

Chapter I

The Official Theory

"BLANK STATE" is a loose translation of the medieval Latin term *tabula rasa*—literally, "scraped tablet." It is commonly attributed to the philosopher John Locke (1632–1704), though in fact he used a different metaphor. Here is the famous passage from *An Essay Concerning Human Understanding*:

Let us then suppose the mind to be, as we say, white paper void of all characters, without any ideas. How comes it to be furnished? Whence comes it by that vast store which the busy and boundless fancy of man has painted on it with an almost endless variety? Whence has it all the materials of reason and knowledge? To this I answer, in one word, from EXPERIENCE.¹

Locke was taking aim at theories of innate ideas in which people were thought to be born with mathematical ideals, eternal truths, and a notion of God. His alternative theory, empiricism, was intended both as a theory of psychology—how the mind works—and as a theory of epistemology—how we come to know the truth. Both goals helped motivate his political philosophy, often honored as the foundation of liberal democracy. Locke opposed dogmatic justifications for the political status quo, such as the authority of the church and the divine right of kings, which had been touted as self-evident truths. He argued that social arrangements should be reasoned out from scratch and agreed upon by mutual consent, based on knowledge that any person could acquire. Since ideas are grounded in experience, which varies from person to person, differences of opinion arise not because one mind is equipped to grasp the truth and another is defective, but because the two minds have had different histories. Those differences therefore ought to be tolerated rather than suppressed. Locke's notion of a blank slate also undermined a hereditary royalty and aristocracy, whose members could claim no innate wisdom or merit if their minds had started out as blank as everyone else's. It also spoke against

the institution of slavery, because slaves could no longer be thought of as innately inferior or subservient.

During the past century the doctrine of the Blank Slate has set the agenda for much of the social sciences and humanities. As we shall see, psychology has sought to explain all thought, feeling, and behavior with a few simple mechanisms of learning. The social sciences have sought to explain all customs and social arrangements as a product of the socialization of children by the surrounding culture: a system of words, images, stereotypes, role models, and contingencies of reward and punishment. A long and growing list of concepts that would seem natural to the human way of thinking (emotions, kinship, the sexes, illness, nature, the world) are now said to have been "invented" or "socially constructed."²

The Blank Slate has also served as a sacred scripture for political and ethical beliefs. According to the doctrine, any differences we see among races, ethnic groups, sexes, and individuals come not from differences in their innate constitution but from differences in their experiences. Change the experiences—by reforming parenting, education, the media, and social rewards—and you can change the person. Underachievement, poverty, and antisocial behavior can be ameliorated; indeed, it is irresponsible not to do so. And discrimination on the basis of purportedly inborn traits of a sex or ethnic group is simply irrational.

THE BLANK SLATE is often accompanied by two other doctrines, which have also attained a sacred status in modern intellectual life. My label for the first of the two is commonly attributed to the philosopher Jean-Jacques Rousseau (1712–1778), though it really comes from John Dryden's *The Conquest of Granada*, published in 1670:

I am as free as Nature first made man,
Ere the base laws of servitude began,
When wild in woods the noble savage ran.

The concept of the noble savage was inspired by European colonists' discovery of indigenous peoples in the Americas, Africa, and (later) Oceania. It captures the belief that humans in their natural state are selfless, peaceable, and untroubled, and that blights such as greed, anxiety, and violence are the products of civilization. In 1755 Rousseau wrote:

So many authors have hastily concluded that man is naturally cruel, and requires a regular system of police to be reclaimed; whereas nothing can be more gentle than him in his primitive state, when placed by nature at

an equal distance from the stupidity of brutes and the pernicious good sense of civilized man. . . .

The more we reflect on this state, the more convinced we shall be that it was the least subject of any to revolutions, the best for man, and that nothing could have drawn him out of it but some fatal accident, which, for the public good, should never have happened. The example of the savages, most of whom have been found in this condition, seems to confirm that mankind was formed ever to remain in it, that this condition is the real youth of the world, and that all ulterior improvements have been so many steps, in appearance towards the perfection of individuals, but in fact towards the decrepitness of the species.³

First among the authors that Rousseau had in mind was Thomas Hobbes (1588–1679), who had presented a very different picture:

Hereby it is manifest, that during the time men live without a common power to keep them all in awe, they are in that condition which is called war; and such a war as is of every man against every man. . . .

