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Hunt, Gather, Parent

Dopamine Kids

A Science-Based Plan to Rewire Your Child's Brain and Take Back Your Family in the Age of Screens and Ultraprocessed Foods

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Avid Reader Press

New York Amsterdam/Antwerp London
Toronto Sydney/Melbourne New Delhi

Avid Reader Press
An Imprint of Simon & Schuster, LLC
1230 Avenue of the Americas
New York, NY 10020

First Avid Reader Press hardcover edition March 2026

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Some names and identifying details have been changed.

Interior design by Joy O'Meara

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 978-1-6680-4983-9
ISBN 978-1-6682-2886-9 (Int Exp)
ISBN 978-1-6680-4985-3 (ebook)

In memory of my mom,
who helped me feel the difference
between wanting and pleasure

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Prologue

Six years ago, I began to notice something sad: I no longer enjoyed activities that once brought me a sense of calm and peaceful joy.

I can't remember exactly when this shift occurred. It slowly crept up on me, over the course of months, perhaps a few years. But I remember when I first noticed it.

I had taken my four-year-old daughter to a beautiful beach on a Saturday afternoon. Perched at the western tip of the San Francisco Bay, this beach offers magnificent views of the Pacific Ocean's cragged coastline. Green grass-covered cliffs plunge a hundred feet into the ocean. Foamy white waves crash along black-and-gray sand. And if you're lucky, you can see gray seals bobbing their shiny, round heads up and down out of the water, as they fish along the surf.

That beach is nothing but magical. And that Saturday afternoon, my daughter, Rosy, had that magic running through her. She hummed along, with a lovely contentment, as she tried to build a crumbly sandcastle with a tiny moat near it. The moment felt sweet, calm, and ideal.

But inside, I felt the opposite. I felt irritable and even glum. I couldn't stop thinking about my work—my email, my texts, my social media accounts. I drew my phone from my pocket, checking each app, one after another. Then a few minutes later, I'd pull out my phone and launch the same circuit over again.

I tried so hard to enjoy "the moment," as my mom always advised. I smiled at Rosy. I laughed with her, and I pointed out the sandpipers zigzagging across the edge of the surf. Then I would close my eyes so I could hear the crash of the waves and feel the warm sun on my face.

But inside, this low, constant hum of anxiety churned in the back of my mind. It felt like a continuous wondering of *What's next? What's next? What's next?*

From that point on, I began to notice this anxious hum whenever I wasn't at work. I felt it while our family ate Belgian waffles with strawberries for brunch on Sunday mornings. I felt it walking around the wet, grassy fields of Golden Gate Park on Sunday afternoon, as Rosy raced ahead of me. And I felt it after work, while I sat on the living room floor, as Rosy colored in her Disney Princess coloring book. Whenever I had a moment of downtime, I simply couldn't enjoy it. Somehow I always had a reason to check my phone or go on the internet. And if I didn't have my phone with me, I couldn't wait to go back home and check it.

Where once I would have felt relaxed, I now felt restless and cranky. Sometimes I even snapped at my daughter or husband.

Low as this background hum may have been, I knew it was affecting my parenting. I had a hard time just *being* with Rosy as we went through our day. We would go for a ten-minute bike ride to the park, and I would check my phone every time we stopped at a traffic light. At night, I couldn't wait for Rosy to go to sleep so I could watch HBO. Sometimes I'd even become short with her because she wouldn't fall asleep quickly enough. *Please, please go to sleep, Rosy. Mommy needs to watch* Succession.

One time, I was typing furiously on my phone, trying to respond to an angry comment on Twitter. When I looked up, I saw Rosy watching me, intensely. I felt a tinge of guilt. A tiny worry cropped up in my mind: *Oh gosh, am I re-creating my phone habits inside her?*

As the months went by, another question slowly arose in my thoughts: Had I always been like this? I didn't think so. It seemed like my brain had changed somehow.

I began to notice a similar change in my relationship with food. I

wasn't overweight, but I often ate past what felt good. And between meals, I experienced what some people called food noise. I couldn't stop thinking, even obsessing over what we would eat next—the next trip to a restaurant, the next glass of wine, the next stop at Starbucks.

What's next? What's next? What's next? The question churned nonstop in my mind. Somewhere along the way, I had forgotten how to spend time away from the internet or text messages. And I couldn't go two hours without a latte or a slice of pumpkin banana bread.

If I examined my daily routine closely, I could see that I rarely felt a sense of satisfaction. I rarely had the wonderful feeling of *Aaah, I have what I need now and I can rest. Life is good just how it is.* When that feeling did arrive, it fluttered away in seconds.

This constant need for something painted a dull, gray feeling across my mood and life. Not so much a depression but more a varnish of discontentment.

Finally, in 2020, during the pandemic, I grew fed up with this feeling. I didn't want to spend the rest of my life not enjoying the beautiful beach on a Saturday afternoon or the calm stroll through the park on Sundays. I didn't want to spend the rest of my life, or the rest of Rosy's childhood, not appreciating my time with her.

So I set out to try to fix my problem. I wanted to understand why I stayed in this perpetual state of anxiety about what to do with myself—why I always felt a little unsettled and distracted. Then I would use that knowledge to quiet the background noise. I wanted to reclaim the joy of my previous hobbies and leisure time. I wanted to reclaim calm. And I wanted this all just as much for Rosy and my family as for myself.

Because if I struggled so much with my phone and food, how was I ever going to teach Rosy to have a healthy relationship with them?

