Two

KITS, CATS, SACKS, AND UNCERTAINTY

How the brain's basic structure poses problems for love

Love fits with gliding ease into the heart of a troubadour's croon or a poet's couplet. There, in the mental balance weighing such correspondences, love indisputably belongs. But the prospect of putting humanity's palpitating heart under the scientist's steely gaze gives pause. Science operates under a bare but effective dictum: to understand a portion of the natural world, take it apart. Love is irreducible. The impasse looks definitive. How can investigation proceed? What can hard-edged objectivity apprehend about evanescent, ephemeral, *personal* love?

As it happens, science is less inimical to phantoms than it once was. The first years of the twentieth century crushed the conception of the natural world as a neat meshing of cogs, the inner details revealing themselves to any observer with a magnifying monocle of sufficient power and delicacy. As physicists and mathematicians delved deeper into the stuff of reality, they collided with the end of objectivity's jurisdiction. "O body swayed to music, O brightening glance / How can we know the dancer from the dance?" asked William Butler Yeats in 1928. The poet was in perfect harmony with the science of his age, which was reeling at the impossibility of dividing—as traditional science demanded—the knower from the known. Those hard-won lessons in scientific subjectivity can help us to understand why our age is at last on the brink of a revolution in humanity's vision of its own heart.

The first blow to the clockwork universe came from Albert Einstein. His relativity theory proposed that the flow of time depends on where you are, and that different observers may not agree even

about the chronological order of the events they witness. A few years later, Kurt Gödel demonstrated that any mathematical system contains, like the gleaming and inaccessible jewels of a dragon's lair, true theorems that can never be proven. Between Einstein and Gödel came Werner Heisenberg and his uncertainty principle. Heisenberg showed that the more precisely one determines the position of an atomic particle, the less one can know about its speed. These shy qualities reverse their roles: the more exactly a particle's velocity is measured, the more elusive its location becomes.

The significance of Heisenberg's discovery expanded beyond the atomic level and recast the foundations of scientific endeavor. "Science does not describe and explain nature," Heisenberg concluded, but "nature as exposed to our method of questioning." Together with Gödel and Einstein, he introduced scientists to an uncomfortably indefinite world—where the extent of the knowable disappointingly dwindles, and such intangibles as *point of view* and *method of questioning* permeate previously solid truths. After 1930, mystery formed not only the perimeter of scientific knowledge but also its ineradicable center. For science to penetrate the mystery of love, its own style of questioning had to improve.

An old riddle illustrates how questions delimit the discoverable:

As I was going to St. Ives
I met a man with seven wives
Every wife had seven sacks
Every sack had seven cats
Every cat had seven kits
Kits, cats, sacks, and wives,
How many were going to St. Ives?

Many children know the best answer is one: the narrator alone is *known* to be bound for St. Ives. The listener isn't told and cannot divine the destination of the other travelers. The puzzle is fashioned to conceal the gap in the listener's knowledge. *How many were going to St. Ives?* yields an answer only by sweeping past the question crouching behind it—*Where is everyone going?* That question is unanswerable—and so it is rendered unthinkable. The cascading sevens distract the unwary as deftly as a conjurer diverts attention from a palmed ace. Seduced into the certain and the known, the listener is left scribbling away at an irrelevant calculation.

We cannot hope to unravel the heart's enigmas without knowing something about what love is made of, and how it operates. Biology has played almost no role in the most popular and influential views of love to date—because, as the St. Ives riddle portrays and Heisenberg proved, the questions we ask change the world we see. *What can the structure and design of the brain tell us about the nature of love?* could not have been glimpsed a hundred years ago. Absence of knowledge about the brain was not then deemed an impediment to understanding emotional life. Indeed, the omission was scarcely noticed.

Today, the relevance of love's physiology is here to stay. Love itself has not surrendered to reductionism, but in the last two decades of the twentieth century, the brain that produces love *did.* The advent of modern neuroscience, with its high-tech scanners and miniature tools of painstaking dissection, finally provided what the study of love had always lacked: a physical substrate that can be taken apart.

Seekers of the heart's secrets might be tempted to detour around the essential facts of brain structure, fearing the subject is impossibly technical and probably soporific. It is not. No one disputes that the brain's dense, delicate, filamentous intricacy inspires awe, and more than occasionally dismay. Those who wish to drink in the details, however, need not drown in them. Anybody can operate a car without an engineering degree. A working knowledge of internal combustion—what gasoline is, where it goes, and why you shouldn't peer into the tank with a lit match—is indispensable. You don't have to wade through back issues of *Scientific American* to grasp the nature of love, but acquaintance with the basics of the brain's origins and mechanisms can prevent some explosive misconceptions as passion's sparks begin to fly.

