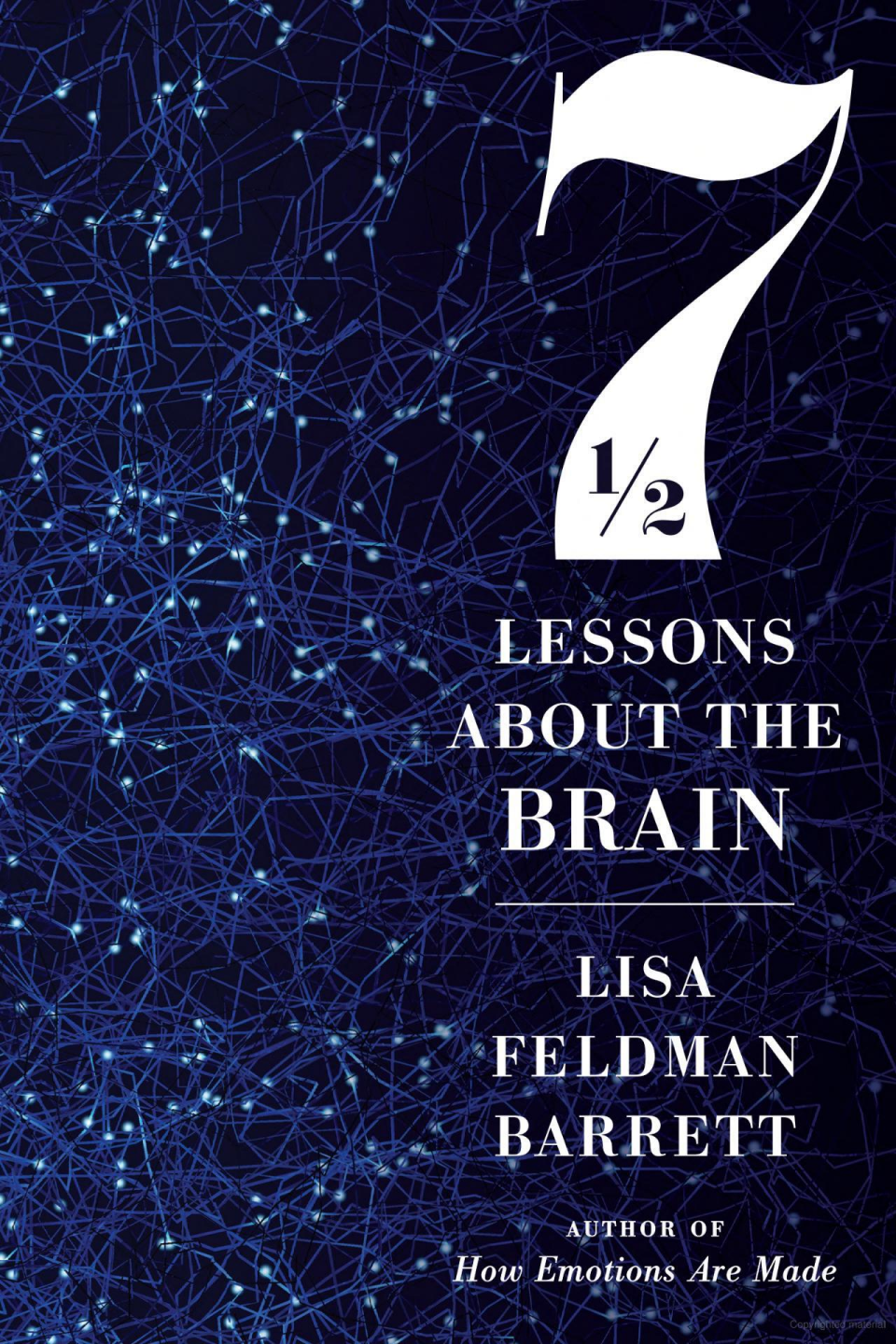

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Author's Note

I wrote this book of short, informal essays to intrigue and entertain you. It's not a full tutorial on brains. Each essay presents a few compelling scientific nuggets about your brain and considers what they might reveal about human nature. The essays are best read in order, but you can also read them out of sequence.

As a professor, I usually include loads of scientific details in my writing, such as descriptions of studies and pointers to journal papers. For these informal essays, however, I've moved the full scientific references to my website, sevenandahalflessons.com.

Also, at the end of this book, you'll find an appendix with selected scientific details. It offers a bit more depth on some essay topics, explains that certain points are still debated by scientists, and gives credit to other people for some interesting turns of phrase.