The Parenting Problem That No One Has Had Before

In the past fifteen years, American families have been hit by a train, a bullet train. It ripped through the front door, passed through the

living room, and headed straight for the bedrooms. "You really have to appreciate, from a parent's standpoint, how quickly this technology revolution happened," said therapist Bob Keane at Boston College. "Phones, iPads, social media, video game consoles, streaming platforms, these technologies were on us—in our homes—before we even knew they were coming."

The first versions of Facebook cropped up in 2004. The first smartphones launched in 2007. By 2012, 50 percent of homes in the United States had smartphones, and teenagers spent, on average, about three hours each day online. Today, as this book goes to press, 95 percent of families have smartphones, and teenagers spend, on average, about 8.5 hours each day online, with nearly five hours devoted solely to social media (mostly on YouTube and TikTok).

An object that didn't even exist two decades ago is now omnipresent in our lives. It dines with us at restaurants. Joins us in the bathroom. Sleeps next to us at night. Speaks to us inside our cars. Inside our ears.

For many of us, this black box of plastic and glass has become an extension of our bodies, our arms, our hands. It's the first thing we touch in the morning. And the last thing we stroke at night.

Over this time, the games and apps on smartphones have shifted nearly every aspect of our lives, including how we communicate and spend our time—at work, at home, and at school. They've even changed the way we have sex. And they've shifted childhood in astonishing ways—the way our children play, learn, socialize, and sleep.

If you've struggled in your own family with screens, as our family has, I feel like it's crucial to understand both the power and novelty of this technology. Over tens of thousands of years of raising children, no previous generation of parents has had to contend with this force. For my previous book, *Hunt, Gather, Parent*, I garnered ancient parenting advice from hundreds of experts and families across the world. Those insights have helped our family in nearly every facet of life. They've helped me and my husband raise a kind, helpful, and generous child. Just last night, I accidentally dropped a glass jar on the floor. After it shattered, Rosy hopped from the dinner table, grabbed the broom, and said, "I'll help

you pick it up, Mama." But ancient parenting wisdom hasn't helped with two areas of modern life: screens and ultraprocessed foods.

While the bullet train of screens barreled into our homes, American parents were already being hit with a second but closely related revolution. This one arose inside our kitchens and our bellies. I'm talking about the ultraprocessed food revolution.

This revolution occurred more slowly than the technological one. It happened so slowly that many parents (including myself) barely noticed it. It launched back in the early 1900s, when companies began to concoct an array of foods that families couldn't create in their own kitchens, such as Kraft macaroni and cheese, Wonder Bread, Minute Rice, and Oreo cookies. Food companies also started to use preservatives, flavorings, and vitamins to create shelf-stable snacks and quick-to-prepare dishes. Decade by decade, the amount of ultraprocessed food in our diets inched up gradually, until the 1980s, when it exploded—in large part because of tobacco companies.

As cigarette sales plummeted in the late 1980s, tobacco companies purchased food manufacturers, such as Kraft, General Foods, and Nabisco. By the late 1990s, the availability of ultraprocessed foods had skyrocketed, and that growth continued into the twenty-first century. Today 60 to 70 percent of children's calories come from these foods, which often contain high concentrations of fat, sugar, salt, or all three. In many ways, these foods carry just as much power and influence on our lives as apps and devices.

On the surface, screens and ultraprocessed foods don't appear to have much in common. At first, I didn't see the connection either. But as we'll learn, they're intimately entwined inside our brains. The neurological pathways that drive our desires for high-fat and high-sugar foods overlap substantially with those driving our consumption of videos, games, and social media. Once we understand how one technology works in our brain, we understand how the other works.

Both ultraprocessed foods and activities on screens create what neuroscientists call motivational magnets in our daily lives. They're objects, devices, and foods that pull us to them, largely subconsciously, like a magnet pulls a piece of metal to it. Once we're locked into these

powerful magnets, they take hold of our attention and throw off our internal compass. They can make us forget about the genuine rewards and pleasures in life. They make us lose track of what we value and really want out of life. These magnets have become so strong and ubiquitous that we now orient our lives around them.

And so throughout the book, instead of saying "devices and ultraprocessed foods" repeatedly, I'm going to combine them into one term that encompasses how they work in our lives (and in our brains). I'm going to call them magnets (or dopamine magnets). My daughter, Rosy, enjoys using this term. In the grocery store, she says "magnet on" when she gravitates toward the cookie aisle or cheese counter. But, she also came up with her own term for ultraprocessed foods: "pood," which stands for "poopy food."

In many ways, it feels like these dopamine magnets control our families. They determine how we spend our time and what we eat throughout the day. They toy with our emotions and determine our moods. They add stress to our children's lives, stress to our relationships with our children, and stress to our bodies.

In our home, these magnets not only generated a huge amount of conflict; they also encouraged our daughter to misbehave horribly. Initially, my husband, Matt, and I followed the advice of the American Academy of Pediatrics: "No more than two hours of screen time a day." But when Rosy spent two hours streaming cartoons at night, an entirely different child emerged at the end. Once I closed the screen, our thoughtful and helpful child reverted back to a wild hyena toddler, running around the house at 9:00 p.m., yelling and crying to be allowed another cartoon.

Then the next evening we would start the same exhausting cycle over again.

This shift in our lives hit us so quickly that parents haven't had the chance to pause and consider a critical question: Why? Why, in such a short period of time, have phones, tablets, consoles, and streaming platforms become indispensable in our lives? Or why, at least, do they seem that way?

And what can we do about it?

The Truth About Dopamine Magnets

In the past two decades, neuroscientists have been mapping out how pleasure and reward work inside our brains. In the process, they've revolutionized our understanding of what triggers our desires and how those cravings turn into habits. Meanwhile, tech and food companies have been designing products that tap into those pathways like never before.