In such condition there is no place for industry, because the fruit thereof is uncertain: and consequently no culture of the earth; no navigation, nor use of the commodities that may be imported by sea; no commodious building; no instruments of moving and removing such things as require much force; no knowledge of the face of the earth; no account of time; no arts; no letters; no society; and which is worst of all, continual fear, and danger of violent death; and the life of man, solitary, poor, nasty, brutish, and short.⁴

Hobbes believed that people could escape this hellish existence only by surrendering their autonomy to a sovereign person or assembly. He called it a leviathan, the Hebrew word for a monstrous sea creature subdued by Yahweh at the dawn of creation.

Much depends on which of these armchair anthropologists is correct. If people are noble savages, then a domineering leviathan is unnecessary. Indeed, by forcing people to delineate private property for the state to recognize—property they might otherwise have shared—the leviathan creates the very greed and belligerence it is designed to control. A happy society would be our birthright; all we would need to do is eliminate the institutional barriers that keep it from us. If, in contrast, people are naturally nasty, the best we can hope for is an uneasy truce enforced by police and the army. The two theories have implications for private life as well. Every child is born a savage (that is, uncivilized), so if savages are naturally gentle, childrearing is a matter of providing

children with opportunities to develop their potential, and evil people are products of a society that has corrupted them. If savages are naturally nasty, then childrearing is an arena of discipline and conflict, and evil people are showing a dark side that was insufficiently tamed.

The actual writings of philosophers are always more complex than the theories they come to symbolize in the textbooks. In reality, the views of Hobbes and Rousseau are not that far apart. Rousseau, like Hobbes, believed (incorrectly) that savages were solitary, without ties of love or loyalty, and without any industry or art (and he may have out-Hobbes'd Hobbes in claiming they did not even have language). Hobbes envisioned—indeed, literally drew—his Leviathan as an embodiment of the collective will, which was vested in it by a kind of social contract; Rousseau's most famous work is called *The Social Contract*, and in it he calls on people to subordinate their interests to a "general will."

Nonetheless, Hobbes and Rousseau limned contrasting pictures of the state of nature that have inspired thinkers in the centuries since. No one can fail to recognize the influence of the doctrine of the Noble Savage in contemporary consciousness. We see it in the current respect for all things natural (natural foods, natural medicines, natural childbirth) and the distrust of the man-made, the unfashionability of authoritarian styles of childrearing and education, and the understanding of social problems as repairable defects in our institutions rather than as tragedies inherent to the human condition.

THE OTHER SACRED doctrine that often accompanies the Blank Slate is usually attributed to the scientist, mathematician, and philosopher René Descartes (1596–1650):

There is a great difference between mind and body, inasmuch as body is by nature always divisible, and the mind is entirely indivisible. . . . When I consider the mind, that is to say, myself inasmuch as I am only a thinking being, I cannot distinguish in myself any parts, but apprehend myself to be clearly one and entire; and though the whole mind seems to be united to the whole body, yet if a foot, or an arm, or some other part, is separated from the body, I am aware that nothing has been taken from my mind. And the faculties of willing, feeling, conceiving, etc. cannot be properly speaking said to be its parts, for it is one and the same mind which employs itself in willing and in feeling and understanding. But it is quite otherwise with corporeal or extended objects, for there is not one of them imaginable by me which my mind cannot easily divide into parts. . . . This would be sufficient to teach me that the mind or soul of man is entirely different from the body, if I had not already been apprised of it on other grounds.⁵

A memorable name for this doctrine was given three centuries later by a detractor, the philosopher Gilbert Ryle (1900–1976):

There is a doctrine about the nature and place of minds which is so prevalent among theorists and even among laymen that it deserves to be described as the official theory. . . . The official doctrine, which hails chiefly from Descartes, is something like this. With the doubtful exception of idiots and infants in arms every human being has both a body and a mind. Some would prefer to say that every human being is both a body and a mind. His body and his mind are ordinarily harnessed together, but after the death of the body his mind may continue to exist and function. Human bodies are in space and are subject to mechanical laws which govern all other bodies in space. . . . But minds are not in space, nor are their operations subject to mechanical laws. . . .

