformed ideas, until a whole work is created. If the tinkering is extensive enough, and the recombinations novel enough, the end result can serve to inspire the next wave of creators.

Ferguson calls these inspired, adapted works "remixes", a word he borrows from hip-hop culture. Hip-hop, which has an established tradition of recombining and reworking samples of older songs, has understood "copy, transform, combine" from the very beginning. Sugarhill Gang's landmark "Rapper's Delight" borrows its bass riff wholesale from Chic's "Good Times," a riff which has since been sampled dozens of times, by everyone from Grandmaster Flash to Will Smith to Daft Punk.[318]

In fact, Ferguson makes the case that most entertainment is a kind of legal remix. Genres like horror, action, or romantic comedy can only exist because writers have borrowed from each other to create a commonly understood palette of ingredients, from jump scares to car

chases to meet-cutes. This isn't even getting into the number of films each year that are direct remakes, sequels, or adaptations of pre-existing stories. (We're looking at you, superhero movies).

Ferguson vividly demonstrates how even game-changers like filmmaker George Lucas weren't working from scratch. The iconic movie *Star Wars* seemed to invent a new genre out of whole cloth, but, in fact, much of its power comes from the bafflingly wide assortment of older ideas Lucas threw together, from old Flash Gordon flicks to Westerns to Joseph Campbell's philosophies of myths and heroes. In fact, the original trilogy includes many shot-for-shot copies of scenes from other films, including Akira Kurosawa's samurai movies. (Luke's white tunic in the first *Star Wars* is familiar to any young martial arts student, and his light saber is just a sword plus a laser.)[319]

In 2016, Leonardo Dicaprio won an Oscar for Best Actor in Alejandro González Iñárritu's *The Revenant*. Much like Star Wars, the film includes some striking visual parallels to another director's work, namely Soviet filmmaker Andrei Tarkovsky. Iñárritu openly admits to Tarkovsky's influence, among others.[320]

Triumph of the Remix

The key to novel recombination is making surprising new connections across a wide variety of disciplines. Which brings us to Tony-winning composer, actor, rapper, and MacArthur "Genius" winner Lin-Manuel Miranda.

While reading Robert Chernow's biography of Alexander Hamilton, Miranda noticed striking parallels between the life of America's first treasury secretary and the classic hip-hop narrative. The result was *Hamilton*, a hip-hop biographical musical narrated by Aaron Burr, Hamilton's political rival and eventual killer. It's a fresh take on the monumental brilliance and equally monumental egos of our founding fathers, capturing the 18th century revolutionary spirit for new generations of Americans. It is also a stunning example of a Kirby Ferguson-style remix.

The beauty of *Hamilton* is not just the novelty of Miranda's recombination—on the face of it, a rap show about a long-dead treasury secretary doesn't seem like a guaranteed success. But Miranda's extensive domain knowledge of both hip-hop and musical theater, combined with years of historical research and careful tinkering, allow him to translate the story of America's early days into a modern, effective format.

For instance, he captures the machismo and illicit danger of eighteenth century dueling with "The Ten Duel Commandments," an obvious homage to "Ten Crack Commandments" from rapper Biggie Smalls. But even beyond Chernow and Biggie, Miranda cites an almost George Lucas-like array of inspirations, including musicals like *Evita* and *Les Misérables*, the immigrant experience of Miranda's own father (who, like Hamilton, was born in the Caribbean and arrived in America as an ambitious, driven teenager), the free-wheeling comedy podcast *My Brother My Brother and Me*, Aaron Sorkin's *The West Wing*, and the insightful criticism of Miranda's wife, Vanessa.

Similarly to Mark Twain's ritual of reading his early drafts aloud to his wife and daughters, Miranda says that Vanessa's at-times blunt critiques were key to some of the revisions that make the final version work. And the final version did work, by nearly any standard, earning universal critical acclaim, 11 Tony Awards (including Best Musical), and a seemingly endless run of sold-out shows.