When I began looking into this new science of pleasure, I thought I understood what was happening: We were drawn to these magnets because we enjoyed them so much. Human ingenuity, I believed, had finally engineered devices and foods that we loved way more than any other activity or foods available to us (if sometimes too much).

So I thought that we were all overeating and overusing our phones because we were all pursuing pleasure. More specifically, we were all seeking to maximize a reward in the form of a molecule called dopamine.

According to this theory, when I picked up my phone or bit into a slice of pumpkin bread, it triggered a surge of this tiny molecule inside my brain, and this surge gave me a little bump of pleasure. *Aaah. . . . It feels so good!* And that pleasurable feeling, the belief went, was why I repeatedly posted on social media, checked my email, or stopped at the coffee shop for a baked good. I was constantly seeking dopamine and the pleasure it provided.

I believed that I had fallen in love with pleasure and that I had *too much* pleasure in my life. Therefore, to lift away the gray gloominess that I felt, I needed to accept *less* pleasure in life. I needed fewer rewards. And as a parent, I needed to show Rosy how to accept less pleasure as well.

I believed this theory for years. But something also felt fishy about the idea that "dopamine gives us pleasure." Because when I stopped and genuinely paid attention to how I felt while using my phone or eating particular foods, this narrative didn't line up entirely with my experience. While scrolling on my phone late at night or eating my way through a can of Pringles at my desk, I didn't feel

like some blissed-out lotus eater. In fact, I often felt the opposite. Many times after these activities, I felt much worse than I did before them. More times than not, a comment on social media would send me into a spiral of self-doubt, feelings of deficiency, or an intense sense of anger. And yet there I was logging into social media, checking my email, and buying cans of Pringles, day after day. What was going on?

I've spent the past twenty years analyzing complex research about our health and clarifying the confusion created, unintentionally, by inaccurate and flimsy research itself. First, I spent nearly a decade as a biochemist, including two years as a postdoctoral fellow at the National Institutes of Health. More recently, I've been reporting on children's health for NPR, sifting through piles of data and separating myths presented by the media from the facts presented in scientific studies.

So in 2021, I decided to start fact-checking the ideas presented in the media and by some scientists about dopamine and pleasure. As I dug into recent studies and talked to the top researchers in the field, I uncovered a big surprise. I learned that this basic story is wrong—and not wrong by a little bit either. It's completely wrong.

The "dopamine is pleasure" story emerged from a decades-old scientific theory that neuroscientists had actually toppled, slowly but steadily, over the past thirty years. And the misconceptions about how dopamine works have made it more difficult to break habits that we no longer want for ourselves and our children, habits that no longer serve us.

So I set out to piece together—and really understand—the correct story about dopamine, what actually brings us pleasure in life, and how our desires and wants eventually turn into habits and compulsions. This new scientific consensus would explain not only why I felt so gloomy and stuck but also what I could do about it.

That's the main goal of this book: to set the record straight about dopamine and its remarkable roles in our brain. And then to use this new knowledge to help us not just *handle* these powerful magnets in our family lives, but master them.

A New Manual for a New Age

Parents are in uncharted territory. And we need a new operating manual for habit remodeling. One specifically tailored for parents and their children and based on accurate, up-to-date science.

To create this manual, I read hundreds of studies and talked to dozens of neuroscientists, psychiatrists, and psychologists who are world experts on these topics. During our interviews, I would ask them about their own habits: "How do you manage your phone use? Your consumption of ultraprocessed foods?" Many of these scientists were also parents to young children and teenagers. So I'd ask about their parenting: "How do you manage your kids' use of social media? Video games? Ultraprocessed foods?" "How do you know when they're ready for a specific technology?"

Over time, a consensus emerged. All around the country, these scientists-parents had come up with similar approaches to cope with the magnets in their homes, for both themselves and their children.

After incorporating principles and ideas from the emerging field of behavior change, I crystallized their approach into five steps for remodeling habits. I then applied these principles to my habits with my phone and social media and around eating. Within a few months, my habits had transformed. Even better, my mental health had improved dramatically.

The noise inside my head, constantly calling me to check my phone or grab a snack from Starbucks, finally began to quiet. All that itchy agitation faded. I could finally relax. When Rosy wanted to stop in the park for an extra fifteen minutes and build a tiny fairy garden under a tree, I didn't rush her back to the car. I was no longer anxious to see what emails or texts awaited on my phone. In fact, I was happy to be away from the internet.

During this same time, I reduced my drinking from one to two glasses of wine each night to one or two glasses a month. I learned how to stop overeating and lost fifteen pounds without realizing it, and, perhaps most miraculously, I stopped fighting with my mother (that one was a big surprise).

On top of that, I became uberproductive at work—the most productive of my twenty-year career.

My husband noticed my transformation and wanted to experience it for himself. He started applying the method to his own harmful habits (e.g., checking the news hundreds of times each day; browsing social media until 1:00 a.m. each night). And then together we drafted a plan for our daughter, who at that point had grown from a chubby, tantrum-ridden toddler into a helpful, ambitious seven-year-old. Her behavior shifted even faster than my own. As we'll learn, children's brains are more flexible than adults', and their behaviors can change quite quickly if you know how to shape their environment properly.

I then set goals for her that might have sounded silly—or nearly impossible—just a few months earlier: Could I get her to *want* to practice piano or work on reading at night instead of streaming cartoons on Netflix? Could I get her to pick up a book first thing in the morning instead of wanting to grab my phone? Could I motivate her to grab the carrots sitting on the counter instead of digging through the pantry in search of Oreos? Would she ever *want* to go play outside after dinner, voluntarily—no begging, no nagging, no power struggle needed but rather because she held a genuine desire to be outside?

This book explains how I did it—and how you can do it for your family.