THE INSIDE STORY

The brain is a network of *neurons,* the individual cells of the nervous system. This account renders the brain in essence no different from the heart or the liver—organs that are also linked collections of similar cells. What gives an organ identity and power is the specialized function that its constituent cells stand ready to perform. The peculiar calling of a neuron is *cell-to-cell signaling.* Those signals are both electrical and chemical; the molecules whose restless shuttling sends the chemical portion of the message are the *neurotransmitters.* When people say that someone is afflicted with a "chemical imbalance" (now synonymous with "undesirable behavior beyond voluntary control"), they refer to one half of the signaling process, an unintended slight to a neuron's electrical potency. While few have witnessed electricity's flair for altering minds, everybody has seen chemicals change people. Coffee boosts alertness, alcohol dissolves inhibitions, LSD provokes hallucinations, and Prozac alleviates depression, obsessions, and low self-confidence—all by enhancing or disrupting these signals. Any substance that mimics or blocks native neurotransmitters can fiddle with an aspect of the mind: vision, memory, thought, pain, consciousness, emotionality, and yes, love.

What is the purpose of this assemblage of cells ceaselessly signaling one another? What useful property emerges from this festival of communication, and what end does it advance? Survival. A collection of signaling cells can engineer sudden reactions to instantaneous changes. Information from the environment can be translated into inbound signals, and after a flurry of internal processing within a centralized group of neurons, outbound signals produce *action:* a swipe at a fleeing morsel of food, or a leap to evade the pounce of a predator. Equipped with the best neurons firing in the best order, animals live longer. If they make it to the next mating season, they win. Natural selection awards no prize for second place.

Proud as we are of the nervous systems that tingle within our skulls, we should recognize that such an approach to the game of life represents one survival strategy among many. The world's most successful life-forms have no brains and no use for them. Bacteria, easily the most numerous creatures on Earth, are simple single cells that triumphed and persisted without any multicellular cooperative signaling or the complex behaviors that such communication bestows. Despite this seeming disability, they have exploited every ecological niche, from the arctic tundra to simmering sulfur hot springs. And the planet's longest-lived organism—the giant redwood tree of northern California, with a span of four thousand years—lives every minute of its nearly interminable life without the ability to react quickly to anything.

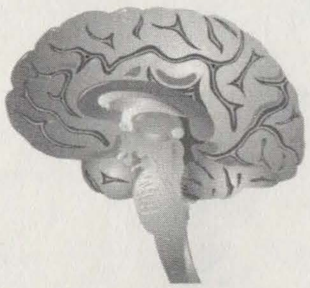
The earliest aggregations of signaling cells were sparse assemblies that embodied instructions for meeting the simplest environmental contingencies: encounter a noxious stimulus on the left, move right, and vice versa. Ages later, one hundred billion neurons make up the human brain. The brain's Byzantine conformation determines everything about human nature—including the nature of love.

The Triune Brain

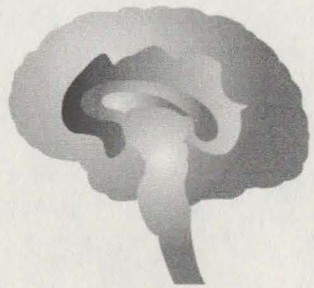
No concerted development scheme forged the human brain. Evolution is a wandering process wherein multiple simultaneous influences, including chance and circumstance, shape biological structures over eons. A more capricious designer than any committee, evolution is a story full of starts, setbacks, compromises, and blind alleys, as generations of organisms adapt to fluctuating conditions. We are accustomed to thinking of these adaptations as gradual and progressive, but, as Niles Eldredge and Stephen Jay Gould argued twenty-five years ago, the fossil record belies this impression. Rather than a series of smooth transitions, the evolutionary process is punctuated with bursts of metamorphosis. If an environment shifts fast enough or a favorable mutation arises, organismic modifications can explode into being.

Thus the development of the human brain was neither planned nor seamlessly executed. It simply *happened*—and that pedigree nullifies reasonable expectations about the brain's configuration. *A priori,* no one would suppose that advanced neural design should require an organism to slip regularly into a helpless torpor that invites predation. But sleep is universal throughout the mammalian world, although its neural function remains unknown. The same fallible common sense suggests that the human brain is likely to be unitary and harmonious. It isn't. A homogeneous brain might function better, but humans don't have one. Evolved structures answer not to the rules of logic but only to the exigencies of their long chain of survival victories.

Dr. Paul MacLean, an evolutionary neuroanatomist and senior research scientist at the National Institute of Mental Health, has argued that the human brain is comprised of three distinct subbrains, each the product of a separate age in evolutionary history. The trio intermingles and communicates, but some information is inevitably lost in translation because the subunits differ in their functions, properties, and even their chemistries. His neuroevolutionary finding of a three-in-one, or *triune,* brain can help explain how some of love's anarchy arises from ancient history.



