CHAPTER 1

TO INNOVATE IS HUMAN

WHY CAN'T WE FIND THE PERFECT STYLE?

To appreciate the human requirement to innovate, look no further than the sculpting of hair on the heads around you.

This same sort of reworking is seen across all the artifacts we create, from bicycles to stadiums.




This all begs a question: why do hairstyles and bikes and stadiums keep changing? Why can't we find the perfect solution and stick with it?

The answer: innovation will never stop. It's never about the *right* thing; it's about the *next* thing. Humans lean into the future, and there is never a settling point. But what makes the human brain so restless?

WE QUICKLY ADAPT

At any moment, roughly a million people are reclining in comfortable chairs thousands of miles above the surface of the planet. Such has been the success of commercial flight. It was not long ago that traveling through the sky was an unthinkably rare and risky adventure. Now it hardly lifts an eyebrow: we board like sleepwalkers, only becoming energized if something gets in the way of our expectation of delicious meals, reclining seats and streaming movies.

In one of his routines, the comedian Louis C.K. marvels at the degree to which travelers have lost their wonder with commercial flight. He impersonates a griping passenger: "And then we get on the plane and they made us sit there on the runway, for forty minutes. We had to sit there." Louis' response to the passenger: "Oh? Really? What happened next? Did you fly through the air, incredibly, like a bird? Did you partake in the miracle of human flight, you non-contributing zero?" He turns his attention to people who complain about delays. "Delays? Really? New York to California in five hours. That used to take thirty years. Plus, you would die on the way there." Louis recalls his first experience with wifi on a flight, in 2009, when the concept was first unveiled. "I'm sitting on the plane and they go, "Open up your laptop, you can go on the internet." And it's fast, and I'm watching YouTube clips. It's amazing: I'm on an airplane!" But a few moments later, the wifi stops working. And the passenger next to Louis gets angry. The passenger exclaims, "This is bullshit!" Louis says, "I mean, how quickly does the world owe him something that he knew existed only ten seconds ago?"

How quickly? Very quickly. The new rapidly evolves into the normal. Just consider how unremarkable smartphones are now – but it wasn't long ago that we jingled coins in our pockets, hunted for phone booths,

tried to coordinate meeting spots and botched encounters because of planning errors. Smartphones revolutionized our communications, but new tech becomes basic, universal, and invisible before our eyes.

The shine rapidly wears off the latest technology, and the same is true in the arts. The twentieth-century artist Marcel Duchamp wrote:

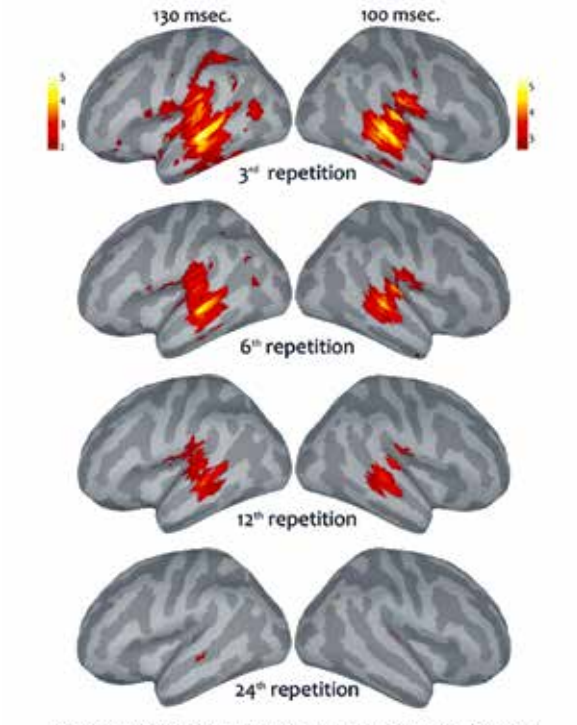
> Fifty years later there will be another generation and another critical language, an entirely different approach. No, the thing to do is try to make a painting that will be alive in your own lifetime. No painting has an active life of more than thirty or forty years … After thirty or forty years the painting dies, loses its aura, its emanation, whatever you want to call it. And then it is either forgotten or else it enters into the purgatory of art history.[1]

Over time, even great works that once shocked the population will fall somewhere between the sanctioned and the forgettable. The avant-garde becomes the new normal. The cutting edge becomes less sharp.