To my surprise, the process didn't involve feats of willpower or settling for more boredom and deprivation in our lives. It unexpectedly meant exerting less willpower and bringing more pleasure, joy, and excitement into my family's life. It meant having more fun, more leisure time, and more peace in our home.

And all it took was learning how to wield a few parenting superpowers that I didn't even realize I had tucked up my sleeves.

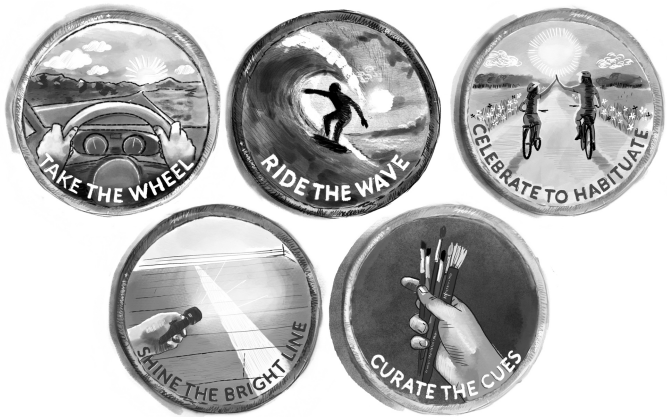
How to Use This Book

This book contains two major stories or threads. In the first story, we'll examine the **science** and history of how we've all come to sur-

round ourselves with these dopamine magnets, which pull on our attention and appetites throughout the day. And then in the second section, I'll offer a **practical guide** for how to not only take back control but also have fun doing it. Having fun is actually critical to the process.

I present both parts of the book in parallel. So we'll start with one chapter on the science of magnets, and then immediately afterward I'll present a practical chapter, providing a new strategy for countering them.

As we move through the book, we'll combine all the strategies together into a five-step protocol that allows you to break any habit of your child that you'd like and replace it with a new habit that aligns with your values and goals for your family—and that also brings you and your family more joy and pleasure.



Then we'll use this protocol to transform your family's relationship with ultraprocessed foods. We'll learn how to eliminate snacking on these foods and how to put the kibosh on picky eating. In the end, you'll give your children a glorious gift: the love and desire for whole foods—foods that truly fill them up and make their bodies feel good afterward.

In the science thread, we'll follow the research of a few brilliant and daring neuroscientists who went against their entire field to uncover one of the biggest scientific errors in the twentieth century. Over

the course of a few decades, these scientists unraveled the true role dopamine plays in our brain and how it alters our behavior.

They mapped out a circuitry inside our brains that drives a powerful form of motivation—one that propels children to work hard, be persistent, and overcome obstacles. We'll learn how the tech and food companies have tapped into this circuitry to design devices, games, and foods that lure kids to their products and lead to unfulfilling habits and compulsive consumption.

Through their research, a stark reality emerges: Over the past fifteen years, families have locked in more and more tightly to these magnets, without really understanding their costs. We've done so while operating with a collective misunderstanding of the science of pleasure, habit, and fulfillment. To escape, we must learn this anew.

Once we understand how these magnets work, we can flip the power dynamic around. We can release ourselves, and our children, from their grip, and we can come out on the other side so much better. We can use this same motivation circuitry to remodel our family's habits into ones that are more meaningful, productive, and—surprisingly—more rewarding. That's the goal of the second part of the book.

In the practical thread, we'll learn five new strategies for weakening children's motivation for dopamine magnets and strengthening their desire for high-value activities, which give them a true sense of accomplishment and a genuine excitement for life.

We'll see how these high-value activities achieve what dopamine magnets can't: they fulfill children's fundamental requirements as human beings. Sprinkled throughout the book, I've included seven mini-chapters about what children require to be healthy, both mentally and physically. In these chapters, I describe **seven fundamental needs** that American children often miss out on. I explain how dopamine magnets prevent them from satisfying these needs, and then I provide a list of easy, low-parenting activities that can fill in these gaps.

During the practical chapters, I'll also discuss four common mistakes parents make when handling magnets and how these mistakes fill our lives with more stress and more conflict.

At the end of the book, I'll provide a four-week guide for revamp-

ing your family's habits with screens, permanently. You'll learn how to move these magnets to the wings of your life so that four critical skills can take center stage and flourish in your children's lives: talking with your family, focusing on productive work, sleeping well, and embarking on fun adventures.

As you begin to understand how dopamine magnets work in your brain—and in your child's brain—you're going to experience something wonderful. These magnets will immediately begin to lose some of their power over you. As you continue reading, and begin experimenting with some of the strategies in this book, you'll slowly regain control of your family's time and habits, and the emotional well-being of your family will improve as a result. You'll begin to manage technology and ultraprocessed foods in a way that actually enhances your life instead of tarnishing it. And you'll have the tools to give your child a twenty-first-century superpower: the ability to concentrate on challenging tasks for extended periods of time, without distraction.

CHAPTER 1

But She Loves It So Much

For years, watching cartoons seemed like Rosy's favorite hobby—bar none.

Every day, she would ask for screen time way in advance, sometimes even as soon as we walked in the door after school. "Mama, when can I watch? When can I watch?" she would chant, even though she still had hours to go before I'd give her the laptop.

Then, when she finally covered her ears with turquoise headphones and pressed "Start" on the *Lego Friends: Girls on a Mission* show, she would enter a remarkable state of concentration. Her mouth hung open, about a half inch. Her eyes rarely blinked. And her body sat as perfectly still as an opossum playing dead on the side of a road. *Lego Girls* transfixed her.