Miranda emphatically attributes his success not to genius, but to hard work. "I'm not a ****ing genius," he told Rolling Stone in 2015. "I work my *** off. Hamilton could have written what I wrote in about three weeks. That's genius."[321] Miranda, meanwhile, took seven years of rough drafts and top-down editing to bring *Hamilton* to life.

Interestingly, at least one person would disagree with Miranda's assessment of Hamilton's genius: Hamilton himself.

> "Men give me credit for some genius," Hamilton is reported to have said. "All the genius I have lies in this: when I have a subject in hand, I study it profoundly. Day and night it is before me. My mind becomes pervaded with it. Then the effort that I

> have made is what people are pleased to call the fruit of genius. It is the fruit of labor and thought."[322]

Analogous Thinking

You may not be writing your own Broadway show about a founding father, but if you're looking to unearth some creative recombinations of your own, you might consider the concept of analogous thinking.

This approach suggests that often you can reach the best solution to one problem by looking at what already exists in a different domain. By adapting elements of those works to your own purposes, you can create something new, exciting, and effective.

Researcher Gary A. Davis estimates that "perhaps 80% of creative ideas"[323] follow this formation. The key is those clever recombinations. This is also why, in a brainstorming session, an outsider with limited domain knowledge about the subject but with strong expertise about some analogous field can help spur some startling discoveries.

Miranda is not the first to find grist for musicals in unlikely places; as creativity expert Davis points out, the Broadway juggernaut *Cats* was inspired by T.S. Eliot's *Book of Practical Cats*. But Miranda may be the first to reimagine George Washington's cabinet meetings as vitriolic rap battles between Alexander Hamilton and Thomas Jefferson.

In the 90's, engineer and bird-watcher Eiji Nakatsu of Japan was working for the rail company JR-west when he observed a kingfisher diving for fish while barely disturbing the water. Realizing that the head and beak shape resulted in incredible aerodynamics, Nakatsu modeled the front train car after the bird to create a quieter, faster bullet train.[324]

The shape of Pringles potato chips was inspired by how tightly and compactly wet leaves can stack on each other. (If you prefer a heartier, more old-fashioned chip, you may be able to find other parallels between Pringles and dead leaves.)[325]

The ubiquitous fastening material Velcro, beloved by parents of toddlers everywhere, came out of a fateful 1941 trip in the Alps, when

Swiss engineer George De Mestral and his dog bumped into burdock thistles. Later, De Mestral was surprised by the thistles' sticking power to his clothes and dog. Intrigued, he grabbed an old microscope and magnified a sample. The burr was covered in tiny hooks that stuck to the natural loops created by fabric or fur.

De Mestral says he instantly recognized the analogy between thistles and clothing fasteners. He's quoted as recounting his reaction at the time like so:

> "I will design a unique, two-sided fastener, one side with stiff hooks like burrs and the other side with soft loops like the fabric of my pants. I will call my invention 'Velcro,' a combination of the word 'velour' and 'crochet.' It will rival the zipper in its ability to fasten."[326]

Whether this was his exact thought process, or, more likely, how he remembered it later (keeping in mind that memory is not a perfect recorder of events), the key point is that De Mestral's analogous brain made the link.

As all good invention stories go, his bold challenge to the tried and true zipper initially brought its share of ridicule. De Mestral, however, was undaunted, and spent years employing top-down problem-solving, working through a variety of material applications, until, through trial and error, he hit upon nylon sewn under infrared light as the perfect hooks for his artificial burrs. He patented the idea in 1951 and never looked back as Velcro went on to become a multimillion-dollar business.