This normalization of the new happens with the best-laid plans of corporations. Every several years, companies expend big bucks on consultants who tell them to switch up what they have – say, an open layout of desks versus the privacy of cubicles. As we'll see later, there is no right answer about how to do this: it's the *change* that matters. The consultants aren't wrong, it's simply that the details of their advice don't matter. It's not always about the particular solution, but instead about the variation.

Why do humans adapt to everything around us so quickly? It's because of a phenomenon known as repetition suppression. When your brain gets used to something, it displays less and less of a response each time it sees it. Imagine, for example, that you come across a new object – say,

a self-driving car. The first time you see it, your brain shows a large response. It's absorbing something new and registering it. The second time you see it, your brain shows slightly less response. It doesn't care quite as much about it, because it's not quite as novel. The third time: less response again. The fourth time: even less.



MEG-derived (dSPM) brain sources at the time-interval of the N1m component at 130 msec. (left hemisphere) and 100 msec. (right hemisphere). Neural activity located in auditory areas shows a suppression of activity when the same stimulus is repeatedly presented (3rd, 6th, 12th, and 24th).

Repetition suppression in action.[2]

The more familiar something is, the less neural energy we spend on it. This is why the first time you drive to your new place of work, it seems to take a long time. On the second day, the drive feels a little shorter. After a while, getting to work takes almost no time at all. The world wears off as it becomes familiar; the foreground becomes the background.

Why are we like this? Because we're creatures who live and die by the energy stores we've built up in our bodies. Navigating the world is a difficult job that requires moving around and using a lot of brainpower – an energy-expensive endeavor. When we make correct predictions, that saves energy. When you know that edible bugs can be found beneath certain types of rocks, it saves turning over *all* the rocks. The better we predict, the less energy it costs us. Repetition makes us more confident in our forecasts and more efficient in our actions.

So there's something appealing (and useful) about predictability. But if our brains are going to all this effort to make the world predictable, that begs the question: if we love predictability so much, why don't we, for example, just replace our televisions with machines that emit a rhythmic beep twenty-four hours a day, predictably?

The answer is that there's a problem with a lack of surprise. The better we understand something, the less effort we put into thinking about it. Familiarity breeds indifference. Repetition suppression sets in and our attention wanes. This is why marriage needs to be constantly rekindled. This is why you'll only laugh so many times at the same joke. This is why – no matter how much you enjoyed watching the World Series – you aren't going to be satisfied watching that same game over and over. Although predictability is reassuring, the brain strives to incorporate new facts into its model of the world. It always seeks novelty. The brain gets excited when it updates.

As a result of our neural machinery, good ideas don't hold their shine. Take the list of the bestselling books from the year 1945:

1. *Forever Amber* Kathleen Winsor
2. *The Robe* Lloyd C. Douglas
3. *The Black Rose* Thomas B. Costain
4. *The White Tower* James Ramsey Ullman
5. *Cass Timberlane* Sinclair Lewis
6. *A Lion Is in the Streets* Adria Locke Langley
7. *So Well Remembered* James Hilton
8. *Captain from Castile* Samuel Shellabarger
9. *Earth and High Heaven* Gwethalyn Graham
10. *Immortal Wife* Irving Stone

These were books that seized the public imagination, but it's quite possible that you've never heard of any of them. Recall that these were the books on everyone's lips that year. The authors honored dinners with their presence. They signed countless copies. Presumably, they would have had a hard time imagining these books would someday be totally forgotten.

We constantly thirst for the new. In the movie *Groundhog Day*, a weatherman played by Bill Murray is forced to re-live a single day over and over again. Confronted with this seemingly endless loop, he eventually rebels against living through the same day the same way twice. He learns French, becomes a piano virtuoso, befriends his neighbors, champions the downtrodden.

Why do we cheer him on? Because we don't want perfect predictability, even if what's on repeat is appealing. Surprise engages us. It allows us to escape autopilot. It keeps us awake to our experience. In fact, the neurotransmitter systems involved in reward are tied to the

level of surprise: rewards delivered at regular, predictable times yield a lot less activity in the brain than the same rewards delivered at random, unpredictable times. Surprise gratifies.