But never let that quiet stillness fool you. Because, in our home, it was the eye of the hurricane. When I needed her to *stop* watching and get ready for bed . . . Oy! Just thinking about these moments floods me with dread and stress. Because stopping was extremely difficult. And I spent an enormous amount of time, thought, and effort over the years trying to conceive of new and more effective ways to transition her off the screen.

I began to think about this moment as the "dismount." You know, like in gymnastics when the athlete must dismount off the apparatus. To get off the high bar, for example, they're expected to perform some

high-flying, high-risk maneuvers that involve a whole series of flips and twists.

I felt like Rosy needed to "dismount" from Netflix. Except *I* was the one who had to do a double flip, with a triple twist.* Otherwise, chaos ensued right at the time each evening when we all needed to calm down and get ready for bed. Rosy would revert to her two-year-old self—screaming, crying, and running around the house like a lunatic. One night she curled up into the fetal position and hid under her desk for fifteen minutes, softly whimpering. I had to coax her out, gently, by rubbing her back and talking to her in a whisper.

Why are we going through this horrible routine each night? I would wonder. *Well, it's her favorite hobby.*

I interpreted all these intense behaviors around screens—the begging beforehand, the insane focus during, the tantrums afterward—in one way: that Rosy loved, loved, loved what she was watching. *My seven-year-old daughter loves screen time*, was how I thought about it. *She loves* Lego Girls *on Netflix. She loves "educational videos" on YouTube. She loves* Toca Boca World. *It brings her a huge amount of pleasure. She would rather do that than anything else in the world. And she needs it to relax and settle down each day. It's the best leisure and pleasure in her life.*

So I always felt really bad taking it away from her. I felt like a mean mom, dedicated to stripping away from her only daughter the very activities that she loved more than anything else in the world. Why would a mom do that?

I've heard similar tales from many parents across the country. They told me that their children love, more than anything else, TV shows such as *Paw Patrol*, *Bluey*, or *Full House*. Other children passionately love and need video games such as *Minecraft* and *World of Warcraft*. Or they love TikTok and YouTube so much that scrolling on these platforms isn't just their favorite hobby; it's essentially their only hobby.

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* I began to notice this tough "dismount" everywhere in my life. Once I decided to have a glass of wine, how did I stop at one or two? Once I decided to watch *Couples Therapy*, how did I stop at one or two episodes? Once Rosy ate three shortbread cookies, how did she stop there? We all have to dismount off the cycles of wanting. Turns out, we have quite a few tools to help us. We'll learn about those in Step 3.

In other words, what holds kids to these magnets so darn tightly is love and pleasure. And yet as our children spend more and more time on these devices, collectively, do they seem to be happier? Are their lives overflowing with pleasure?

In our home, I surely didn't see more and more joy as Rosy spent more and more time on Netflix or YouTube. I saw the opposite. I saw more and more conflict, tears, and overall difficulties for our entire family. I observed a calm child turn into a tornado of yelling and anger, a cheerful child turn into a sad one.

And so this was the first question that I posed to neuroscientists about modern activities on the screens: What happens to the joy? These activities start off fun, lighthearted, and over time, that pleasure seems to fade (and even reverse itself).

That's how I came to realize that everything I knew about wanting and pleasure turned out to be wrong. Rosy's tantrums weren't about *love*. I had been operating with a faulty understanding of neuroscience—one rooted in a scientific blunder from the 1950s.

It all began one Sunday evening in 1954, when a young neuroscientist burst home from a long day at the laboratory and made a bold proclamation to his wife.

"I have discovered the pleasure center [of the brain]!" Jim Olds exclaimed to his wife as he walked into the couple's Montreal home.

At the time, Olds was a postdoctoral fellow at McGill University, studying the brains of rats. He believed his discovery was so revolutionary that it would shift the path of neuroscience and psychology. And he was right about that. Even today, Olds's conclusions continue to reverberate in science and shape the lives of most American families.

But what Olds didn't realize was that his conclusions were totally wrong. And his misinterpretation would send scientists down a crazy rabbit hole from which they're only now, some seventy years later, finally climbing out.

Many of us base our understanding of pleasure and addiction on these faulty conclusions made back in the 1950s, and that misunder-

standing has left us ill prepared to deal with our relationship with our phones, Netflix, Oreo cookies, and—for me—that daily glass of Chardonnay.

On that fateful Sunday afternoon, Olds had been tinkering around with a cutting-edge—albeit barbaric—neuroscience technique. It's called deep brain stimulation. Essentially, he took several wires, scratched off the ends to expose the electricity flowing from them, and then inserted the wires into a rat's brain. Then when Olds pressed a little lever, he could turn on the electricity through the wire and activate that region of the brain. Buzz, buzz!

That day, Olds had inserted the wires into a specific part of the rat's brain—just behind the animal's eyes, on either side of the head. And when he switched on the electricity, buzz, buzz, the animal behaved in a surprising way. The rat acted as if he liked, maybe even loved, being shocked in this part of the brain. Could this be the region of the brain that when activated makes us feel oh, so amazingly good? Olds wondered.

When Olds let the rat turn on the electricity himself—buzz, buzz—by tapping on the lever—tap, tap—then the rat went to town—*tap, tap, tap*—lighting up this tiny part of his brain, over and over again. All day long. *Tap, tap, tap. Tap, tap, tap.*

In one experiment, a rat "self-stimulated" himself for three weeks straight, zapping himself about 850,000 times. *Tap, tap, tap.* The rat would have never stopped if the two scientists running the experiment hadn't become exhausted watching the animal and finally stopped the process.