The Velcro idea has continued to morph across other domains, from healthcare to children's shoes to space travel. NASA's astronauts use a Velcro like product to keep their dinner plates from floating away during weightlessness in orbit.[327]

While Velcro's unexpected success is inspiring, analogous thinking has a much bigger story to tell from a pivotal year way back in 1859, when Charles Darwin published *The Origin of Species*. He arrived at his central notion of evolution by employing analogous thinking when

he reverse-engineered the human practice of selective cattle breeding to better understand how a species evolves over time.[328]

Analogous Thinking in Business

In 2008, Oliver Gassmann and Marco Zeschky chronicled their research of analogous thinking in the world of product innovation.[329] The researchers were spurred on by BMW's 2001 iDrive, which used a standard video game joystick to eliminate up to 200 different knobs and switches, creating a simpler dashboard in BMW's luxury cars.

Seeing this crossover problem solving led Gassmann and Zeschky to wonder how often engineering teams were employing this technique. They decided to study companies who were using analogous thinking to spark creative breakthroughs.

One of those case studies was the AlpineCo, a prominent ski manufacturer. The company discovered that at high speed, their snow skis developed vibrations, called 'resonance frequency.' At 1800 hertz, the vibration became so intense that it made their skis extremely difficult to control, and, therefore, dangerous.

AlpineCo's Research and Development team thought they could save time if they looked to other industries that had already solved vibration problems. Without a solid idea how to refine their initial search, the R&D team simply began by kicking around general concepts on the Internet like, 'vibration, damping, and cushioning.' From the very start, they were open to and "actively looking for analogous solution,"[330] but this by itself wasn't enough.

The problem was that without any way to define a task set, the scope of the inquiry became overwhelming. Chasing down the plethora of industries that had at one time or another dealt with vibration problems proved to be untenable. Finally, one of the R&D team members realized that they might have more luck if they only focused on vibration solutions developed to counter a frequency of 1800 hertz or higher.

This led them to a rather surprising solution. It seems that this high hertz vibration problem was well known in the field of acoustics,

particularly to the makers of bowed instruments. Drawing a bow quickly across strings can produce a chattering effect, similar to how it feels when you slam on your car's anti-lock brakes. In a violin, it results in uneven pitch—not quite the deadly danger of uncontrollable skis, but still a drawback that demanded solutions.

One enterprising luthier had solved the chattering problem by incorporating a deadening layer of material in his bows, which smoothed out bowing by absorbing the vibration and knocking out the resonance feedback. The R&D team at AlpineCo tested the idea and found that this same material could easily be incorporated into their skis at a minimal cost and effort. This ski dampening has the impressive name of 'frequency tuning,' and is now standard operating practice throughout the ski industry.

At first blush, it might not seem like a luthier would have much to teach a ski maker. But analogous thinking shows us that solutions in one domain can be repurposed again and again for other domains. That's why it might not be surprising to learn that in an analysis of patents, "most inventions were based on a rather small number of generally applicable principal solutions."[331]

Researchers Oliver Gassmann and Marco Zeschky say there are three important points to keep in mind when applying analogous thinking to innovation and problem solving.

First, it's critical to break down the problem and its context until you thoroughly understand exactly what you're dealing with. As in Kaizen, an in-depth analysis is key to determine the root cause. In the case of the ski company, this meant they needed to understand just what was happening to their skis at high speed. This, in turn, leads to abstractions from the problem into specificities like vibration, dampening and cushioning.

Second, you can't access solutions across domains unless you're willing to think outside the confines of your immediate subject. Even though the AlpineCo R&D team did not have exposure to the field of acoustics, the R&D leader opened the door for looking at other possibly relevant opportunities. This deliberate break with conventional thinking is

necessary to allow for the identification of novel solutions. The Greeks called it 'synectics,' "the joining together of different and apparently irrelevant elements."[332] This is the real power in analogous thinking.

Finally, you have to carefully assess your results to ensure that the repurposing of the idea has merit. AlpineCo ran material tests to satisfy themselves that indeed there was a crossover between instrument bow dampening and improved ski design.

Gary A. Davis suggests that to better employ analogous thinking in your problem-solving, you should ask yourself these four important questions:[333]

> What else is like this?
>
> What have others done?
>
> Where can I find an idea?
>
> What idea can I modify to fit my problem?