This is why jokes are structured the way they are. It's never two guys who walk into a bar – it's always three. Why? Because the first guy sets things up, and the second guy establishes the pattern. This is the shortest possible path for the third guy to break the pattern by sidestepping the brain's prediction. In other words, humor arises from the violation of expectations. If you were to tell the joke to a robot it would simply listen to what each of the three guys does, but presumably it wouldn't find the joke funny. The joke only works because the brain always tries to predict, and the punchline knocks it off balance.[3]

Advertisers know that constant creativity is required to keep us engaged. Their ads nudge us towards a particular brand of detergent or chips or perfume but if the ads aren't continually refreshed, we'll tune them out; they lose their impact.

The avoidance of repetition is the fountainhead of human culture. People often say that history repeats itself, but the statement is not quite true. At most, as Mark Twain said, history rhymes. It tries out similar things at different times, but the details are never the same. Everything evolves. Innovation is requisite. Humans require novelty.

So there's a balancing act here. On the one hand, brains try to save energy by predicting away the world; on the other hand, they seek the intoxication of surprise. We don't want to live in an infinite loop, but we also don't want to be surprised all the time. You don't want to wake up tomorrow to find it's Groundhog Day again, and you also don't want to awaken to discover that gravity has reversed and you're stuck against the ceiling. There's a trade-off between exploiting what we know, and exploring the unknown.

THE BALANCING ACT

Brains seek a balance between exploiting previously-learned knowledge and exploring new possibilities. This is always a tricky trade-off.[4] Say you're deciding which restaurant to go to for lunch. Do you stick with your traditional favorite or try something new? If you go for your familiar haunt, you're exploiting knowledge you've gained from past experience. If you jump into the culinary abyss, you're exploring untried options.

Across the animal kingdom, creatures set their trade-off point somewhere in the middle. If you learn through experience that the red rocks have grubs under them while the blue rocks do not, you need to exploit that knowledge. But one day you may find that grubs aren't there, whether because of drought, fires or other foraging animals. The rules of the world rarely hold constant, and this is why animals need to take what they've learned (*the red rocks yield grubs*) and balance that against attempting new discoveries (*I wonder what's under these blue rocks?*). And this is why an animal will spend most of its time looking under the red rocks, but not all of it. It'll spend some time looking under the blue rocks, even if it has looked there several times in the past, unsuccessfully. It'll continue to explore. It'll also spend some time looking under the yellow rocks and in tree trunks and in the river, because one never knows where the next meal is going to come from. Across the animal kingdom, hard-won knowledge is counterbalanced with new pursuits.

In the course of developing over eons, brains have achieved an exploration/exploitation trade-off that strikes the balance between flexibility and rigor. We want the world to be predictable, but not *too* predictable, which is why hairstyles don't reach an endpoint, nor do bicycles, stadiums, fonts, literature, fashion, movies, kitchens, or cars.

Our creations may look largely like what's come before, but they morph. Too much predictability and we tune out; too much surprise and we become disoriented. As we'll see in the coming chapters, creativity lives in that tension.

The exploration/exploitation trade-off also explains why our world is so densely populated with skeuomorphs: features that imitate the design of what has come before. Consider that when the iPad was introduced it featured a "wooden" bookshelf with "books" on it – and the programmers went to great lengths to make the "pages" turn when you swiped your finger. Why not simply redefine a book for the digital era? Because that's not what made customers comfortable; they required a connection to what had come before.

Even as we move from one technology to the next, we establish ties with the old, marking a clear path from what was to what is. On the Apple Watch, the "Digital Crown" looks like the knob used to move the hands and wind the springs on an analog timepiece. In an interview with the *New Yorker*, designer Jonathan Ive said that he placed the knob slightly off-center to make it "strangely familiar." If he had centered it, users would have expected it to perform its original function; had he removed it, the watch wouldn't have looked enough like a watch.[5] Skeuomorphs temper the new with the familiar.