Eventually, Olds and other scientists tested the same self-stimulation experiments on a whole menagerie of animals—dogs, chickens, goldfish, rabbits, dolphins, monkeys, and, yes, humans (in highly unethical experiments).* All the animals behaved the same way. They pressed the button compulsively. *Tap, tap, tap.* And often

* The neuroscientist Robert Heath performed these unethical experiments on people who were institutionalized because of epilepsy, depression, schizophrenia, and other severe cognitive disorders.

at the exclusion of doing much else, even sleeping or eating. *Tap, tap, tap.*

One man, whom doctors had hospitalized for depression and "homosexuality," pressed the button roughly fifteen hundred times during a three-hour session. (With people, these experiments were not only unethical, but their conclusions weren't as straightforward as scientists first presented. In fact, the human experiments poked the first holes in Olds's pleasure hypothesis.)

While reading about these experiments, I thought of a thirteen-year-old friend of mine who loves to play video games for four, five, six hours straight, *tap, tap, tap*. I thought of myself scrolling on Twitter until 1:00 a.m., night after night, *swipe, swipe, swipe*. And Rosy eating Ritz Crackers until the box is empty, *crunch, crunch, crunch*.

And I thought that the animals, and people, must be pressing the lever because they liked how it felt, right? Tap-tap-tap equals happy-happy-happy, yes? All this self-stimulation is making us feel so good.

That's what Olds concluded. That indeed, he had discovered the pleasure center of the brain. A little cluster of neurons, about the size of a walnut behind each eye, that when activated gives us this wondrous feeling of *Aaah! Pure pleasure*.

The idea was so appealing. It appeared to offer an easy way to fix unhappiness or suffering. "Drugs and electrical stimulation could induce bliss for the masses," neuroscientists wrote about this at the time. *Tap, tap, tap.*

And so the scientific community—and popular culture—gobbled up the idea of a "pleasure center" hook, line, and electrode. Psychologists quickly changed their beliefs about human motivation. What drives us to act, the new theory went, isn't the need to satisfy some fundamental need (say, for food) or relieve some pain caused by the lack of a fundamental need (say, a feeling such as thirst), but instead what motivates us all, from rats and rabbits to rabbis and roboticists, is *pleasure*. Our intense and unbridled desire for pleasure.

Neuroscientists quickly pinpointed the chemical, or neurotransmitter, inside the brain that appears to encode pleasure: L-3,4-dihy-

droxyphenethylamine. Using the underlined letters, they abbreviated it in a snappy way: DOP + amine = DOPAmine.* And "dopamine jumped from relative obscurity to being critical for life as we know it," neuroscientists wrote more than sixty years later in the journal *Current Biology*.

Over the next few decades, the pleasure hypothesis strengthened further. And by the 1980s, scientists thought they pretty much had pleasure—and dopamine—figured out. Oodles of studies appeared to confirm it. The hypothesis had become scientific canon—and, through articles, books, news segments, and eventually social media, we all became citizen "experts" on the magical neurotransmitter, using jargon like "molecule of pleasure" and "dopamine hits" as ways of describing how apps, video games, and all the tap-tap-taps, swipe-swipe-swipes, and crunch-crunch-crunches make us feel.

We all believed that pleasure motivates us to act and to repeat actions ad nauseam. If an activity on a screen engages us so intensely that we can't pull ourselves away, then that activity must be giving us pleasure. If we repeatedly put one potato chip after another into our mouths, then each additional chip must bring us more and more pleasure. And to interrupt that—and suggest a person do something a bit less "stimulating" or eat something less enticing—would mean something horrible: taking away pleasure. And who wants that?

But what if that entire hypothesis is wrong? What if Olds's rats, our children, and even us adults are all tap-tap-tapping, swipe-swipe-swiping, and crunch-crunch-crunching for another reason?

But what if that entire hypothesis is wrong?

* Interestingly, the word "dope" comes from the Dutch "doop," which originally meant a thick sauce, like a gravy. The term eventually turned into a word for the thick juice of a poppy flower—that is, opium. But, as we'll see, contrary to what such a linguistic connection might suggest, dopamine can have the opposite effect of opium on the brain.

What if the monkey sitting in the chair tapping away on the lever for sixteen hours a day wasn't feeling pleasure? Not quite. And maybe he had even felt something negative. Something uncomfortable. Something similar to how Rosy felt after watching *Lego Girls* for three hours? Or something similar to that gloominess that I felt on the beach when I couldn't stop checking my email, texts, and social media, over and over again? Tap-tap-tap.

And yet the monkey, Rosy, and I still couldn't stop pressing the button. Why?

What if dopamine doesn't encode pleasure at all but something else?

That's exactly what a young neuroscientist at the University of Michigan began to realize, thirty years after Olds made the bold claim to his wife that he had found the pleasure center of the brain. And this young professor's discovery completely toppled the scientific canon around pleasure and dopamine.

When I first met Kent C. Berridge in his office in Ann Arbor, Michigan, I felt like I had traveled back in time, maybe to the 1950s. Berridge has furnished his office with a distinctive old-school, academia style: leather chairs, leather sofa, and dark wooden bookshelves. On his desk, he has an antique jar filled with clear liquid and a brain floating inside it.

"Is this human?" I asked, pointing to it.

"Yes, that's a human brain," Berridge answered with a quiet chuckle.

With big, round eyes and a gentle, upbeat demeanor, Berridge reminded me of the type of dad you'd see on a 1950s TV show, like *Leave It to Beaver* or *Father Knows Best*.

You would never guess that Berridge has emerged as a scientific hero, especially in the addiction field. He has worked persistently across decades to uncover key factors that cause people to relapse when trying to recover from addiction, as well as new tools to help prevent it. In the process, he has overturned the prevailing wisdom around how dopamine works in our brains.

But reaching the status of "hero" hasn't been easy for Berridge. First he had to endure a decade of derision and ostracization by those in the dopamine field.