If you frame your world in this way, you open yourself up to exploring more domains. By comparing and contrasting new information to your own domain expertise, you can hit upon some uniquely creative ideas.[334]

In your culinary adventures, you might not think about mixing chocolate with bacon, but many people swear by it. Paul Simon's *Graceland* melds traditional American roots rock with Cajun zydeco and South African mbaqanga, among other influences.[335] Music and fashion icon David Bowie's inspirations included sci-fi novels, miming, the Japanese theater tradition of Kabuki and avant garde performance artists, to name a few.[336]

Eli Whitney, of cotton gin fame, was the first to figure out how to clean short-staple cotton, and he drew his inspiration from watching a cat trapped on one side of a wire fence trying to pull a chicken through the fence.[337] (A pretty rough day for the chicken, but a great day for Whitney.)

Medici Effect

If you're a fan of the Renaissance, you are probably familiar with the House of Medici.[338] This powerful political dynasty bankrolled generations of thinkers, poets, philosophers, sculptors, painters, architects, and scientists. It is no exaggeration to say that in 15th century Italy, the Medicis were a driving force behind making Florence, well, Florence. We still enjoy their creative legacy; Medici sponsorships enabled the work of heavy hitters like Galileo and Botticelli, as well as Donatello, Raphael, Michelangelo and Da Vinci. (The artists, not the Teenage Mutant Ninja Turtles.)

The innovations of the Renaissance, Frans Johansson argues in his book *The Medici Effect*,[339] were partly spurred by the natural result of funding and gathering so many intellectual and artistic masters in one place, where they rubbed shoulders and exchanged ideas. According to Johansson, the Medici genius was in creating conditions that fostered the intersection of diverse disciplines, enabling analogous thinking and thus ratcheting up Kirby Ferguson's copy, transform and combine process. This co-mingling ultimately led to extraordinary creative leaps in innovation.

These intersections have occurred throughout time—more recently, in California's Silicon Valley. As more and more people moved to take advantage of the dot COM explosion, a culture began to emerge that fostered a new way to think about the possibilities of computer technology. And that can foster a collective momentum, a kind of group growth mindset. Experts teach each other, challenge each other, and inspire each other. When people share passion and proximity, creativity becomes contagious.

Often when we think of creativity, we might think of it on an individual basis: the lone wolf like Velcro's De Mestral, relentlessly pursuing his passionate idea, while others ridicule and deride. Let's face it, there is something intoxicating about the legend of the underdog, and the "I told you so" moment when perseverance triumphs over the doubters.

Still, when those individuals converge on epicenters like Florence and Silicon Valley, creativity multiplies by force. And although it is true that individuals have created some incredible innovations, a disproportionate amount of creative breakthroughs occur in clusters around creative centers, where analogous thinking and the trading of domain knowledge becomes the common currency.

Johansson suggests you can create your own little Medici effect by correctly setting up your environment. The real power lies in the brain's ability to combine domain information from all walks of life. It's at these nexus points that you can spark some surprising insights. One of Johansson's central themes is to immerse yourself in as many different experiences as possible, with an eye toward seemingly unrelated connections to create new insights.

Identifying these points of connection is at the heart of analogous thinking and Kirby Ferguson's creative model of "copy, transform and combine." Johansson suggests that the key to novel ideas is keeping an aggressively open mind in the recombination phase, what he calls "the intersection", bringing together elements that might, on the surface, seem out of place. (For instance, Alexander Hamilton and Jay-Z.)

As Johansson says, "The world is connected and there is a place where those connections are made—a place called the Intersection. All we have to do is find it... and dare to step in."[340]

Superlinear Scaling

One of the intriguing things about large cities is that they produce a disproportionate number of patents and inventions. Theoretical physicist Geoffrey West demonstrated that large cities follow a power law known as 'superlinear scaling': they generate more creativity, and at a faster rate.