Our smartphones are packed with skeuomorphs. To place a call, we touch an icon of an old phone handset with an extruded earpiece and mouthpiece – a profile that departed the technology landscape long ago. The camera on your smartphone plays an audio file of a shutter sound, even though digital cameras don't have mechanical shutters. We delete the zeros and ones of our apps by dragging them to the "trash can." We save files by clicking on the image of a floppy disk – an artifact that has gone the way of the mastodon. We purchase items online by dropping them into a "shopping cart." Such ties create a smooth transition from the past to the present. Even our most modern tech is tethered with an umbilical cord to its history.

The exploration/exploitation trade-off is not unique to humans, but while generations of squirrels have poked around in different bushes, humans have taken over the planet with their technology. So there's something very special about the human brain. What is it?

WHY ZOMBIES DON'T DO WEDDINGS AND BAR MITZVAHS

If you sat down for dinner with a zombie, you would not expect to be impressed with a creative idea. Their behaviors are automatized: they are only running pre-configured routines. That's why zombies don't skateboard, write memoirs, launch ships to the moon, or change their hairstyles.

Make-believe though they are, zombies show us something important about the natural world: creatures throughout the animal kingdom run mostly on automated behavior. Consider a honeybee. A stimulus leads to the same reaction, every time, enabling the bee to negotiate such options as *land on blue flower, land on yellow flower, attack, fly away*. But

why doesn't a bee think creatively? Because its neurons are fixed into place and pass signals from input to output like firefighters passing water pails in a bucket brigade.[6] In the bee's brain these brigades begin to form before birth: chemical signals determine the routes of the neurons, and thus build the different brain regions associated with movement, hearing, vision, smell, and so on. Even when it is exploring new territory, the bee is operating largely on auto-pilot. You can't reason with a bee any more than you can with a zombie: it is a biological machine, with its thinking hard-wired by millions of years of evolution.

We have quite a bit of the bee in us: the same sort of neural machinery allows us to have our massive portfolio of instinctual behaviors, from walking to chewing to ducking to digesting. And even as we learn new skills, we tend to streamline them into habits rapidly. When we learn how to ride a bicycle, drive a car, use a spoon, or type on a keyboard, we burn the task into fast pathways in the neural circuitry.[7] The most rapid conduit becomes favored over other solutions, minimizing the brain's chance of making an error. Neurons that are not required for that task are no longer triggered.

If the story ended there, the human ecosystem as we know it wouldn't exist: we wouldn't have sonnets, helicopters, pogo sticks, jazz, taco stands, flags, kaleidoscopes, confetti, or mixed drinks. So what's the difference between a bee brain and ours? While a bee brain has one million neurons, a human one has one hundred *billion*, giving us a larger repertoire of behaviors. And we're privileged in another way, too: not only in the quantity, but the organization of those neurons. Specifically, we have more brain cells between sensation (*what's out there?*) and action (*this is what I'm going to do*). This allows us to take in a situation, chew on it, think through alternatives, and (if necessary) take

action. The majority of our lives take place in the neural neighborhoods between sensing and doing. This is what allows us to move from the reflexive to the inventive.

The massive expansion of the human cortex unhooked huge swaths of neurons from early chemical signals – hence these areas could form more flexible connections. Having so many "uncommitted" neurons gives humans a mental agility other species don't have. It makes us capable of mediated behaviors.

Mediated (as opposed to automated) behaviors involve thought and foresight: understanding a poem, navigating a difficult conversation with a friend, generating a new solution to a problem. That kind of thinking involves seeking out new paths for innovative ideas. Rather than a push-button response, the neural chatter is like parliamentary debate.[8] Everyone joins in the discussion. Coalitions form. When a strong consensus emerges, an idea may rise to conscious awareness, but what can feel like a sudden realization actually depends on extensive internal debate. Most importantly, the next time we ask the same question, the answer might be different. We wouldn't expect bees to enchant their queen with *A Thousand and One Nights* of stories; instead, it would just be the same night over and over, because their brains follow identical pathways each time. Thanks to our improvisatory neural architecture, we can weave tales and remodel everything around us.

