

"A riveting read. Once you understand the power and peril of dopamine, you'll better understand the human condition itself."

—DANIEL H. PINK, AUTHOR OF *DRIVE* AND *WHEN*



# THE MOLECULE OF MORE

How a Single Chemical in Your Brain Drives  
Love, Sex, and Creativity—and Will Determine  
the Fate of the Human Race

DANIEL Z. LIEBERMAN, MD  
AND MICHAEL E. LONG

## **PRAISE FOR THE MOLECULE OF MORE**

“Daniel Lieberman and Michael Long have pulled off an amazing feat. They have made a biography of a neurotransmitter a riveting read. Once you understand the power and peril of dopamine, you’ll better understand the human condition itself.”

—**Daniel H. Pink, author of *Drive and When***

“Meet a molecule whose fingerprint rests upon every aspect of human nature—from desire and drugs to politics and progress. Lieberman and Long tell the epic saga of dopamine as a page-turner that you simply can’t put down.”

—**David Eagleman, PhD, neuroscientist at Stanford and New York Times bestselling author**

“I’ve worked as an artist for forty years, and the question ‘Why am I like this?’ has been a puzzle, a mystery, a plea, and an occasional cry to the heavens. Lieberman and Long have created a road map for all those wrestling between insatiable longing and the here and now.”

—**Thomas F. Wilson, actor and comedian**

“Why do we crave what we don’t have rather than feel good about what we do—and why do fools fall in love? Haunting questions of human biology are answered by *The Molecule of More*, a must-read about the human condition.”

—**Gregg Easterbrook, author of *It’s Better Than It Looks***

“As a guy who creates musical stuff for a living and reads science books for kicks, I was doubly hooked by *The Molecule of More*. Lieberman and Long lay out the astoundingly wide-ranging effects of dopamine with nimble metaphors and fat-free sentences. And the research linking creativity and madness, with dopamine as the hidden culprit—let’s just say it hit home. Reading each chapter, I felt myself fitting a key smoothly into a locked door, opening onto a fresh-yet-familiar room.”

—**Robbie Fulks, Grammy-nominated recording artist**

“Jim Watson, who deciphered the genetic code, famously said, ‘There are only molecules; the rest is sociology,’ adding fuel to C. P. Snow’s complaint that Science and the humanities are two fundamentally different “cultures” which will never meet. The authors argue provocatively, yet convincingly, that the molecule that allows us to bridge the chasm between them is dopamine. Though written for ordinary people, the narrative is sprinkled throughout with dazzling new insights that will appeal equally to specialists.”

—V.S. Ramachandran, PhD, professor at the University of California, San Diego, and at Salk Institute and author of *The Emerging Mind*

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Figure 2 (page 41) by Sasangi Umesha

Figure 4 (page 115) and Figure 5 (page 191) by Thomas Splettstoesser ([www.scistyle.com](http://www.scistyle.com))



BenBella Books, Inc.

10440 N. Central Expressway, Suite 800  
Dallas, TX 75231

[www.benbellabooks.com](http://www.benbellabooks.com)

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For Sam and Zach,  
who open my eyes to seeing the world in new ways.  
—DZL

For Dad,  
who would have told everyone even if they didn't want to hear it; and

For Kent,  
who left just when things were getting interesting.  
—ML





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## About the Authors



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Finally, this book began as an effort by two friends so uninterested in normal pastimes like fishing and baseball that the only thing we could do together was eat lunch more often or write a book. We remain friends, though a couple times it was a close call.

Daniel Z. Lieberman & Michael E. Long  
February 2018

In the beginning God created the heavens and the earth.

## Introduction

# UP VERSUS DOWN

**L**ook down. What do you see? Your hands, your desk, the floor, maybe a cup of coffee, or a laptop computer or a newspaper. What do they have in common? These are things you can touch. What you see when you look down are things within your reach, things you can control right now, things you can move and manipulate with no planning, effort, or thought. Whether it's a result of your work, the kindness of others, or simple good fortune, much of what you see when you look down is yours. They're things in your possession.

Now look up. What do you see? The ceiling, perhaps pictures on a wall, or things out the window: trees, houses, buildings, clouds in the sky—whatever is in the distance. What do they have in common? To reach them, you have to plan, think, calculate. Even if it's only a little, it still requires some coordinated effort. Unlike what we see when we look down, the realm of up shows us things that we have to think about and work for in order to get.

Sounds simple because it is. Yet to the brain this distinction is the gateway between two wildly different ways of thinking—two utterly different ways of dealing with the world. In your brain the down world is managed by a handful of chemicals—neurotransmitters, they're called—that let you experience satisfaction and enjoy whatever you have in the here and now. But when you turn your attention to the world of up, your brain relies on a different chemical—a single molecule—that not only allows you to move beyond the realm of what's at your fingertips, but also motivates you to pursue, to control, and to possess the world beyond your

immediate grasp. It drives you to seek out those things far away, both physical things and things you cannot see, such as knowledge, love, and power. Whether it's reaching across the table for the salt shaker, flying to the moon in a spaceship, or worshipping a god beyond space and time, this chemical gives us command over every distance, whether geographical or intellectual.

