ALSO BY ROBERT M. SAPOLSKY

Why Zebras Don't Get Ulcers:
A Guide to Stress, Stress-Related Diseases, and Coping

Stress, the Aging Brain,
and the Mechanisms of Neuron Death

THE TROUBLE WITH TESTOSTERONE

and Other Essays on the Biology of the Human Predicament

ROBERT M. SAPOLSKY

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For my mother, who,
a long time ago,
read to me

THE TROUBLE WITH TESTOSTERONE

Introduction

We all have encountered Reinhold Niebuhr's serenity prayer at some point:

> *God, grant me the serenity to accept the things I cannot change, courage to change the things I can, and wisdom to know the difference.*

Behavioral biology is often the scientific pursuit of that prayer. Which of our less commendable ways of behaving, asks the behavioral biologist, can we hope to change (and how) and which are we stuck with? Asked in a harsher way—as our society so often poses these questions of nature and nurture—for which of our failings should we be held responsible? Did Charles Whitman open fire from the University of Texas observation tower and kill eighteen people because of his brain tumor? Did Richard Speck murder eight nurses because of his alleged extra Y chromosome? Did Dan White kill San Francisco mayor George Moscone and city supervisor Harvey Milk because of his "diminished capacity": attributable, in part, his lawyers claimed, to a junk food addiction? Did John Hinckley shoot President Reagan because of insanity? Or were they all just rotten characters? What about the spouse sunk in depression? Is a neurochemical imbalance to blame, or is the person just indulging in a profound sulk? Is the floundering schoolchild limited by a learning disability, or plain lazy?

In the most narrow sense, behavioral biologists seek to answer questions such as these by exploring the interface

between our minds and our bodies. How is it that you can think a thought, have a memory or a surge of emotion—products of our minds—and, as a result, alter the activities of virtually every cell in the body? And, in turn, what are the mechanisms by which events in our bodies—changes in hormonal status, nutrition, health—can change our thoughts and feelings? Answering questions such as these begins to answer the broadest questions of all—what is the biology of what makes us who we are, what is the biology of our individuality, our limits and potentials?

This is frightening ground to tread, partly because of the complexity of the questions asked. It's easier to determine how birds navigate while migrating or how muscle fibers contract than to answer a question like "Is there a genetic basis to criminality?" Scarier still are the abuses to which this work is subject. It's difficult to become an ideologue about bird migration or muscle physiology, but behavioral biology is a magnet for those with an ax to grind. Conscientious scientists fear that a minute observation, tenuously offered, might be seized upon by someone eager to lend scientific authority to claims like "I'm not responsible for my problems," or worse, "I don't have to help you in combating your problems, because they are incurable." At one extreme can be a wasted life, when prejudice dictates that there is a limit that does not exist. Witness those who have been discriminated against by race, ethnicity, or gender because they were believed to be biologically—and therefore, in this view, irredeemably—inferior. At the other extreme, the specter of blame can haunt the blameless, when ignorance leads to failure to recognize a real biological constraint that exists. In that case, witness the generations of dyslexics wrongfully condemned as stupid.

No matter how obscure the subfield of science, there is bound to be some crazed egghead out there who finds it fascinating. When it comes to the biology of our individuality,

issues are raised that should be fascinating to each of us for the simple reason that we are all asked to function as behavioral biologists on some occasion. Most importantly, those occasions matter: We serve on juries and decide the culpability of someone regarding something awful that they have done. We are asked to vote on referendums about expenditures of public funds to try to fix some social ill, and we have to decide if we think it can be fixed. We see someone stymied in their learning, claiming to be at their limits, and we must decide whether pushing them harder represents inspiration or cruelty. And perhaps we will have to watch a loved one decline with some terrible disease, watch their personality be transformed, and have to learn that this is due to the illness and not to them.

Insofar as we are forced to be practicing behavioral biologists, we might as well be competent at it. This collection of essays is meant to help a bit in that direction in that it offers a tour of the field (albeit a highly unsystematic one, which is to say that it covers a hodgepodge of topics that I'm particularly fascinated by). Broadly, the essays fall into three categories. One group presents some of the latest breakthroughs in psychiatry, neuroscience, and endocrinology. One might assume that much of these findings will be about big, messy problems in abnormal human behavior, about mental illness, uncontrollable violence—the arena of "them and their diseases." As will be seen, some of the most provocative findings in the field are a lot closer to home, are about far more subtle issues—why we differ in our sexual orientation, in our desire for novelty, in styles of thinking and feeling; this is not about them and their diseases, but about the biology of the quirks and idiosyncrasies of our everyday behaviors. It is my experience from lecturing about these topics that people get fairly disturbed by the implications of some of these findings, as we wind up seeming to have a lot less volition in our behaviors than most like. The extreme example of this is "Circling the

Blanket for God," the final essay in the collection, in which I consider some of the neuropsychiatric roots of religious belief.