One might imagine that a large city means more people, and more people would, by definition, mean more creativity. But West's research showed "the average resident of a metropolis with a population of five million people was almost three times more creative than the average resident of a town of a hundred thousand."[341]

So what's going on? Researchers from the MIT Media Laboratory's Human Dynamics Lab think they know the answer.[342] Their work indicates that greater population density means more face-to-face interaction. And face-to-face interaction means greater chance of ideas becoming contagious. It's the same principle that drives the common cold, and the Internet. The greater the network, the faster and more forcefully ideas or germs can spread.

When novel thinkers congregate in one area, they have the possibility of trading, spreading, and acquiring new ideas every time they make a morning coffee run. They could encounter a colleague. They could encounter a rival. They could encounter a friend of a friend, working in a somewhat adjacent field, whose observations could spark an entirely new train of thought.

Steven Johnson says to think about your brain as a 'network' of roughly 86 billion neurons. "By comparison there are somewhere on the order of 40 billion plus pages on the Web—that means you and I are walking around with a high-density network in our skulls that is orders of magnitude larger than the entirety of the Web."[343]

When we talk about creativity in the abstract, it can sound almost too simplistic– that everything could come down to something as simple as conversations. But when you consider how often innovation lies at the surprising intersection of two seemingly disparate ideas, you begin to understand the potential power of face-to-face interaction for cultivating creativity.

Cultivating Creativity

When it comes to cultivating creativity, Scott Barry Kaufman and Carolyn Gregoire say that beat writer Jack Kerouac had it right: "The best teacher is experience."[344] According to them, the single most consistent trait that predicts creative triumph is "the drive for cognitive exploration of one's inner and outer worlds."

We've talked about this in terms of the rage to master, as well as Dweck's model for growth mindset, but Kaufman and Gregoire take a more nuanced look at growth mindset. They discuss the idea of 'openness'

to learning in three distinct areas: intellectual engagement (problem solving), affective engagement (connecting to a subject emotionally) and aesthetic engagement (the seeking of beauty in the arts).

We can think of intellectual engagement as correlating to scientific creativity, while affective and aesthetic engagement are more connected to artistic creativity. Kaufman and Gregoire's research suggests that when it comes to producing creative thinking, openness trumps both IQ and divergent thinking.

At a neurological level, openness is driven by neurotransmitters like dopamine. Kaufman and Gregoire say that simply characterizing dopamine as the "feel-good" hormone is selling this versatile neurotransmitter short. Dopamine also seems to facilitate plasticity in thinking, which drives greater associative algorithms.[345]

Kaufman and Gregoire suggest that, beyond the notion of reward, dopamine promotes a *wanting,* a kind of unremitting need, the kind of desire associated with addiction and the rage to master. In this regard, dopamine is less about a physically pleasurable payoff and more about what psychologist Colin DeYoung of the University of Minnesota calls the satisfaction that comes with exploration and mastery. She labels dopamine as, "the neuromodulator of exploration."

As discussed, identifying patterns to predict future outcomes is more than a hallmark of associative memory; it's an evolutionary advantage. Recognizing the connection of the changing seasons and food availability allowed our ancient ancestors to develop migratory patterns during the cold season, a pretty important chapter in the 'stay alive' hand book. Here, dopamine is clearly much more than a feel-good drug.

We learned in Chapter Four that focus is an essential ingredient in building a solid practice app, but Harvard psychologist Shelly Carson and her team's research led to an unusual discovery about dopamine's effect on focus and creativity.

Reduced Latent Inhibition

Reduced latent inhibition can be described as difficulty filtering out interruptions in everyday experience, or the inability to stay focused. Your senses are constantly under assault: sirens, an office worker chewing loudly in the cubicle next to you, the smell of cologne in a crowded elevator, the roar of a crowd, or the buzz of email. Distraction is ever present. Obviously, these annoyances diminish our ability to focus, which in turn, might negatively affect our ability to generate creative ideas.