When Berridge first started as a professor, in the late 1980s, he had no intention of disrupting the dogma around dopamine. "I was totally convinced by James Olds's work," Berridge said. "I was totally convinced that dopamine generated pleasure. I was even teaching the hypothesis in my classes."

And so he set out to confirm Olds's theory with his own laboratory experiments. "I was delighted to add one more little piece of evidence to the pleasure-hypothesis pile," Berridge said with a gentle smile.

At the time, Berridge had developed the perfect tool to do just that. During his graduate work he had devised a way to measure how much a rat likes an experience. How much "pleasure" it provides. (I put pleasure in quotes because we can never know if a rat experiences the emotion of pleasure.)

Berridge realized that animals, including humans, show that they *like* the way something tastes by their facial expression. For example, when Rosy was a squishy six-month-old baby, I gave her a little taste of ice cream. Her face lit up instantly. She smiled, smacked her lips, and then licked them. Her facial expressions showed clearly, *Oh yes! I like this!*

"For thousands of years, this is how parents knew that babies liked a food, right?" Berridge said, demonstrating how the baby responds, by smacking his lips and smiling.

"Rats, it turns out, make similar expressions," he added. They lick their lips. They rub their paws on their faces. They demonstrate that the taste of sugar makes them feel something good.

Berridge decided that these rat expressions were the perfect tool to prove once and for all that dopamine encodes pleasure in animals' brains. He could perform an easy experiment. He would simply block dopamine in some rats' brains with a drug, give each animal a sweet treat (a sugary drink), and then show how the animals no longer enjoyed the drink. They wouldn't smack their lips or rub their paws on their face.

Berridge remembered clearly when he ran that first experiment. "It was during the Christmas break," he said. He and a graduate student were working in the lab over the holidays. "And when we gave the animals the sweet taste, we couldn't believe our eyes."

Even when the animals had no dopamine in their brains, they still seemed to *love* the sugar solution. Not just a little but just as much as they had loved it when they had dopamine flowing in their brains. The animals licked their lips. They rubbed their paws on their mouths. Blocking the release of dopamine appeared to have no effect on how much pleasure the sugary drink gave the animals. None at all.

"They had perfectly normal reactions to the sweetness," Berridge recalled.

At first, Berridge dismissed the results. "The graduate student didn't believe it," he told me. "My colleague down the hall didn't believe it either. Nobody believed it. We all thought we had made a mistake. You know, science is like making a soufflé. You have to do every step right or it doesn't work."

So he and the graduate student did what great scientists do best: They repeated the experiment, not just once, but many, many times. And with many different variations. They tried different drugs to block the dopamine. They even used a toxin to wipe out almost all the dopamine neurons in the rats' brains. Time and again, Berridge saw the same results: When he got rid of dopamine, the rats still liked the taste of sugar.

What on earth was going on?

When Berridge published the findings, his colleagues chalked up the results to incompetence. They said, "Well, you clearly can't do experiments. You can't even replicate something that is well known. Maybe you should find another career," he recalled quite bluntly. "Well, they weren't that harsh," he added with a chuckle and then a sigh. But to Berridge, the message was clear: *He* was the one who was off, not the pleasure hypothesis. "I don't blame them for not believing me," he added. "I had this one experiment showing a failure [of the hypothesis] . . . and they had this huge pile of positive evidence. Who would you believe?"

He remembered one scientific conference where other senior researchers wouldn't even stop at his poster to talk about his findings. "They didn't want to get trapped in a discussion with this crazy person," he remembered.

But Berridge wasn't crazy, and when you're with him that's clear. Even with the friendly, TV dad demeanor, the clearness of his logic and his willingness to be persistent come across as palpable pieces of his personality. He's a dogged scientist through and through.

So he thought deeply about his experiments, searching, like a crime investigator, for a clue as to what was going on. Then he remembered something peculiar about the behavior of the dopamine-free rats: They were lazy. *Super*-lazy. During the experiment, they had morphed into the biggest couch potato rats on the planet. They were a bit like stoners on a Friday night: They loved the sugar water immensely, but they were too lazy to even walk across their cage to lick it up. Berridge and his students had to feed the animals through tubes because they had such little motivation to go and drink it themselves.

And that made Berridge start to wonder. Could dopamine be more about motivation than pleasure? Maybe it's what gives us the drive to go and get the pleasure?

To test that hypothesis, Berridge created the opposite of couch potato rats. He created super-dopamine rats.

Instead of shutting down the dopamine circuitry, Berridge revved it up like a hot rod ready for a Saturday night of drag racing.

What happened? Well, the rats didn't seem to like the sugar water any more or less than normal rats. "The extra dopamine definitely wasn't making the sugar more pleasant," Berridge said. "If anything it made them like it a little *less*. They became averse to it."

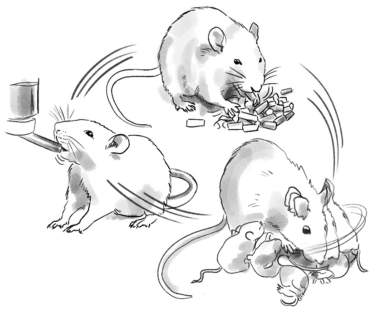
When Berridge revved up the dopamine in the rats' brains, they didn't just hang around and relish the good life. They didn't have an eternal feeling of *Aaah, life is so pleasurable*.

Instead, they acted in the opposite way. They became incredibly busy. It was like Berridge had given the furry animals magical shots of espresso that never wore off.

"Rather than sit there and enjoy the electrodes, the rats became

very highly motivated," Berridge explained. And they each focused their motivation on one particular activity. For example, some super-dopamine rats drank a whole bunch of water . . . all day long. Some tried to have sex with another rat, over and over again. Some rats even became highly motivated moms and dads. They acted like helicopter parents, showing tons of love and attention to their pups.