. . . Such in outline is the official theory. I shall often speak of it, with deliberate abusiveness, as "the dogma of the Ghost in the Machine."⁶

The Ghost in the Machine, like the Noble Savage, arose in part as a reaction to Hobbes. Hobbes had argued that life and mind could be explained in mechanical terms. Light sets our nerves and brain in motion, and that is what it means to see. The motions may persist like the wake of a ship or the vibration of a plucked string, and that is what it means to imagine. "Quantities" get added-or subtracted in the brain, and that is what it means to think.

Descartes rejected the idea that the mind could operate by physical principles. He thought that behavior, especially speech, was not *caused* by anything, but freely *chosen*. He observed that our consciousness, unlike our bodies and other physical objects, does not feel as if it is divisible into parts or laid out in space. He noted that we cannot doubt the existence of our minds—indeed, we cannot doubt that we *are* our minds—because the very act of thinking presupposes that our minds exist. But we *can* doubt the existence of our bodies, because we can imagine ourselves to be immaterial spirits who merely dream or hallucinate that we are incarnate.

Descartes also found a moral bonus in his dualism (the belief that the mind is a different kind of thing from the body): "There is none which is more effectual in leading feeble spirits from the straight path of virtue, than to imagine that the soul of the brute is of the same nature as our own, and that in consequence, after this life we have nothing to fear or to hope for, any more than the flies and the ants."⁷ Ryle explains Descartes's dilemma:

When Galileo showed that his methods of scientific discovery were competent to provide a mechanical theory which should cover every

occupant of space, Descartes found in himself two conflicting motives. As a man of scientific genius he could not but endorse the claims of mechanics, yet as a religious and moral man he could not accept, as Hobbes accepted, the discouraging rider to those claims, namely that human nature differs only in degree of complexity from clockwork.⁸

It can indeed be upsetting to think of ourselves as glorified gears and springs. Machines are insensate, built to be used, and disposable; humans are sentient, possessing of dignity and rights, and infinitely precious. A machine has some workaday purpose, such as grinding grain or sharpening pencils; a human being has higher purposes, such as love, worship, good works, and the creation of knowledge and beauty. The behavior of machines is determined by the ineluctable laws of physics and chemistry; the behavior of people is freely chosen. With choice comes freedom, and therefore optimism about our possibilities for the future. With choice also comes responsibility, which allows us to hold people accountable for their actions. And of course if the mind is separate from the body, it can continue to exist when the body breaks down, and our thoughts and pleasures will not someday be snuffed out forever.

As I mentioned, most Americans continue to believe in an immortal soul, made of some nonphysical substance, which can part company with the body. But even those who do not avow that belief in so many words still imagine that somehow there must be more to us than electrical and chemical activity in the brain. Choice, dignity, and responsibility are gifts that set off human beings from everything else in the universe, and seem incompatible with the idea that we are mere collections of molecules. Attempts to explain behavior in mechanistic terms are commonly denounced as "reductionist" or "determinist." The denouncers rarely know exactly what they mean by those words, but everyone knows they refer to something bad. The dichotomy between mind and body also pervades everyday speech, as when we say "Use your head," when we refer to "out-of-body experiences," and when we speak of "John's body," or for that matter "John's brain," which presupposes an owner, John, that is somehow separate from the brain it owns. Journalists sometimes speculate about "brain transplants" when they really should be calling them "body transplants," because, as the philosopher Dan Dennett has noted, this is the one transplant operation in which it is better to be the donor than the recipient.