It's true that diminished focus might be a negative net result of heightened sensory awareness, but Carson's team discovered something unusual when they looked at Havard staff members well known for creative prowess. It seems that "The university's eminent creative achievers were seven times more likely to have reduced latent inhibition—meaning that they had a harder time filtering out seemingly irrelevant information and continued to notice familiar things."[346]

So how could a propensity for distraction lead to greater creative output?

Rather than a detriment, researcher Darya Zabelina of Northwestern University says that having a 'leaky' sensory filter—a brain that struggles to filter irrelevant information from the environment—is linked with higher levels of creativity, because these people simply process more information than their better-focused counterparts.[347] And the more information a person can process, the wider the set of associative connections, which leads to a greater possibility of novel solutions.

History is rife with examples of well-known creatives and their easy distractibility.[348] Charles Darwin, Marcel Proust and Franz Kafka all are reported to have had a hypersensitivity to sound; something as simple as a loud ticking clock could derail their thinking. But the flip side of their heightened sensory awareness was that they were less likely to miss out on the linkage of everyday experience and its connection to more powerful ideas.[349]

Problem Finders

In the 1960's, social scientists Jacob Getzels and Mihaly Csikszentmihalyi were searching for the root cause of creativity. Their quest brought them to the Art Institute of Chicago, where they observed fourth-year students preparing to draw a still life by arranging standard drawing class objects on a table. In *To Sell is Human,* Daniel Pink describes what happened next:

> "The young artists approached their task in two distinct ways. Some examined relatively few objects, outlined their idea swiftly, and moved quickly to draw their still life. Others took their time. They handled more objects, turned them this way and that, rearranged them several times, and needed much longer to complete their drawing. As Csikszentmihalyi saw it, the first group was trying to solve the problem: How can I produce a good drawing?"(solely about the technique) "The second was trying to find a problem: What good drawing can I produce?" (about creating art)

In a subsequent art show, a panel of experts declared that the problem finders generally had the better drawings. Follow-up studies eighteen years later confirmed the finders were indeed more successful in the art world.[350]

According to Pink, "Getzel and Csikszentmihalyi's research influenced the modern understanding and academic study of creativity. In subsequent research, they and other scholars found that people most disposed to creative breakthroughs in art, science, or any other endeavor tend to be problem finders." These people tend to experiment more across a variety of disciplines, search for unique combinations, and show flexibility in both their approach and their willingness to change course as necessary.

Creativity in Motion

If you were going to try to imagine a problem finder's lair, the hideout of a person who created a piece of technology that revolutionized

the fitness world and left a worldwide cultural impact, you probably wouldn't picture a barn in rural Minnesota.

But to be fair, you've probably never driven out to the wide-open farmlands of small-town Waconia, past an electronically operated gate and down a long dirt road to visit former hockey goalie and full-time entrepreneur Scottie Olson.

Chickens roam the grounds. Swans bob around in the lake out back, their honks creating a sort of free-form jazz. But the focal point of the yard is definitely the large loop of elevated track, like a misplaced section of the Chicago 'L'. It's a full-size prototype of a contraption somewhere between a ski lift and a gentle roller coaster. *SkyRide*, a sign proclaims.

After that, the white barn perched atop a hill, with its swooping green metal roof, seems relatively normal. Except, perhaps, for the oversized replica of a trophy-mounted zebra head above the double doors.

"When I bought [the barn] it had piles of hay in it," remembers Olson. But he'd known right away it would be one of his future homes. "That was always my dream," he told us, "to live in a barn."

Olson is a man who trusts his instincts, whether he's developing the SkyRide or commissioning his artist friend Jimmy Hartman to design a penguin lawn ornament—or creating the Rollerblade. If you've ever strapped on a pair of Rollerblades and gone racing through your neighborhood, you have Scottie Olson to thank.