Another set of essays explores many of these same issues from the perspective of evolutionary biology and animal behavior. Initially, many of these pieces will seem to be about how some of our close relatives—nonhuman primates, for example—turn out to be vastly more subtle and complex in their behaviors and emotions than one would ever have guessed from watching *Wild Kingdom.* What often only sinks in next is not only how subtle and complex they are but how familiar, reinforcing the lesson that we humans are just another primate species: a terribly neurotic, screwed-up, overly self-conscious one with some fancy thumbs, but still just another primate. As but one example of this style, "Primate Peekaboo," written a year ago when, to my embarrassment, I was devoting about ten hours a day to thinking about the O.J. trial, considers the intense voyeurism that is common to all of us primates.

Finally, another group of essays considers some of the political or social implications of findings in these areas. Some of these are historical, reviewing some of the disastrous dead-ends in behavioral biology, some of which are the end-product of well-intentioned mistakes, some the end-product of anything but good intentions. For example, in "Poverty's Remains," I recall the history of an imaginary disease that was invented around the turn of the century because scientists did not yet know anything about how stress affects the body, and before it was over with, thousands of people were killed by the consequences of medical belief in this erroneous discovery. And some of these pieces are meant to alert us to some of the dangers to come. In "How Big Is Yours?" for example, I discuss some recent and controversial evidence that the size of a certain sliver of the brain has something to do with a man's sexual orientation and then raise the question—what happens

when brain imaging techniques get to the point, as they soon will, where a ten-year-old can be informed as to the size of that silver in his own brain?

Thus, the ground that will be covered. A final note: I believe that everyone can benefit from learning some science these days, regardless of how efficient a job those teachers did in junior high school convincing us that we hated the subject. When science works right, it is an amazing thing to behold—it provides us with some of the most elegant, stimulating puzzles that life has to offer. It throws some of the most provocative ideas into our arenas of moral debate. And occasionally, it even improves our lives. The subjects contained in here, I feel, have the abundant potential to accomplish all of that; thus, I have made an effort to write these essays so that they will be accessible to anyone, even the card-carrying science-phobic. I think I can guarantee that the facts in here will be relatively simple, and I know I can guarantee that their implications will not be.

Acknowledgments

Some of the topics covered in these essays are related to my area of research, and I am supposed to know something about them. In many cases, though, these are about subjects that are not in my area of expertise (which, as will be seen, hasn't prevented me from developing some addled opinions about them). In these cases, I have been very dependent on the generosity and clarity of some of my colleagues in discussing their work and ideas. I thank Jeanne Altmann, Jay Belsky, Laurel Brown, Jonathan Cobb, Jared Diamond, Bill Durham, Laurence Frank, James Gross, Ben Hart, Charles Nemeroff, Craig Packer, Edward Paul, Larry Squire, Michele Surbey, Andrew Tomarken, the late Amos Tversky, and Richard Wrangham for their assistance; any factual errors are of my own doing.

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Walter Bode rather indirectly made it possible for these essays to see the light of day, and I thank him for that. Liz Ziemska, my agent, far more directly made it possible, and my great thanks to her as well. Hamilton Cain and Jennifer Chen have helped every step of the way at Scribner, and it has been a great pleasure to work with them.