The doctrines of the Blank Slate, the Noble Savage, and the Ghost in the Machine—or, as philosophers call them, empiricism, romanticism, and dualism—are logically independent, but in practice they are often found together. If the slate is blank, then strictly speaking it has neither injunctions to do good nor injunctions to do evil. But good and evil are asymmetrical: there are more ways to harm people than to help them, and harmful acts can hurt them to a

greater degree than virtuous acts can make them better off. So a blank slate, compared with one filled with motives, is bound to impress us more by its inability to do harm than by its inability to do good. Rousseau did not literally believe in a blank slate, but he did believe that bad behavior is a product of learning and socialization.⁹ "Men are wicked," he wrote, "a sad and constant experience makes proof unnecessary."¹⁰ But this wickedness comes from society: "There is no original perversity in the human heart. There is not a single vice to be found in it of which it cannot be said how and whence it entered."¹¹ If the metaphors in everyday speech are a clue, then all of us, like Rousseau, associate blankness with virtue rather than with nothingness. Think of the moral connotations of the adjectives *clean*, *fair*, *immaculate*, *ily-white*, *pure*, *spotless*, *unmarred*, and *unsullied*, and of the nouns *blemish*, *blot*, *mark*, *stain*, and *taint*.

The Blank Slate naturally coexists with the Ghost in the Machine, too, since a slate that is blank is a hospitable place for a ghost to haunt. If a ghost is to be at the controls, the factory can ship the device with a minimum of parts. The ghost can read the body's display panels and pull its levers, with no need for a high-tech executive program, guidance system, or CPU. The more not-clockwork there is controlling behavior, the less clockwork we need to posit. For similar reasons, the Ghost in the Machine happily accompanies the Noble Savage. If the machine behaves ignobly, we can blame the ghost, which freely chose to carry out the iniquitous acts; we need not probe for a defect in the machine's design.

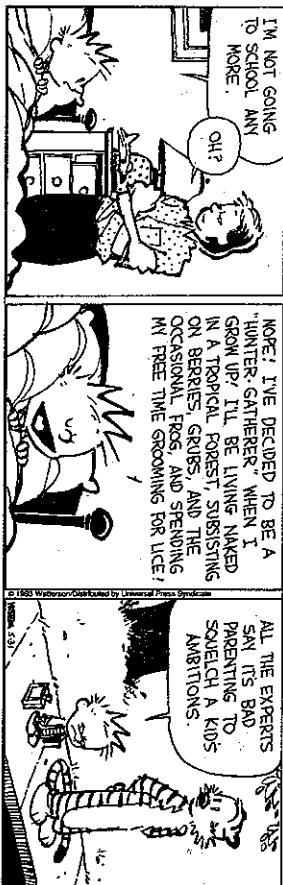
PHILOSOPHY TODAY GERS NO respect. Many scientists use the term as a synonym for effete speculation. When my colleague Ned Block told his father that he would major in the subject, his father's reply was "Luff!"—Yiddish for "air." And then there's the joke in which a young man told his mother he would become a Doctor of Philosophy and she said, "Wonderfull! But what kind of disease is philosophy?"

But far from being idle or airy, the ideas of philosophers can have repercutations for centuries. The Blank Slate and its companion doctrines have infiltrated the conventional wisdom of our civilization and have repeatedly surfaced in unexpected places. William Godwin (1756–1835), one of the founders of liberal political philosophy, wrote that "children are a sort of raw material put into our hands," their minds "like a sheet of white paper."¹² More sinisterly, we find Mao Zedong justifying his radical social engineering by saying, "It is on a blank page that the most beautiful poems are written."¹³ Even Walt Disney was inspired by the metaphor: "I think of a child's mind as a blank book," he wrote. "During the first years of his life, much will be written on the pages. The quality of that writing will affect his life profoundly."¹⁴

Locke could not have imagined that his words would someday lead to Bambi (intended by Disney to teach self-reliance); nor could Rousseau have anticipated Pocahontas, the ultimate noble savage. Indeed, the soul of Rousseau seems to have been channeled by the writer of a recent Thanksgiving op-ed in the *Boston Globe*:

I would submit that the world native Americans knew was more stable, happier, and less barbaric than our society today . . . there were no employment problems, community harmony was strong, substance abuse unknown, crime nearly nonexistent. What warfare there was between tribes was largely ritualistic and seldom resulted in indiscriminate or wholesale slaughter. While there were hard times, life was, for the most part, stable and predictable. . . . Because the native people respected what was around them, there was no loss of water or food resources because of pollution or extinction, no lack of materials for the daily essentials, such as baskets, canoes, shelter, or firewood.¹⁵

Not that there haven't been skeptics:



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The third doctrine, too, continues to make its presence felt in modern times. In 2001 George W. Bush announced that the American government will not fund research on human embryonic stem cells if scientists have to destroy new embryos to extract them (the policy permits research on stem-cell lines that were previously extracted from embryos). He derived the policy after consulting not just with scientists but with philosophers and religious thinkers. Many of them framed the moral problem in terms of "ensoulment," the moment at which the cluster of cells that will grow into a child is endowed with a soul. Some argued that ensoulment occurs at conception, which implies that the blastocyst (the five-day-old ball of cells from which stem cells are taken) is morally equivalent to a person and that destroying it is a form of murder.¹⁶ That argument proved decisive, which means that the

American policy on perhaps the most promising medical technology of the twenty-first century was decided by pondering the moral issue as it might have been framed centuries before: When does the ghost first enter the machine?

These are just a few of the fingerprints of the Blank Slate, the Noble Savage, and the Ghost in the Machine on modern intellectual life. In the following chapters we will see how the seemingly airy ideas of Enlightenment philosophers entrenched themselves in modern consciousness, and how recent discoveries are casting those ideas in doubt.



The difference between these two mechanisms underscores another insight of the cognitive revolution. Before the revolution, commentators invoked enormous black boxes such as "the intellect" or "the understanding," and they made sweeping pronouncements about human nature, such as that we are essentially noble or essentially nasty. But we now know that the mind is not a homogeneous orb invested with unitary powers or across-the-board traits. The mind is modular, with many parts cooperating to generate a train of thought or an organized action. It has distinct information-processing systems for filtering out distractions, learning skills, controlling the body, remembering facts, holding information temporarily, and storing and executing rules. Cutting across these data-processing systems are mental faculties (sometimes called multiple intelligences) dedicated to different kinds of content, such as language, number, space, tools, and living things. Cognitive scientists at the East Pole suspect that the content-based modules are differentiated largely by the genes;²⁴ those at the West Pole suspect they begin as small innate biases in attention and then coagulate out of statistical patterns in the sensory input.²⁵ But those at both poles agree that the brain is not a uniform meatloaf. Still another layer of information-processing systems can be found in the affect programs, that is, the systems for motivation and emotion.

The upshot is that an urge or habit coming out of one module can be translated into behavior in different ways—or suppressed altogether—by some other module. To take a simple example, cognitive psychologists believe that a module called the "habit system" underlies our tendency to produce certain responses habitually, such as responding to a printed word by pronouncing it silently. But another module, called the "supervisory attention system," can override it and focus on the information relevant to a stated problem, such as naming the color of the ink the word is printed in, or thinking up an action that goes with the word.²⁶ More generally, the interplay of mental systems can explain how people can entertain revenge fantasies that they never act on, or can commit adultery only in their hearts. In this way the theory of human nature coming out of the cognitive revolution has more in common with the Judeo-Christian theory of human nature, and with the psychoanalytic theory proposed by Sigmund Freud, than with behaviorism, social constructionism, and other versions of the Blank Slate. Behavior is not just emitted or elicited, nor does it come directly out of culture or society. It comes from an internal struggle among mental modules with differing agendas and goals.