Low-Dopamine Rat



Super-Dopamine Rat

And then there were the overeaters. "When we turned on the electrode, they would eat four to eight times more than normal," Berridge said. Four to eight times the number of calories that they needed! That's the equivalent of me eating sixteen to thirty-two Big Macs each day.

But—and this was key—these overeaters didn't appear to *like* the food or sugar any more when the electrode was turned up. They just ate—and ate and ate and ate. Crunch-crunch-crunch . . .

Revving up the rat's dopamine system superhigh didn't magically make the rat's life more enjoyable or pleasurable, Berridge observed. Instead, it created obsessive loops of desire. It sent their *wanting* into overdrive.*

And in that moment Berridge finally believed his data. He saw

* An accidental experiment with a Parkinson's drug has demonstrated similar findings in people. Revving up people's dopamine system doesn't make them enjoy life more or give them more pleasure in life. Instead it causes many of them to become addicted to eating, drinking, shopping, sex, pornography, and other consumer activities.

that the neuroscience field had made a big mistake. "That's when I knew dopamine didn't encode pleasure," Berridge said.

So, in his small, start-up lab in Ann Arbor during the early 1990s, Berridge and his graduate students began to demolish the old model of dopamine, one experiment on rats after another.

Berridge and his students were beginning to see what the rest of the neuroscience field couldn't. High levels of dopamine inside your brain don't give you a surge of pleasure, as the old model claimed. Instead, dopamine gives you a surge of *motivation*. It gives you an intense feeling of desire. And it gives you the energy and oomph to go get what you want.

But it's not a case of wanting something for a single time. Dopamine doesn't stop at "Just one, thank you, ma'am." A surge of dopamine tells you to do something now . . . and then do it again when you can. Press the button again. Comment again. Scroll again. Watch again. Crunch again. Dopamine makes you want, over and over again.

And that's why, Berridge explained, all the animals and humans back in the 1950s couldn't stop "self-stimulating" by pressing the lever. The electricity flowing through their dopamine system kept triggering the thought, *Do it again. Do it again. Do it again.* The animals and people didn't *love* the electrode. They didn't feel constant pleasure. They felt a constant desire to tap, tap, tap. They felt a constant longing. A ceaseless wanting.

"So the pleasure hypothesis is completely wrong?" I asked him.

"Well, it was such a compelling hypothesis," he answered. "But yes, the pleasure hypothesis is completely wrong."

While Berridge explained this to me, in his office that day, my thoughts turned back to Rosy and her need to watch cartoons, over and over again. How after an hour or more of watching, she didn't seem overwhelmed with pleasure or joy, but rather intensely motivated to watch more videos.

Then, when I returned back home with Rosy, I kept thinking about Berridge's super-dopamine rats, overeating and overdrinking. I started to realize that I, like the dopamine field, had made a big mistake. As the scientists misinterpreted the rat's behavior (tap-tap-tap), I had completely misinterpreted Rosy's behavior (watch-watch-watch). I had mixed up wanting and pleasure.

Let's go back to a typical evening at the Doucleff homestead. It's 8:00 p.m. and *Lego Girls* has transfixed Rosy into a trancelike state. Her eyes stare with intense concentration at the screen. Her body stays perfectly still.

As Rosy watches cartoons or plays video games, her brain releases little surges of dopamine, over and over again, said neuroscientist Anne-Noël Samaha, who studies addiction at the University of Montreal and also has young children. As we'll explore, there are many ways that apps and shows can trigger these small spikes in dopamine. They often occur when the show or game poses a small question to the child. *What will happen to Bluey next? What's hidden behind that bush?* These questions then trigger the feeling of desire in the child because they want to answer that question.

"So dopamine levels will periodically increase while children watch a video or play a game based on the content on the screen and your level of engagement," Samaha explained.

Then, while Rosy's transfixed on *Lego Girls*, I come into the bedroom with my timer and her toothbrush and say, "Time's up. Close the app and brush your teeth. It's time for bed." And then, all hell breaks loose! She screams, cries, runs, and hides under the desk in the living room. Sometimes she even throws objects.

I had always interpreted this extreme behavior—this extreme desire and need for cartoons—as extreme love and pleasure from cartoons. But Berridge helped me realize that my interpretation was wrong. Instead, in those moments, when I tried to help her dismount, I began to see that Rosy felt another emotion.

"When you stop the child abruptly [from their game or video],

the dopamine levels are still high," Samaha explained. "And what does dopamine do? It tells you that you need to mobilize yourself. You need to go do something. It tells you something important is happening."

It told Rosy to do it again! *Watch again. Watch again.* And it motivated Rosy to go get what she wanted, hell or high water. It told her to persist, work through challenges that arise, and accomplish this important goal of watching *Lego Girls*. To push through and find a way around any obstacles. It told her not only to tap, tap, tap but also to *fight* for the tap, tap, tap.

In other words, the extra dopamine in Rosy's brain told her to find a way around this crazy middle-aged woman with a timer and toothbrush who was thwarting her from reaching her goal. It told her to find a way around bedtime!

After I talked to Berridge and read his papers on dopamine's true role in our brains, a liberating idea began to arise in my mind: In those moments when Rosy felt such intense emotions around cartoons, she wasn't experiencing *insane pleasure*. Instead, she was experiencing *insane motivation*.

Like Berridge's rats, her intense motivation didn't mean that intense enjoyment would always follow. In fact, as I would soon come to learn, oftentimes she would put in a huge amount of intense work and time and receive only a crumb of reward.