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Introduction

A FEW years back, a wild rat broke into my office, making a cozy nest for himself in an open drawer of a filing cabinet by shredding old neuroscience journals. For most people, seeing any kind of rat at work would be unexpected. But where rats are concerned, I am not most people. When my uninvited visitor snuck in, I had been studying, caring for, and writing about lab rats for decades. I knew that a wild rat in my office might harbor pathogens that could threaten the lab rat colony down the hall, so the little guy had to go. A seasoned rat researcher like me would be more than equal to the task of evicting a single wild rat, right? I quickly discovered that my decades of lab rat experience simply didn't translate to a wild specimen, so I called in a professional.

As the pest control specialist made several futile attempts to trap the wild rat, I couldn't help but marvel at its resilience and adaptability. Like a scene from a *Mission: Impossible* thriller, the rodent intruder navigated the live traps to grab the food treat without triggering the mechanism that closed the door. My docile laboratory rodents down the hall were a world away from this wily intruder. Following three weeks of the pest control specialists' best rat-trapping efforts, the rodent visitor disappeared, likely returning to the great outdoors. But the encounter—with a creature shaped by the challenges of its natural habitat—taught me, a seasoned neuroscientist, an unexpected lesson about animal brains and behavior. Not long after, I found my attention straying beyond the walls of my laboratory to the fields, cities, and forests where animals live exciting, dangerous lives. The neuroscience research I'd undertaken for decades had been full of challenges and insights, sure, but my research subjects with their timed feedings in a world free of predators began to appear less like their wild cousins and more like a different species altogether.

I followed my newfound curiosity to a twilight "rodent-watching" field trip through the alleys of Baltimore, where I was captivated by the choreography of the city's nocturnal residents. As sunset darkened the horizon, rats emerged from their hidden burrows, scurrying across streets with apparent purpose. They investigated the fresh bounty of garbage bags set out during the day and exchanged nose-to-nose greetings. Casting little shadows in the moonlight, the occasional pair reared up toward one another on their hind legs as if dancing. The urban rats in their element were more than captivating; I found the experience practically intoxicating. It was a feeling I had never experienced under the fluorescent lights of my rodent laboratory. The world I had staked out as a researcher began to seem small, even a bit—and it pains me to write this—boring.

It pains me because I've seen firsthand just how valuable, and surprising, lab research can be. Scientists have made incredible discoveries by studying easily managed and often predictable laboratory rodents. In such a setting, scientists enjoy unparalleled control, which can be wielded like a scalpel for knowledge, teasing out answers with fantastic precision. We can trace the lineage of our rodent participants back for generations, monitor every morsel they consume, and catalog each social interaction they've had since birth. I still hold laboratory rat–derived lessons in high regard. I've even continued to do lots of lab research after my encounter with the wild rat in my office and the nocturnal rodent spectacular I found in Baltimore. But the research I do now is different. For years, I've been breaking down the barriers between the lab and the wild. This isn't just a newfound curiosity. It's a necessary and long-overdue change in how neuroscience research is conducted. What I will show you in *Wild Brains* is that (carefully) bringing aspects of the wild into the lab—and the techniques and concepts of the lab out into the wild—promises to help us solve some of the biggest and most intractable problems facing neuroscientists today.

Why Go Wild?

Neuroscience research using traditional methods has been hitting walls in key areas for decades. Informed and skilled investigators have discovered many fascinating truths about how animal and human brains work, but that information has been, at best, disappointingly slow to translate into clinical interventions that effectively treat disruptive mental illnesses. Consequently, advances in psychiatry have paled in comparison to successful treatments for nonpsychiatric medical conditions such as cardiovascular disease, diabetes, many forms of cancer, and AIDS.

Why is it more difficult to develop effective interventions for brains? This discrepancy likely stems from the way research is conducted. As a behavioral neuroscientist, I'm committed to uncovering clues about how to nurture and maintain healthy brains. That means studying brains that are resilient to the challenges of life. In the wild, animals are tested daily in their ability to thrive, and they must succeed or die. In the lab, they only need to keep eating the food given to them and can survive almost regardless of their mental well-being. Studying animals in natural settings will reveal essential insights about how to build and maintain healthy brains, and those experiments will help us confront the mental health crises that plague humans today. We need to reconsider the old-school practice of using *standard* research models (mostly rodents) housed in predictable laboratory environments as the go-to method for identifying the intricate mechanisms of complex human brains.

Understandably, controlled and sterile laboratory settings are appealing from a scientific perspective. It is easier to design experiments to investigate one particular variable when we can hold all other variables constant. Interested in the impact of a specific diet on neural complexity? Start with two identical groups of rodents and give one group the experimental diet and the other its normal diet, and—voila—you have a bona fide research study. However, all isn't as it appears.

Real life is messy and unpredictable, and one could argue that our research settings should reflect those conditions. Just as cancer cells need to be cultured in appropriate chemical environments to activate their underlying physiological mechanisms, brains that evolved to navigate complex, dynamic worlds should be investigated in environments that mirror those realities—settings with unpredictable obstacles, fluctuating resources, and ample space for exploration and social interaction.

Thankfully, nature has generated an expansive inventory of brains, with varying shapes, sizes, and adaptations. Consequently, we can learn valuable brain secrets by broadening our studies to include diverse species with genetic variability and, when possible, investigating these brains in their natural habitats. Even if we are unable to visit those wild places ourselves, we can improve on current research practices by creating naturalistic habitats inside the lab. This naturalistic laboratory approach, in conjunction with work in the field, will diversify our neuroscience knowledge portfolio, increasing our chances of identifying the characteristics of flourishing brains and effective interventions for mental illness. It's time to step away from our dependence on one-size-fits-all research models and take a walk on the wild side if we want to discover the wisdom of brains responding naturally in their native habitats.