The idea from the cognitive revolution that the mind is a system of universal, generative computational modules obliterates the way that debates on human nature have been framed for centuries. It is now simply misguided to ask whether humans are flexible or programmed, whether behavior is universal or varies across cultures, whether acts are learned or innate, whether we are essentially good or essentially evil. Humans behave flexibly because they are

programmed: their minds are packed with combinatorial software that can generate an unlimited set of thoughts and behavior. Behavior may vary across cultures, but the design of the mental programs that generate it need not vary. Intelligent behavior is learned successfully because we have innate systems that do the learning. And all people may have good and evil motives, but not everyone may translate them into behavior in the same way.

THE SECOND BRIDGE between mind and matter is neuroscience, especially cognitive neuroscience, the study of how cognition and emotion are implemented in the brain.²⁷ Francis Crick wrote a book about the brain called *The Astonishing Hypothesis*, alluding to the idea that all our thoughts and feelings, joys and aches, dreams and wishes consist in the physiological activity of the brain.²⁸ Jaded neuroscientists, who take the idea for granted, snickered at the title, but Crick was right: the hypothesis is astonishing to most people the first time they stop to ponder it. Who cannot sympathize with the imprisoned Dmitri Karamazov as he tries to make sense of what he has just learned from a visiting academic?

Imagine: inside, in the nerves, in the head—that is, these nerves are there in the brain . . . (damn them!) there are sort of little tails, the little tails of those nerves, and as soon as they begin quivering . . . that is, you see, I look at something with my eyes and then they begin quivering, those little tails . . . and when they quiver, then an image appears . . . it doesn't appear at once, but an instant, a second, passes . . . and then something like a moment appears; that is, not a moment—devil take the moment!—but an image; that is, an object, or an action, damn it! That's why I see and then think, because of those tails, not at all because I've got a soul, and that I am some sort of image and likeness. All that is non-sense! Rakitin explained it all to me yesterday, brother, and it simply bowled me over. It's magnificent, Alyosha, this science! A new man's arising—that I understand. . . . And yet I am sorry to lose God!²⁹

Dostoevsky's prescience is itself astonishing, because in 1880 only the rudiments of neural functioning were understood, and a reasonable person could have doubted that all experience arises from quivering nerve tails. But no longer. One can say that the information-processing activity of the brain causes the mind, or one can say that it is the mind, but in either case the evidence is overwhelming that every aspect of our mental lives depends entirely on physiological events in the tissues of the brain.

When a surgeon sends an electrical current into the brain, the person can have a vivid, lifelike experience. When chemicals seep into the brain, they can alter the person's perception, mood, personality, and reasoning. When a patch

of brain tissue dies, a part of the mind can disappear: a neurological patient may lose the ability to name tools, recognize faces, anticipate the outcome of his behavior, empathize with others, or keep in mind a region of space or of his own body. (Descartes was thus wrong when he said that "the mind is entirely indivisible" and concluded that it must be completely different from the body.) Every emotion and thought gives off physical signals, and the new technologies for detecting them are so accurate that they can literally read a person's mind and tell a cognitive neuroscientist whether the person is imagining a face or a place. Neuroscientists can knock a gene out of a mouse (a gene also found in humans) and prevent the mouse from learning, or insert extra copies and make the mouse learn faster. Under the microscope, brain tissue shows a staggering complexity—a hundred billion neurons connected by a hundred trillion synapses—that is commensurate with the staggering complexity of human thought and experience. Neural network modelers have begun to show how the building blocks of mental computation, such as storing and retrieving a pattern, can be implemented in neural circuitry. And when the brain dies, the person goes out of existence. Despite concerted efforts by Alfred Russel Wallace and other Victorian scientists, it is apparently not possible to communicate with the dead.

Educated people, of course, know that perception, cognition, language, and emotion are rooted in the brain. But it is still tempting to think of the brain as it was shown in old educational cartoons, as a control panel with gauges and levers operated by a user—the self, the soul, the ghost, the person, the "me." But cognitive neuroscience is showing that the self, too, is just another network of brain systems.