The idea of attaching a row of wheels to a shoe is not a new one. In-line skates have existed since at least the mid-1800s. In 1849, when German composer Giacomo Meyerbeer wanted characters in his opera *Le prophète* to appear to ice skate onstage, he had a butcher named Louis Lagrange whip up a primitive version of the wheeled skate, although this model had some essential drawbacks. For instance, it was almost impossible to turn or stop, two fairly important features in any skate design.[351]

We tend to think of the clunkier looking quad skates (also known as "roller skates") as a primordial ancestor to the sleeker in-line skate, but in fact, at the time, the quad skates' double row of wheels was an innovation, since putting more weight on one side or the other allowed 19th century skaters something like steering. For the next century, quad skates left their in-line forbearers in the dust.

In-line skates survived here or there as a curiosity, but they were unknown to mainstream society when Olson tried on his first pair as a teenager in the late 1970's. Olson was back in the U.S. after playing as the only American in Canada's Junior A ice hockey league, even making it to the Memorial Cup. "I had a really good career as a goalie," he remembers. "And then I signed a contract and played in the farm league down here, in the States, but I always had that idea that I was gonna be my own boss doing something. And then I happened to fall into the blades."

It was love at first skate for Olson, who immediately saw the potential. Here was a way to free ice skating from the ice—to skate anywhere and in any weather. "And then I realized that, as great as they were, they were sure slow," he says. In fact, early in-line skates were slower than roller skates. "They were made by a guy out in LA, who had never skated on them," he explains. Olson, on the other hand, brought with him the speed demon expectations of a serious ice hockey player. He figured there had to be a way to make them go faster.

Olson got to work. He and his brother began to tinker with the initial set-up of the skate, remaking it with modern materials. They added a rubber toe break and polyurethane wheels, and after some experimentation, borrowed their ball bearing design from roller skates. In a stunning victory for analogous problem solving, they'd found that the roller skate's ball bearing configuration was also the most effective one for this new type of skate.

Inspirations came from other athletic gear as well. "One of the big reasons the Rollerblade became a big recreational skate was the type of boot we ended up using," he says. "We got lucky, because just at that time, the first plastic boots were being produced [for ice hockey]." This itself had been a product of analogous thinking: "They took the

technology from ski boots, which used to be leather."

And so Olson had a Medici moment of sorts, traveling to Italy, which was then at the forefront of the plastic athletic boot scene. Olson was thus able to borrow the plastic boot design from ice skates, which had borrowed it from skiing. "That way, a recreational person could get that support you really needed."

Olson describes his work with Rollerblades as a combination of top-down and bottom-up thinking. Like a younger, more physically fit Edison, he says the process included a number of promising ideas which didn't go anywhere. Still, he doesn't see himself as the inventor of the in-line skate; after all, other models had already existed. But by 1981, the new innovations, including those clever recombinations of features from other forms of skates, had created something all its own: a Kirby Ferguson-style remix you could wear on your feet.

Olson was equally ingenious in marketing. His ice hockey friends used Rollerblades for off-season training. He organized roller hockey teams. And he spread the word by skating everywhere he went—sidewalks, cities, beaches, even airports. In the days before the TSA, he said it wasn't uncommon for him to Rollerblade right down the aisle of an airplane. People took notice.

The timing was right for it, he adds, unknowingly reflecting Daniel Kahneman's truism about hard work plus luck. Rollerblades provided an alternative to ice skates for American athletes tired of the long-running Canadian monopoly on ice hockey. And they were a sleeker, cooler alternative to roller skates for a public that was just beginning to go crazy for outdoor fitness.

By the early nineties, Rollerblades was a $650 million sensation—and Olson was no longer with the company. The friend he'd hired as his accountant had been embezzling, and they were far behind on their taxes. The resulting financial straits led Olson to turn to some wealthy local businessmen for help, who ultimately bought him out of his own company, in a move that was technically legal but which arguably played on the business naiveté of a young guy from Minnesota.