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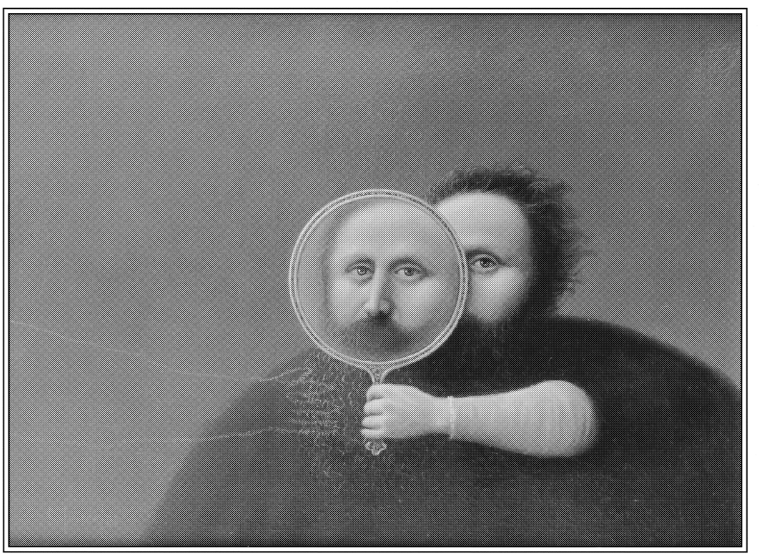
How Big Is Yours?



Alfredo Castañeda, When the Mirror Dreams with Another Image, *1988; courtesy Mary-Anne Martin/Fine Art, New York*

During my graduate school days in New York City I lived along the East River, and at times when I felt like indulging a simultaneous sense of adventure and melancholy I would visit Roosevelt Island. The island was a sliver of land in the river, two and a half miles long, accessible from Manhattan by a pleasing aerial tramway. Today most of Roosevelt Island is filled with high-rise apartment buildings. But in earlier times it was the dumping ground for various incorrigible or unmanageable members of society. At the very tip of the island are some remnants of those times—the rubble of a mental asylum abandoned in the first half of this century.

A decade ago it was still possible to climb around in those ruins. You could shin up the banister of a staircase whose steps had long since decayed away, push open creaking metal doors half off their hinges, and enter a room without a roof. You could then tiptoe through a third-floor hallway about to give way and hurtle you through the splinters into the basement (and, you were sure, into a nest of rats the size of pit bulls).

It was impossible to inch through the debris without being moved by the events that must have taken place in this ghost of Bedlam. There were doors marked INSULIN SHOCK ROOM, rusted gurneys with restraining straps teetering halfway through holes in the floor, and bloodstains on the walls. Even on a warm autumn day with the sun shining on the roofless

building, the whole place still felt dank and shadowed, the walls humid with the screams of misery and sadness.

Contemplating the treatment of an insane person from a century ago is something of a Rorschach test for us. Do we focus on the vast progress that has been made in psychiatry? Or do we see no difference at all from our own miserably inadequate treatment of the mentally ill?

Some things remain depressingly the same across the centuries: In so many times and places, the mentally ill give the rest of us the willies, and they are carefully isolated and ostracized. Yet many other things have changed. When we discuss treatments now, we think of drugs to manipulate brain chemicals such as neurotransmitters, while in earlier times it was lobotomies and insulin-induced comas, and still earlier, restraint and ice baths. Our notions of causes have changed as well. Now we discuss receptor regulation and genes, while earlier we would have blamed mothers sending conflicting signals of love and hate to impressionable young children.

What has changed most palpably, however, is our attitude toward abnormal behavior. We have become far more subtle when we consider the thorny issues of blame. Centuries ago epileptics were persecuted for their presumed bewitchment. We no longer do that, nor would any rational person prosecute an epileptic for assault and battery should that epileptic injure someone while flailing during a seizure. We have been trained to have a strikingly compassionate thought that is one of the triumphs of our century: "It's not him. It's his disease." We have been taught to draw a line between the essence of a person and the neuropsychiatric disorder that distorts and constrains that essence.

We are very good at drawing that line in rejecting the idea that an epileptic is violent because his arms move uncontrollably during a seizure. But we are not particularly good at drawing the line between a person and his disease in many

other realms. Witness, for example, the Neanderthal bellowing in so many editorials about how John Hinckley was "getting away with it" when he was hospitalized as a schizophrenic rather than being jailed after shooting Reagan. Or contemplate the number of teachers and parents who are not very good at drawing the line between the essence of who a child is and the learning disabilities that impinge on that essence—and who instead let words like "lazy" or "stupid" creep in.

If many of us are not very good at drawing that line now, that problem is going to get worse. Some astonishing new trends in neuropsychiatry and behavioral biology indicate that the line will shift in directions we never would have guessed. This shift affects much more than our understanding of the biological imperatives that drive a small group of us to monstrous behavior. It also affects how we view the quirks and idiosyncrasies that make each of us a healthy individual.