Humans live inside a competition between automated behavior, which reflects habits, and mediated behavior, which defeats them. Should the brain streamline a neural network for efficiency, or arborize it for flexibility? We depend on being able to do both. Automated behavior gives us expertise: when the sculptor chisels, the architect builds a model or the scientist conducts an experiment, practiced dexterity helps to make

new outcomes possible. If we can't execute our new ideas, we struggle to bring them to life. But automated behavior can't innovate. Mediated behavior is how we generate novelty. It is the neurological basis of creativity. As Arthur Koestler said, "Creativity is the breaking of habits through originality." Or as inventor Charles Kettering put it, "Get off Route 35."

SIMULATING THE FUTURE(S)

The giant number of brain cells interposed between stimulus and action is a critical contributor to the massive creativity of our species. It is what allows us to consider possibilities beyond what is right in front of us. And that's a large part of the magic of human brains: we relentlessly simulate what-ifs.

In fact, this is one of the key businesses of intelligent brains: the simulation of possible futures.[9] *Should I nod in agreement, or tell the boss that it's a dumb idea? What would surprise my spouse for our anniversary? Will I enjoy Chinese or Italian or Mexican for dinner tonight? If I get the job, should I live in a home in the Valley or an apartment in the city?* We can't test every conceivable action to understand the outcomes, so we run simulations internally. All but one of those scenarios won't actually happen – or maybe none of them will – but by preparing ourselves for the alternatives, we're able to more flexibly respond to the future. This sensitivity marks the major change that allowed us to become cognitively modern humans. We are masters at generating alternative realities, taking what is and transforming it into a panoply of what-ifs.

We are drawn to future simulations early in life: pretend play is a universal feature of human development.[10] A child's mind swirls with visions of becoming President, hibernating on the way to Mars, heroically

somersaulting during a firefight. Pretend play enables children to envision new possibilities and gain knowledge about their surroundings.

As we grow up, we simulate the future each time we consider alternatives or wonder what might happen if we choose a different path. Whenever we buy a house, pick a college, ponder a potential mate, or invest in the stock market, we accept that most of what we consider may be wrong or may never occur. Expectant parents ask, "Will it be a boy or a girl?" Not yet sure, they discuss alternatives for names, clothing, decor and toys. Penguins, horses, koalas, and giraffes all produce single offspring, but none is known to brood over this question the way humans do.

Thinking about what-ifs is so rooted in our daily experience that it's easy to overlook what an imaginative exercise it is. We endlessly speculate on what might have been, and language is designed to make it easy for us to download our simulations to one another.[11] If you had come to the party, you would have had fun. If you'd taken this job, you'd be rich by now – but unhappy. If the manager had swapped pitchers, the team would have won the game. Hope is a form of creative speculation: we imagine the world as we wish it to be rather than as it is. Without realizing it, we spend a great portion of our lives in the realm of the hypothetical.[12]

Simulating futures comes with the benefits of safety: we try out moves in our minds before trying them out in the world. As the philosopher Karl Popper said, our capacity to simulate possible futures "allows our hypotheses to die in our stead." We run a simulation of the future (*what would happen if I stepped off this cliff?*) and adjust our future behavior (*take a step backward*).

But more than keeping ourselves alive, we use these mental tools to flesh out worlds that don't exist. These alternative realities are the vast plains from which our imaginations reap their harvest. What-ifs

put Einstein in an elevator in deep space in order to understand time. What-ifs carried Jonathan Swift to islands of lumbering giants and teeny Lilliputians. What-ifs led Philip K. Dick to a world in which the Nazis had won the Second World War. What-ifs conveyed Shakespeare into the mind of Julius Caesar. What-ifs transported Alfred Wegener to a time when the continents were fused. What-ifs allowed Darwin to witness the origin of species. Our gift for simulation paves new roads for us to travel. The business magnate Richard Branson has started more than one hundred companies, including a spaceline that will fly civilians beyond Earth's atmosphere. To what does he attribute his knack for entrepreneurship? His ability to imagine possible futures.

And there's one more factor that turns on the turbobooster of creativity, something that lives beyond your brain. Other people's brains.

CREATIVITY IS SOCIALLY ENHANCED

F. Scott Fitzgerald and Ernest Hemingway were young impoverished friends in Paris. The young Robert Rauschenberg had romantic relationships with painters Cy Twombly and Jasper Johns in his twenties, before any of them were famous. The twenty-year-old Mary Shelley wrote *Frankenstein* during a summer spent with fellow writers Percy Bysshe Shelley and Lord Byron. Why do creators gravitate toward one another?