The first hint came from Phineas Gage, the nineteenth-century railroad worker familiar to generations of psychology students. Gage was using a yard-long spike to tamp explosive powder into a hole in a rock when a spark ignited the powder and sent the spike into his cheekbone, through his brain, and out the top of his skull. Phineas survived with his perception, memory, language, and motor functions intact. But in the famous understatement of a co-worker, "Gage was no longer Gage." A piece of iron had literally turned him into a different person, from courteous, responsible, and ambitious to rude, unreliable, and shiftless. It did this by impaling his ventromedial prefrontal cortex, the region of the brain above the eyes now known to be involved in reasoning about other people. Together with other areas of the prefrontal lobes and the limbic system (the seat of the emotions), it anticipates the consequences of one's actions and selects behavior consonant with one's goals.³⁰

Cognitive neuroscientists have not only exorcised the ghost but have shown that the brain does not even have a part that does exactly what the ghost is supposed to do: review all the facts and make a decision for the rest of the brain to carry out.³¹ Each of us *feels* that there is a single "I" in control. But that

is an illusion that the brain works hard to produce, like the impression that our visual fields are rich in detail from edge to edge. (In fact, we are blind to detail outside the fixation point. We quickly move our eyes to whatever looks interesting, and that fools us into thinking that the detail was there all along.) The brain does have supervisory systems in the prefrontal lobes and anterior cingulate cortex, which can push the buttons of behavior and override habits and urges. But those systems are gadgets with specific quirks and limitations; they are not implementations of the rational free agent traditionally identified with the soul or the self.

One of the most dramatic demonstrations of the illusion of the unified self comes from the neuroscientists Michael Gazzaniga and Roger Sperry, who showed that when surgeons cut the corpus callosum joining the cerebral hemispheres, they literally cut the self in two, and each hemisphere can exercise free will without the other one's advice or consent. Even more disconcertingly, the left hemisphere constantly weaves a coherent but false account of the behavior chosen without its knowledge by the right. For example, if an experimenter flashes the command "WALK" to the right hemisphere (by keeping it in the part of the visual field that only the right hemisphere can see), the person will comply with the request and begin to walk out of the room. But when the person (specifically, the person's left hemisphere) is asked why he just got up, he will say, in all sincerity, "To get a Coke"—rather than "I don't really know" or "The urge just came over me" or "You've been testing me for years since I had the surgery, and sometimes you get me to do things but I don't know exactly what you asked me to do." Similarly, if the patient's left hemisphere is shown a chicken and his right hemisphere is shown a snowfall, and both hemispheres have to select a picture that goes with what they see (each using a different hand), the left hemisphere picks a claw (correctly) and the right picks a shovel (also correctly). But when the left hemisphere is asked why the whole person made those choices, it blithely says, "Oh, that's simple. The chicken claw goes with the chicken, and you need a shovel to clean out the chicken shed."³²

The spooky part is that we have no reason to think that the baloney-generator in the patient's left hemisphere is behaving any differently from *ours* as we make sense of the inclinations emanating from the rest of *our* brains. The conscious mind—the self or soul—is a spin doctor, not the commander in chief. Sigmund Freud immodestly wrote that "humanity has in the course of time had to endure from the hands of science three great outrages upon its naive self-love": the discovery that our world is not the center of the celestial spheres but rather a speck in a vast universe, the discovery that we were not specially created but instead descended from animals, and the discovery that often our conscious minds do not control how we act but merely tell us a story about our actions. He was right about the cumulative impact, but it was

cognitive neuroscience rather than psychoanalysis that conclusively delivered the third blow.

Cognitive neuroscience is undermining not just the Ghost in the Machine but also the Noble Savage. Damage to the frontal lobes does not only dull the person or subtract from his behavioral repertoire but can unleash aggressive attacks.³³ That happens because the damaged lobes no longer serve as inhibitory brakes on parts of the limbic system, particularly a circuit that links the amygdala to the hypothalamus via a pathway called the stria terminalis. Connections between the frontal lobe in each hemisphere and the limbic system provide a lever by which a person's knowledge and goals can override other mechanisms, and among those mechanisms appears to be one designed to generate behavior that harms other people.³⁴