Why are there seven and a half lessons rather than

eight? The opening essay tells a story of how brains evolved, but it is just a brief peek into a vast evolutionary history—hence, half a lesson. The concepts that it introduces are critical to the rest of the book.

I hope you'll enjoy learning what one neuroscientist thinks is fascinating about your brain and how that three-pound blob between your ears makes you human. The essays don't tell you what to think about human nature, but they do invite you to think about the kind of human you are or want to be.

SEVEN
AND A HALF
LESSONS
ABOUT THE
BRAIN

The Half-Lesson

Your Brain Is Not for Thinking

ONCE UPON A TIME, the Earth was ruled by creatures without brains. This is not a political statement, just a biological one.

One of these creatures was the amphioxus. If you ever glimpsed one, you'd probably mistake it for a little worm until you noticed the gill-like slits on either side of its body. Amphioxi populated the oceans about 550 million years ago, and they lived simple lives. An amphioxus could propel itself through the water, thanks to a very basic system for movement. It also had an exceedingly simple way of eating: it planted itself in the seafloor, like a blade of grass, and consumed any minuscule creatures that happened to drift into its mouth. Taste and smell were of no concern because an amphioxus didn't have senses like yours. It had no eyes, just a few cells to detect changes in light, and it could not hear. Its meager nervous system included a teeny clump of cells that was not

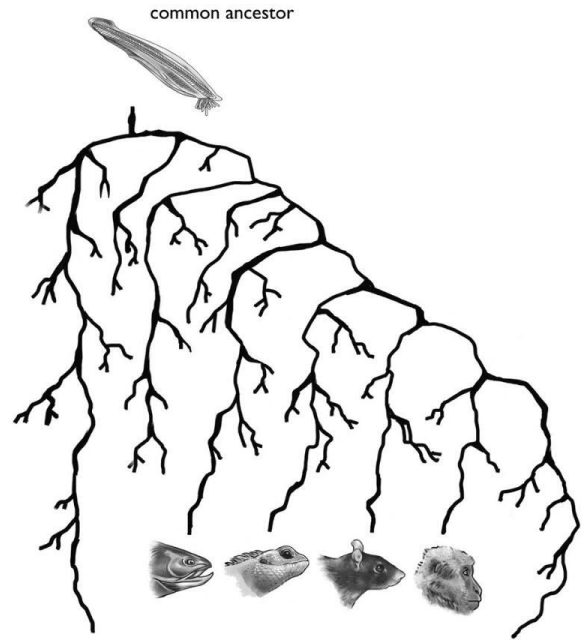
quite a brain. An amphioxus, you could say, was a stomach on a stick.

Amphioxi are your distant cousins, and they're still around today. When you look at a modern amphioxus, you behold a creature very similar to your own ancient, tiny ancestor who roamed the same seas.

Can you picture a little wormy creature, two inches long, swaying in the current of a prehistoric ocean, and glimpse humanity's evolutionary journey? It's difficult. You have so much that the ancient amphioxus did not: a few hundred bones, an abundance of internal organs, some limbs, a nose, a charming smile, and, most important, a brain. The amphioxus didn't need a brain. Its cells for sensing were connected to its cells for moving, so it reacted to its watery world without much processing. You, however, have an intricate, powerful brain that gives rise to mental events as diverse as thoughts, emotions, memories, and dreams—an internal life that shapes so much of what is distinctive and meaningful about your existence.

Why did a brain like yours evolve? The obvious answer is *to think*. It's common to assume that brains evolved in some kind of upward progression—say, from lower animals to higher animals, with the most sophisticated, thinking brain of all, the human brain, at the top. After all, thinking is the human superpower, right?

Well, the obvious answer turns out to be wrong. In fact, the idea that our brains evolved for thinking has been the source of many profound misconceptions about human



Amphioxi were not our direct ancestors, but we had a common ancestor that was very likely similar to a modern-day amphioxus.

nature. Once you give up that cherished belief, you will have taken the first step toward understanding how your brain actually works and what its most important job is —and, ultimately, what kind of creature you really are.

Five hundred million years ago, as little amphioxi and other simple creatures continued to dine serenely on the ocean floor, the Earth entered what scientists call the Cambrian period. During this time, something new and significant appeared on the evolutionary scene: hunting. Somewhere, somehow, one creature became able to *sense the presence* of another creature and deliberately ate it. Animals had gobbled one another before, but now the eating was more purposeful. Hunting didn't require a brain, but it was a big step toward developing one.