A reigning misconception suggests that creative artists function best when they turn their backs on the world. In her 1972 essay "The Myth of the Isolated Artist," author Joyce Carol Oates addressed this: "The exclusion of the artist from a general community is mythical … The artist is a perfectly normal and socially functioning individual, though the romantic tradition would have him as tragically eccentric."[13]

A context in which no one cares, no one pays attention, no one offers support or encouragement is a worst-case scenario for an aspiring creative. The go-it-alone artist, chronically cut off from his or her peers, is a mythical creature. Creativity is an inherently social act.

Few figures epitomize the lone artist more than Dutch painter Vincent van Gogh. He lived in the shadows of the artistic establishment and sold few paintings in his lifetime. But a close look at his life tells a story of someone engaged with his peers. He corresponded with many young artists in letters filled with shoptalk and unvarnished critiques of other painters. When he received his first good review, he sent a cypress tree to the critic as a present. He and Paul Gauguin made plans at one point to build an artist colony in the tropics. So why do people still say that Van Gogh was a splendid isolationist? Because it feeds into a satisfying story about the fountainhead of his genius. But the story is a myth. Neither a misfit nor a loner, he was an active participant in his time.[14]

And the social network doesn't just apply to artists: it applies to all branches of creative invention. E.O. Wilson wrote that "the great scientist who works for himself in a hidden laboratory does not exist."[15] Although many scientists might like to believe they work in ingenious solitude, they in fact operate in a vast web of interdependency. Even the problems they take to be important are influenced by the larger creative community. Isaac Newton, arguably the greatest mind of his time, spent much of his life trying to master alchemy, as that was a prevalent preoccupation in his era.

We're exquisitely social creatures. We labor without pause to surprise each other. Imagine that each time your friend asked you what you did today, you answered precisely the same way. It's not clear the friendship would last for long. Instead, humans seek to astonish each other, to

amaze, to inject wonder, surprise, incredulity. This is what we're wired to do for one another, and this is what we seek in one another.

And this, by the way, is part of the reason why computers aren't terribly creative. Whatever you put in is exactly what you get back out – phone numbers, documents, photos – and this capacity often serves us better than our own memories. But the exactitude of computers is also why they're so bad at, say, cracking a funny joke or acting sweet to get what they want. Or directing a movie. Or giving a TED talk. Or penning a tear-jerking novel. To achieve a creative artificial intelligence, we would need to build a *society* of exploratory computers, all striving to surprise and impress each other. That social aspect of computers is totally missing, and this is part of what makes computer intelligence so mechanical.

DON'T EAT YOUR BRAIN

A small mollusk known as the sea squirt does something strange. It swims around early in its life, eventually finds a place to attach like a barnacle, and then absorbs its own brain for nutrition. Why? Because it no longer needs its brain. It's found its permanent home. The brain is what allowed it to identify and decide on its place to anchor, and now that the mission is accomplished, the creature rebuilds the nutrients of its brain into other organs. The lesson from the sea squirt is that brains are used for seeking and decision-making. As soon as an animal is settled in one place, it no longer needs its brain.

Even the most committed couch potato among us wouldn't eat his own brain, and this is because humans don't have a settling point. Our constant itch to combat routine makes creativity a biological mandate. What we seek in art and technology is surprise, not simply a fulfillment

of expectations. As a result, a wild imagination has characterized the history of our species: we build intricate habitats, devise recipes for our food, dress in ever-changing plumage, communicate with elaborate chirps and howls, and travel between habitats on wings and wheels of our own design. No facet of our lives goes untouched by ingenuity.

Thanks to our appetite for novelty, innovation is requisite. It's not something that only a few people do. The innovative drive lives in every human brain, and the resulting war against the repetitive is what powers the colossal changes that distinguish one generation from the next, one decade from the next, one year from the next. The drive to create the new is part of our biological make-up. We build cultures by the hundreds and new stories by the millions. We surround ourselves with things that have never existed before, while pigs and llamas and goldfish do not.

But where do our new ideas come from?