To me, one of the most intriguing changes has occurred in the way we see "schizotypal" individuals. A few decades ago a team headed by psychiatrist Seymour Kety of Massachusetts General Hospital initiated studies that demonstrated a genetic component to the disordered jumble of thoughts known as schizophrenia. The scientists examined adoption records meticulously maintained in Denmark, reviewing the cases of children adopted from their biological parents very early in life. If a child of a schizophrenic parent was adopted by healthy parents, Kety wanted to know, was the child at greater than average risk for schizophrenia? Conversely, did any child of healthy biological parents raised in a household with a schizophrenic adoptive parent have an increased risk for the illness?

Kety's work showed that genetics does in fact increase the likelihood of the disorder. But to get that answer, doctors had to conduct intensive psychiatric interviews with the various biological and adoptive parents. This involved thousands of people and years of work. No one had ever studied the rela-

tives of schizophrenics in such numbers before. And along the way someone noticed something: a lot of these folks were quirky. These relatives were not themselves schizophrenic—just a bit socially detached and with a train of thought that was sometimes a little hard to follow when they spoke. It was something mild, and not the sort of thing you'd note in talking to the family members of a few schizophrenics, but it suddenly stuck out when you dealt with thousands of them. They believed in strange things and were often overly concerned with magical or fantasy thinking. Nothing certifiably crazy—maybe a heavy interest in science fiction and fantasy, or a firm belief in some New Age mumbo jumbo or astrology, or perhaps a very literal, fundamentalist belief in biblical miracles. None of these are illnesses. Many adults attend Star Trek conventions, presidents' wives consult astrologers and are still taken seriously by the fashion industry, and others believe that the earth really was created in seven days. But today psychiatrists call the collection of traits seen by Kety "schizotypal personality disorder," especially the emphasis on magical thinking and the loosely connected thoughts. Apparently, if you have a certain genetic makeup, you're predisposed to schizophrenia. Have a milder version of this genetic makeup, and you may be predisposed to placing a strong faith in magical ideas that are not particularly based on fact. Is there a gene for believing in the Force and Obi-Wan Kenobi? Certainly not, but perhaps there's something closer to it than we ever would have imagined.

Behavioral biology is also revealing the workings of our normal inhibitions. Over the course of an average day there must be a dozen times in which you have a thought—lustful or angry or petulant or self-pitying—that you would *never ever* say. Damage a certain part of your brain's frontal cortex and you now say those things; the frontal cortex is the closest thing we have, neuroanatomically, to a superego. Phineas Gage, a

nineteenth-century railroad worker, wound up a celebrated neurological patient and fairground exhibit after his left frontal cortex was destroyed in a freak accident. He was transformed from a taciturn man to a pugnacious loudmouth who told everyone just what he thought. "Frontal disinhibition," involving aggressiveness, inappropriate frankness, and hypersexuality, is also often seen in individuals who have sustained stroke damage to that part of the brain. Remarkably, the same appears to happen in Huntington's disease, a rare congenital neurological disorder. Scientists have long thought of the disease as a movement disorder—around age forty to forty-five, patients begin to demonstrate uncontrolled swinging of limbs as an inhibitory motor pathway in the brain degenerates. With time, the movement becomes all-encompassing, constant whole body writhing that incapacitates the person. A lesser-known feature of the disease is a social disinhibition, one that often even precedes the motoric aspects, and in recent years it has been shown that Huntington's individuals also have damage to their frontal cortex.

Some neuroscientists even use the word "frontal" in a sardonic sense: A terrified student gives a quavering lecture to his elders, and some insensitive big shot rises and savages the kid over some minor point, taking the opportunity to toot his own horn while he's at it. "Christ," someone will mutter in the back of the lecture hall, "he's getting more frontal all the time."

Blow away that part of the brain and you can still remember the name of your kindergarten teacher, still do a polka, still feel what all of us feel. You just let other people know about it far more often than do most of us. Is it absurd to hypothesize that there is something a little bit wrong with the frontal cortex of the insensitive big shot in the lecture hall?