However, Olson left Rollerblade as a multi-millionaire, and a man determined to keep creating. He credits some of his determination to his days as a goalie in Canada—the lone American defending the goal, out on the ice by himself.

> "You have to try not to let anything really get you down," he says. "And pressure doesn't bother me. I learned, somehow, to deal with it. I do know exercise certainly helps."

Olson's newer inventions include the RowBike, which marries the concept of a rowing machine with the mobility of a bike to create a form of transport that provides an upper body workout on two wheels. It's beloved by men over fifty, he notes, as well as the disabled community. "That's the beauty of rowing," he says. "You can be a paraplegic and still row."

His current project is the SkyRide, the track-mounted bicycle-powered device that allows riders to pedal in the air. "I don't just want to make fitness fun," he says. "I want to make it exciting." When we caught up with Olson in late 2015, he had just sold his invention to the Carnival Cruise line. "We're actually building, right now, the track that is going up on the ship," he explains. "And we're building the rides here, in our shop. So we're on the fast track now, because all of a sudden, it's gotta get done. Enough dinking around with prototypes. We've gotta build production models."

Talking with Olson, one gets the impression of a man who is always dreaming about his next big idea. Conversation is filled with long pauses. Olson certainly seemed to be a model of reduced latent inhibition, interrupting the interview several times to point out a group of young swans, to admire a hawk in flight, to let a pack of pet dogs in and then out of the room again, and then to scoop up one large dog under its front legs and lift it into his lap while he spoke, as if bouncing a giant baby.

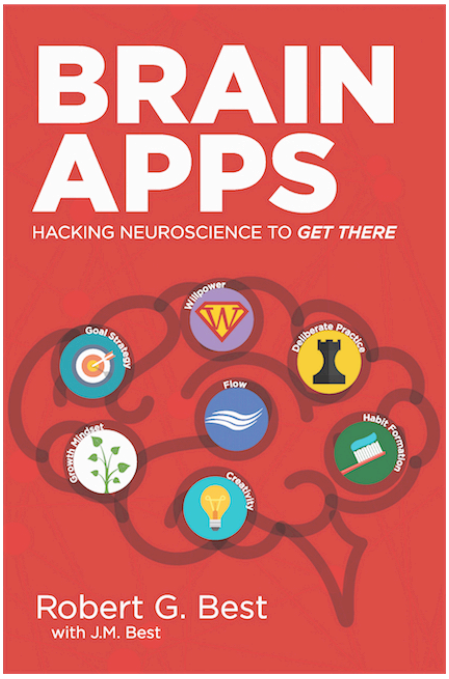
If it made Olson something of a unique interview, these tendencies may also explain some of his success. Perhaps his freewheeling approach to attention allows him to make observations the rest of us miss, watching the birds wheel overhead and allowing the sight to capture his

imagination with a new, surprising thought experiment about kinetic possibilities. Olson himself noted that his best ideas tend to come to him while he's in motion. "I work out in the morning, and I always have my phone or my pen and paper, because it gets me thinking better."

Legions of rollerbladers, disabled athletes, cruise line goers, and penguin lawn ornament fans thank him for it.

Chapter Key Points: Hacking Your Creativity App

- The first step of creative thinking is to develop a deep level of domain knowledge.
- Leverage your own Medici effect. By combining separate spheres of domain knowledge, you create a situation where the whole is greater than the sum of the parts.
- One way to spur analogous thinking is by employing Gary A. Davis's essential questions:
    - What else is like this?
    - What have others done?
    - Where can I find an idea?
    - What idea can I modify to fit my problem?[352]
- Kirby Ferguson's copy, transform and combine model serves as a template for creative behavior.
- Creativity requires a top-down thinking approach, which often results in some degree of failure.
- Remember, epiphanies are not the result of creative lightning, but are the direct consequence of a stymied top-down process.
- For best results, cultivate the flexibility, experimentation, and novel attitudes of a "problem finder."



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