Those down chemicals—call them the Here & Nows—allow you to experience what's in front of you. They enable you to savor and enjoy, or perhaps to fight or run away, right now. The up chemical is different. It makes you desire what you don't yet have, and drives you to seek new things. It rewards you when you obey it, and makes you suffer when you don't. It is the source of creativity and, further along the spectrum, madness; it is the key to addiction and the path to recovery; it is the bit of biology that makes an ambitious executive sacrifice everything in pursuit of success, that makes successful actors and entrepreneurs and artists keep working long after they have all the money and fame they ever dreamed of; and that makes a satisfied husband or wife risk everything for the thrill of someone else. It is the source of the undeniable itch that drives scientists to find explanations and philosophers to find order, reason, and meaning.

It is why we look into the sky for redemption and God; it is why heaven is above and earth is below. It is fuel for the motor of our dreams; it is the source of our despair when we fail. It is why we seek and succeed; it is why we discover and prosper.

It is also why we are never happy for very long.

To your brain, this single molecule is the ultimate multipurpose device, urging us, through thousands of neurochemical processes, to move beyond the pleasure of just being, into exploring the universe of possibilities that come when we imagine. Mammals, reptiles, birds, and fish all have this chemical inside their brains, but no creature has more of it than a human being. It is a blessing and a curse, a motivation and a reward. Carbon, hydrogen, oxygen, plus a single nitrogen atom—it is simple in form and complex in result. This is dopamine, and it narrates no less than the story of human behavior.

And if you want to feel it right now, if you want to put it in charge, you can do that.

Look up.



## A NOTE FROM THE AUTHORS



We've packed this book full of the most interesting scientific experiments we could find. Still, some parts are speculative, especially in later chapters. In addition, there are places where we oversimplify to make the material easier to understand. The brain is so complex that even the most sophisticated neuroscientist must simplify to build a model of the brain that's capable of being understood. Also, science is messy. Sometimes studies contradict one another, and it takes time to sort out which results are correct. Reviewing the entire body of evidence would quickly become tedious for the reader, so we selected studies that have influenced the field in important ways and that reflect scientific consensus, when consensus exists.

Science is not only messy; it can sometimes be bizarre. The search for understanding human behavior can take strange forms. It's not like studying chemicals in a test tube or even infections in living people. Brain researchers have to find ways to trigger important behaviors in a laboratory environment—sometimes sensitive behaviors driven by passions such as fear, greed, or sexual desire. When possible we chose studies that highlight this strangeness.

Human research in all its forms is tricky. It's not the same as clinical care, in which a doctor and a patient work together to treat the patient's illness. In that case, they choose whatever treatment they think will work best, and the only goal is to make the patient better.

The goal of research, on the other hand, is to answer a scientific question. Even though scientists work hard to minimize the risks to their participants, the science must come first. Sometimes, access to experimental treatments can be lifesaving, but usually research participants are exposed to risks they wouldn't experience in the course of regular clinical care.

By volunteering to take part in studies, participants sacrifice some of their own safety for the benefit of others—sick people who will enjoy a better life if the research is successful. It's like a firefighter running into a burning building to rescue the people

trapped inside, choosing to place himself in danger for the welfare of others.

The key element, of course, is that the research participant needs to know exactly what she's getting herself into. It's called informed consent, and usually comes in the form of a lengthy document that explains the purpose of the research and lists the risks of becoming involved. It's a good system, though not perfect. Participants don't always read it carefully, especially if it's very long. Sometimes researchers leave things out because deception is an essential part of the study. But, in general, scientists do their best to make sure their participants are willing partners as they tackle the mysteries of human behavior.



Love is a need, a craving, a drive to seek life's greatest prize.  
—Helen Fisher, biological anthropologist

## Chapter 1

# LOVE

You've found the one you waited for all your life, so why  
doesn't the honeymoon last forever?

In which we explore the chemicals that make you want sex and fall in love  
—and why, sooner or later, everything changes.

Shawn wiped a clear space on his steamed-over bathroom mirror, ran his fingers through his black hair, smiled. “This'll work,” he said.

He dropped his towel and admired his flat belly. His obsession with the gym had produced two-thirds of a six-pack. From that, his mind went to a more pressing obsession: he had not been out with anyone since February. Which was a nice way of saying he hadn't had sex in seven months and three days—and he was disturbed to realize he had kept track so precisely. That streak ends tonight, he thought.

At the bar, he surveyed the possibilities. There were a lot of attractive women here tonight—not that looks were everything. He missed sex, sure, but he also missed having someone in his life, someone to text for no reason, someone who could be a welcome

part of every day. He considered himself a romantic, even if tonight was just about sex.