The argument I make in this book may sound a bit out of character considering my enthusiasm for laboratory rats over the past three decades. I have faithfully sung the praises of the resourceful, adaptive laboratory rat, enough to have written a book, *The Lab Rat Chronicles*, about the valuable lessons gleaned from these crafty animals. We should not abandon our work with laboratory animals altogether. By shifting our perspectives, our protocols, and the animals we work with, neuroscientists will be able to explore new horizons of knowledge.

Slowly and steadily, I've been adding new species and habitats to my research endeavors, and the responses I've observed in the wild have generated new ideas about the neural mechanisms of emotional resilience, neuroplasticity, and overall brain health—mechanisms largely studied within the traditional lab setting. Above, I mentioned the need for better research avenues for mental illness, and that is critically important, but wild neuroscience also promises to help us better understand what makes our brains, ourselves, and thereby our social groups thrive. In *Wild Brains*, you'll learn about my adventures in and beyond the laboratory, as well as those of scientists conducting their own fascinating investigations around the world. The diverse species I feature in the book range from semi-free-ranging macaques in a zoological park in the United States to rescued raccoon orphans in Canada and wild mouse lemurs in Madagascar—and they all offer unique insights into the intricacies of brain adaptation.

For example, you'll learn about the neurobiology of romantic bonds and parental commitment from prairie voles, a mouse-sized rodent found in—you guessed it—the prairies of the midwestern United States. Once researchers identified that wild voles in their natural setting displayed behavioral tendencies toward committed relationships, they deciphered the neural mechanisms of those social bonds in the lab. This is just one example of how studying wild and diverse animals complements and informs ongoing laboratory investigations into big questions, like those related to love and attachment.

Another exciting area of research is helping us develop a better understanding of brain health in creatures that can't tell us when they feel sad, anxious, or alone. What we can look at, though, are behaviors that indicate emotional well-being in animals. The fascinating behavior of play provides valuable neurobiological clues to happy and healthy brains. Across species and habitats, nature has invested in play responses as the tried and true way of fine-tuning brains to thrive in the animals' natural habitat. Watching juvenile macaques through the years, I have marveled at the ease with which they convert their landscapes into playscapes—swinging from vines, bouncing on limbs, investigating each new object they encounter, play-fighting with other young macaques. The fact that this behavior comes at a cost of expending valuable energy and being vulnerable to injury suggests that the return on brain investment must be immense. We also know that play is a critical part of human childhood. A more thorough understanding of this behavior may therefore lead to interventions for developmental disorders such as autism, anxiety, and attention deficit and hyperactivity disorder (ADHD). Scientists who want to study play, however, may never see it occur if their research animals are housed in laboratories or other restricted habitats, even seminatural ones. Traditional lab science can only get glimpses of the vast spectrum of responses that animals use in the wild where they evolved.

By blending laboratory rigor with wild explorations of play, love, and a host of other intriguing behaviors, scientists can also increase our understanding of the best practices for maintaining healthy *human* brains. I'm encouraged by the fascinating investigations into wild brains that are already deepening our understanding of everything neuroscientific, from the molecular fundamentals of brain anatomy to the complexities of human behavior. In the chapters ahead, we'll examine the brains of many species, including the usual suspects—mice and rats—as well as others such as raccoons, octopi, naked mole-rats, turkeys, beavers, mouse lemurs, gorillas, and, not to be left out, humans.

Chapter 1 takes a wide look around the animal kingdom to consider just how limited neuroscience research is in its overwhelming focus on a mere handful of model species, especially the lab rodents I know so well. By sampling some of the most incredible brain stories out there, from tiny shrews that digest their own nervous systems to the precarious intellectual plight of the koala, I demonstrate how understanding an animal's wild, evolutionary context is absolutely critical to understanding its brain and behavior. I explore the roots of our current research predicament in Chapter 2, explaining how the field of neuroscience came to be overwhelmingly tilted toward laboratory rodents and why this narrow-mindedness is holding us back. Lab rats and mice have an evolutionary history, too, even if it is rather strange. We must consider how decades (arguably centuries) of selective breeding have impacted the brains of these amazing creatures. Chapter 3 presents exciting research strategies using a hybrid approach (living laboratories) that draws on the advantages of both laboratory and wild environments, ranging from enriched cages within controlled, lab-like settings to pioneering projects conducted in natural habitats. We will probe the remarkable adaptability and learning capacities of brains in varying environmental contexts in Chapter 4, juxtaposing the constrained nature of traditional laboratory settings with the dynamic challenges of natural habitats. Chapter 5 scrutinizes the repercussions of animals grappling with artificial confines, shedding light on their seeming misbehavior and the invaluable insights they offer into the neural consequences of environmental mismatches.

Armed with a comprehensive understanding of model species and diverse experimental terrains, subsequent chapters delve into specific behavioral and physiological systems. From the intricacies of aging brains (Chapter 6) to the nurturing parental responses that are ubiquitous among mammals (Chapter 7) and the nuanced responses to stress and emotion observed in both controlled laboratory environments and the wild (Chapter 8), we will explore the added value of embracing a wild approach to neuroscience. Culminating our journey, Chapter 9 contemplates ideal habitats that foster flourishing brains in both human and nonhuman inhabitants.

I now invite you to join me on a thrilling odyssey as we explore the resilience and adaptability of brains across species and habitats. At the end of this neuroscience safari, I hope you'll share my enthusiasm for—and see the value in—enhancing our understanding of resilience and neural health through the study of wild brains. Let the adventure begin!

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