Another version of neuropsychiatric disinhibition is seen in Tourette's syndrome, once a diagnostic backwater but fast

threatening to become a fad. Tourette's patients are famed for their scatology, their uncontrolled cursing. But this doesn't even begin to scratch the surface. Tourette's patients do indeed curse, but they also emit a stream of animal sounds—yips and barks and growls—along with facial tics, and violent or lewd body gestures. These are the first genetic and neurochemical hints as to what the disease is about, but it remains, for the most part, a mystery. What is striking, though, is how it differs from the disinhibition of a frontal patient. A frontal individual does or says what the rest of us think about but would never let out of our well-restrained minds. Tourette's patients do not wish to bark like a dog or grab repeatedly at their crotch—these are simply emotive twitches, uncontrolled outbursts that are randomly tossed on top of the person struggling to maintain continuity. Like hiccups of the id.

Thus, a variety of these neuropsychiatric disorders result in marked and puzzling disinhibition. Some epileptics undergo a personality shift in the opposite direction. Roughly defined, an epileptic seizure is an abnormal electrical discharge in the brain. Neurologists have known for a long time that just before the onset of a seizure there will often be a strange sensation, or "aura," and the location of the seizure in the brain can influence the type of aura—for example, epileptics will typically have a sensory aura, perhaps imagining a particular smell. The existence of auras demonstrates the not very surprising fact that sudden bursts of electrical activity in different parts of the brain will influence thought and sensation. Now neurologists are coming to recognize that different types of epilepsy also shape personalities, influencing the person all the time, not merely seconds before a seizure.

People with a type of temporal lobe epilepsy, for example, tend to be extraordinarily serious, humorless, and rigid in their ways. They tend to be phobic about doing new things, and instead perseverate on old behaviors and tastes, tending to

walk to work the same way each day, usually wearing the same types of clothes, ordering the same meal in restaurants. Similarly, they rely upon a very small circle of friends, showing what neuropsychologists pungently call a "viscous" or "sticky" personality. Such people also tend to have an intense interest in religion or philosophy. And, most oddly, they not only think obsessively about their problems, they write about them—endlessly. Temporal lobe epileptics are renowned among neurologists for this "hypergraphia." In a typical scenario, someone first seeing a new neurologist will present the doctor with a carefully handwritten eighty-page diary, insisting that reading it will give the doctor vital insight into the patient. At the next visit the epileptic will return with a new, fifty-page addendum. One might speculate that having a serious neurological illness like epilepsy would make anyone serious and cause people to focus on the philosophical things in life, narrow their horizons, and rely on comfortable, familiar patterns. But this personality change does not arise from other types of epilepsy of an equally serious nature, is not a function of the frequency or severity of seizures or the magnitude with which it disrupts a person's life. Instead, have an uncontrolled and rhythmic outburst of electrical activity in the temporal lobe every now and then and, the rest of the time, you get very interested in philosophy and always order the same meal in a restaurant.

There is another version of a constrained life that is being defined biologically. At some time each of us has, to our irritation, left on a trip and felt such nagging doubt as to whether we locked the door that we returned home to check. Or after dropping a letter into a mailbox, we have peeked in a second or third time just to make sure it went down. Or, during a tough, anxious period in our lives, we find ourselves unable to concentrate because some ridiculous television jingle keeps running through our heads. This is normal and common. But among people with obsessive-compulsive disorder, these

thoughts dominate and ruin their lives. They miss vacations because they return home repeatedly to check if the oven was turned off. They lose their jobs because they are late each day, spending hours each morning washing their hands. They torture themselves by obsessively counting numbers in their heads. For most of us, little rituals of thought or behavior can calm us and provide structure at an anxious time. For someone with obsessive-compulsive disorder—now thought to be caused by an imbalance of brain chemicals, possibly serotonin and dopamine—there are no limits, and the person becomes a creature of these rituals.

What does this tour of neuropsychiatric oddities mean? We are learning to draw that line in new places. Most of these disorders did not exist a few decades ago; we did not even have names for how biology could occasionally destroy the life of an individual. Now we have those names. We are beginning to learn what certain parts of the brain, what specific genes, or what our early development has to do with these tragedies. In the process we are extending our definition of illness. For some time we have generally accepted that people who rave and gibber are ill, that they cannot control these things, are made miserable by them, and deserve care, protection, and forgiveness. Slowly we are coming to recognize that you can also be made miserable by a ceaseless march of number counting in your head, or by paralyzing fears of anything new, and that these too can be uncontrollable illnesses that demand understanding and treatment.

This field continues to move forward, and we might even be able to cure some of these maladies. Another form of progress will be the recognition of increasing numbers of these disorders, the coining of more names to describe our behavioral oddities. What will happen when, eventually, we have a few of these labels?

I recognize facets of myself in these pages. At times when I