He kept meeting the eyes of a young woman standing with a chatty friend at a high-top table. She had dark hair and brown eyes, and he noticed her because she wasn't in the usual Saturday-night uniform; she had on flats instead of heels, and she wore Levis instead of club clothes. He introduced himself and the conversation came quickly and easily. Her name was Samantha, and the first thing she said was that she was more comfortable doing cardio than putting back beers. That led to an in-depth discussion of local gyms, fitness apps, and the relative merits of working out in the morning versus the afternoon. For the rest of the night he didn't leave her side, and she quickly came to like having him there.

Lots of factors pushed them along to what would become a long-term relationship: their common interests, the ease they felt with each other, even the drinks and a little desperation. But none of that was the real key to love. The big factor was this: they were both under the influence of a mind-altering chemical. So was everyone else in the bar.

And, it turns out, so are you.

## **WHAT IS MORE POWERFUL THAN PLEASURE?**

Dopamine was discovered in the brain in 1957 by Kathleen Montagu, a researcher working in a laboratory at the Runwell Hospital near London. Initially, dopamine was seen simply as a way for the body to produce a chemical called norepinephrine, which is what adrenaline is called when it is found in the brain. But then scientists began to observe strange things. Only 0.0005 percent of brain cells produce dopamine—one in two million—yet these cells appeared to exert an outsized influence on behavior. Research participants experienced feelings of pleasure when they turned dopamine on, and went to great lengths to trigger the activation of these rare cells. In fact, under the right circumstances, pursuit of feel-good dopamine activation became impossible to resist. Some scientists christened dopamine the pleasure molecule, and the pathway that dopamine-producing cells take through the brain was named the reward

circuit.

The reputation of dopamine as the pleasure molecule was further cemented through experiments with drug addicts. The researchers injected them with a combination of cocaine and radioactive sugar, which allowed the scientists to figure out which parts of their brains were burning the most calories. As the intravenous cocaine took effect, participants were asked to rate how high they felt. Researchers discovered that the greater the activity in the dopamine reward pathway, the greater the high. As the body cleared the cocaine from the brain, dopamine activity decreased, and the high faded. Additional studies produced similar results. The role of dopamine as the pleasure molecule was established.

Other researchers tried to duplicate the results, and that's when unexpected things began to happen. They reasoned that it's unlikely that dopamine pathways evolved to encourage people to get high on drugs. Drugs were probably causing an artificial form of dopamine stimulation. It seemed more likely that the evolutionary processes that harnessed dopamine were driven by the need to motivate survival and reproductive activity. So they replaced cocaine with food, expecting to see the same effect. What they found surprised everyone. It was the beginning of the end for dopamine as the pleasure molecule.

Dopamine, they discovered, isn't about pleasure at all. Dopamine delivers a feeling much more influential. Understanding dopamine turns out to be the key to explaining and even predicting behavior across a spectacular range of human endeavors: creating art, literature, and music; seeking success; discovering new worlds and new laws of nature; thinking about God—and falling in love.



Shawn knew he was in love. His insecurities melted away. Every day made him feel on the brink of a golden future. As he spent more time with Samantha, his excitement about her grew, and his sense of anticipation became constant. Every thought of her suggested limitless possibilities. As for sex, his libido was stronger than ever, but only for her. Other women ceased to exist. Even better, when he tried to confess all this happiness to Samantha, she interrupted him to say she felt exactly the same.

Shawn wanted to be sure they would be together forever, so

one day he proposed to her. She said yes.

A few months after their honeymoon, things began to change. At the start they had been obsessed with one another, but, with the passage of time, that desperate longing became less desperate. The belief that anything was possible became less certain, less obsessive, less at the center of everything. Their elation receded. They weren't unhappy, but the profound satisfaction from their earlier time together was slipping away. The sense of limitless possibilities began to seem unrealistic. Thoughts about each other, that used to come constantly, didn't. Other women began to draw Shawn's attention, not that he intended to cheat. Samantha let herself flirt sometimes, too, even if it was no more than a shared smile with the college boy bagging groceries in the checkout line.

They were happy together, but the early gloss of their new life began to feel like their old life apart. The magic, whatever it was, was fading.

Just like my last relationship, thought Samantha.

Been there, done that, thought Shawn.

## **MONKEYS AND RATS AND WHY LOVE FADES**

In some ways rats are easier to study than human beings. Scientists can do a lot more to them without having to worry about the research ethics board knocking at their door. To test the hypothesis that both food and drugs stimulate dopamine, the scientists implanted electrodes directly into rats' brains so they could directly measure the activity of individual dopamine neurons. Next, they built cages with chutes for food pellets. The results were just as they expected. As soon as they dropped the first pellet, the rats' dopamine systems lit up. Success! Natural rewards stimulate dopamine activity just as well as cocaine and other drugs.

Next they did something the original experimenters had not. They kept going, monitoring the rats' brains as pellets of food were dropped down the chute, day after day. The results were wholly unexpected. The rats devoured the food as enthusiastically as ever. They were obviously enjoying it. But their dopamine activity shut down. Why would dopamine stop firing when stimulation keeps coming? The answer came from an