Nor is the physical structure of the brain a blank slate. In the mid-nineteenth century the neurologist Paul Broca discovered that the folds and wrinkles of the cerebral cortex do not squiggle randomly like fingerprints but have a recognizable geometry. Indeed, the arrangement is so consistent from brain to brain that each fold and wrinkle can be given a name. Since that time neuroscientists have discovered that the gross anatomy of the brain—the sizes, shapes, and connectivity of its lobes and nuclei, and the basic plan of the cerebral cortex—is largely shaped by the genes in normal prenatal development.³⁵ So is the quantity of gray matter in the different regions of the brains of different people, including the regions that underlie language and reasoning.³⁶

This innate geometry and cabling can have real consequences for thinking, feeling, and behavior. As we shall see in a later chapter, babies who suffer damage to particular areas of the brain often grow up with permanent deficits in particular mental faculties. And people born with variations on the typical plan have variations in the way their minds work. According to a recent study of the brains of identical and fraternal twins, differences in the amount of gray matter in the frontal lobes are not only genetically influenced but are significantly correlated with differences in intelligence.³⁷ A study of Albert Einstein's brain revealed that he had large, unusually shaped inferior parietal lobules, which participate in spatial reasoning and intuitions about number.³⁸ Gay men are likely to have a smaller third interstitial nucleus in the anterior hypothalamus, a nucleus known to have a role in sex differences.³⁹ And convicted murderers and other violent, antisocial people are likely to have a smaller and less active prefrontal cortex, the part of the brain that governs decision making and inhibits impulses.⁴⁰ These gross features of the brain are almost certainly not sculpted by information coming in from the senses, which implies that differences in intelligence, scientific genius, sexual orientation, and impulsive violence are not entirely learned.

Indeed, until recently the innateness of brain structure was an embarrass-

ment for neuroscience. The brain could not possibly be wired by the genes down to the last synapse, because there isn't nearly enough information in the genome to do so. And we know that people learn throughout their lives, and the products of that learning have to be stored in the brain somehow. Unless, you believe in a ghost in the machine, everything a person learns has to affect some part of the brain; more accurately, learning is a change in some part of the brain. But it was difficult to find the features of the brain that reflected those changes amid all that innate structure. Becoming stronger in math or motor coordination or visual discrimination does not bulk up the brain the way becoming stronger at weightlifting bulks up the muscles.

Now, at last, neuroscience is beginning to catch up with psychology by discovering changes in the brain that underlie learning. As we shall see, the boundaries between swatches of cortex devoted to different body parts, talents, and even physical senses can be adjusted by learning and practice. Some neuroscientists are so excited by these discoveries that they are trying to push the pendulum in the other direction, emphasizing the plasticity of the cerebral cortex. But for reasons that I will review in Chapter 5, most neuroscientists believe that these changes take place within a matrix of genetically organized structure. There is much we don't understand about how the brain is laid out in development, but we know that it is not indefinitely malleable by experience.

THE THIRD BRIDGE between the biological and the mental is behavioral genetics, the study of how genes affect behavior.⁴¹ All the potential for thinking, learning, and feeling that distinguishes humans from other animals lies in the information contained in the DNA of the fertilized ovum. This is most obvious when we compare species. Chimpanzees brought up in a human home do not speak, think, or act like people, and that is because of the information in the ten megabytes of DNA that differ between us. Even the two species of chimpanzees, common chimps and bonobos, which differ in just a few tenths of one percent of their genomes, part company in their behavior, as zookeepers first discovered when they inadvertently mixed the two. Common chimps are among the most aggressive mammals known to zoology, bonobos among the most peaceable; in common chimps the males dominate the females, in bonobos the females have the upper hand; common chimps have sex for procreation, bonobos for recreation. Small differences in the genes can lead to large differences in behavior. They can affect the size and shape of the different parts of the brain, their wiring, and the nanotechnology that releases, binds, and recycles hormones and neurotransmitters.

The importance of genes in organizing the normal brain is underscored by the many ways in which nonstandard genes can give rise to nonstandard minds. When I was an undergraduate an exam question in Abnormal Psychology asked, "What is the best predictor that a person will become schizophrenic?"