The emergence of predators during the Cambrian period transformed the planet into a more competitive and dangerous place. Both predators and prey evolved to sense more of the world around them. They began to develop more sophisticated sensory systems. Amphioxi could distinguish light from dark, but newer creatures could actually see. Amphioxi had simple skin sensation, but newer creatures evolved a fuller sense of their body movements in the water and a greater sense of touch that allowed them to detect objects by vibration. Sharks today still use this kind of touch sense to locate prey.

With the arrival of greater senses, the most critical

question in existence became *Is that blob in the distance good to eat, or will it eat me?* Creatures who could better sense their surroundings were more likely to survive and thrive. The amphioxus may have been a master of its environment, but it couldn't sense that it *had* an environment. These new animals could.

The hunters and the hunted also received a boost from another new ability: more sophisticated kinds of movement. For the amphioxus, whose nerves for sensing and moving were woven together, movement was extremely basic. Whenever its stream of food became a trickle, it wriggled in a random direction to plant itself in another spot. Any looming shadow prompted its body to dart away. In the new world of hunting, however, predators and prey alike began to evolve more capable systems for movement, or motor systems, to navigate with greater speed and dexterity. These newer animals could dart, turn, and dive deliberately toward things like food and away from things like threats in ways that suited their environment.

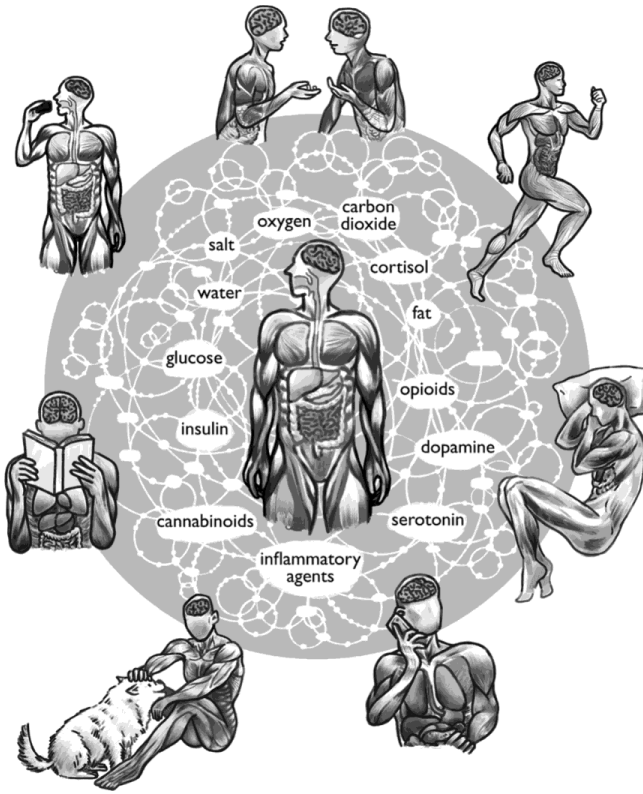
Once creatures could sense at a distance and make more sophisticated movements, evolution favored those who performed these tasks efficiently. If they chased a meal but moved too slowly, something else caught the meal and ate it first. If they burned up energy fleeing from a potential threat that never arrived, they wasted resources that they might have needed later. Energy efficiency was a key to survival.

You can think about energy efficiency like a budget. A

financial budget tracks money as it's earned and spent. A budget for your body similarly tracks resources like water, salt, and glucose as you gain and lose them. Each action that spends resources, such as swimming or running, is like a withdrawal from your account. Actions that replenish your resources, such as eating and sleeping, are like deposits. This is a simplified explanation, but it captures the key idea that running a body requires biological resources. Every action you take (or don't take) is an economic choice—your brain is guessing when to spend resources and when to save them.

The best way to keep to a financial budget, as you may know from personal experience, is to avoid surprises—to anticipate your financial needs before they arise and make sure you have the resources to meet them. The same is true of a body budget. Little Cambrian creatures needed an energy-efficient way to survive when a hungry predator was nearby. Should they wait around until the ravenous beast made its move and then react by freezing or hiding? Or should they anticipate the lunge and prepare their bodies in advance to escape?

When it came to body budgeting, prediction beat reaction. A creature that prepared its movement before the predator struck was more likely to be around tomorrow than a creature that awaited a predator's pounce. Creatures that predicted correctly most of the time, or made nonfatal mistakes and learned from them, did well. Those that frequently predicted poorly, missed threats, or false-



Your brain runs a budget for your body that regulates water, salt, glucose, and many other biological resources inside you. Scientists call the budgeting process *allostasis*.

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