The human brain.

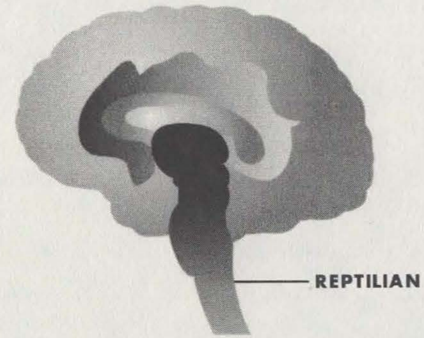


The triune brain.

The Reptilian Brain

The oldest or *reptilian* brain is a bulbous elaboration of the spinal cord. This brain houses vital control centers—neurons that prompt breathing, swallowing, and heartbeat, and the visual tracking system a frog relies on to snap a dancing dragonfly out of the air. The startle center is here, too, because a swift reaction to abrupt movement or noise is the principal reason animals have brains at all.

Steeped in the physiology of survival, the reptilian brain is the one still functioning in a person who is "brain-dead." If the reptilian brain dies, the rest of the body will follow; the other two brains are less essential to the neurology of sustaining life. Consider the railroad worker turned neurologic legend Phineas Gage. In 1848, an explosion drove a steel bar through Gage's skull; the rod entered below his left eye and exited the top of his head, taking a sizable piece of his neocortical brain and his reasoning faculty with it. Gage was a changed man after the accident, his diligence and tidiness forever transformed into sloth and disorganization. But after the blast, from the minute he sat up, Gage could walk and talk normally; he could eat, sleep, breathe, run, and gargle as fluently as any man. He lived another thirteen years without that cylinder of neocortical brain. Had the blast sent a spike hurtling through Gage's



The reptilian brain.

reptilian brain, he would have died before the first drops of blood hit the ground.

As long as the reptilian brain survives, it will keep the heart beating, the lungs expanding and relaxing, salt and water balanced in the blood. Like programmed appliances in a house whose owners have departed, a reptilian brain can plug away for years, despite the death of what makes a brain *human.* Our society greets with perplexity someone whose sole viable brain is reptilian: is such a person dead or alive? Is this a *person*? Sad as it may be, a body animated by the reptilian brain is no more human than a severed toe. The qualities that set us apart from other animals, or that distinguish one person from another, do not belong to this archaic conglomeration of cells.

We will be disappointed if we expect the reptilian brain to play a major role in the structure of the emotional mind. Reptiles don't have an emotional life. The reptilian brain permits rudimentary interactions: displays of aggression and courtship, mating and territorial defense. As MacLean notes, some lizard species attack and repel intruders from the district they have claimed as their own, illustrating just how primitive turf battles are in the history of terrestrial vertebrates. When we see urban gangs mark their domains and harass someone for stepping onto the wrong city block, or for wearing a blue shirt in a zone where red shirts rule, we are witnessing, in part, a product of this antediluvian brain, with motivations more suited to the lives of the asocial carnivores that brain was designed to serve.

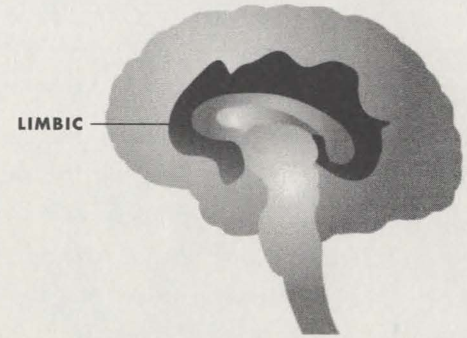
The Limbic Brain

In 1879, the French surgeon and neuroanatomist Paul Broca published his most important finding: that the brains of all mammals hold a structure in common, which he called the *great limbic lobe* ("*le grand lobe limbique*"). Because he could see a "line of demarcation" between this convolution and the rest of the cerebral hemisphere, Broca coined his term from the Latin word *limbus,* meaning "edge, margin, or border." Since the structure he discovered marks the evolutionary division between two disparate ways of life, his initial designation proved unusually apt.

Humanity's second or *limbic* brain drapes itself around the first with a languid ease. Within its smooth curves, however, lies a company of neural gadgets with tongue-twisting appellations. The limbic list sounds like the incantation of a magus: hippocampus, fornix, amygdala, septum, cingulate gyrus, perirhinal and perihippocampal regions.

Early mammals evolved from small, lizardish reptiles. The peculiar mammalian innovation—carrying developing young within a warm-blooded body rather than leaving them outside in eggs—had been established well before an errant asteroid rammed the planet and put the chill on the dinosaurs. The rapid demise of the reptilian giants left open opportunities for an upwardly mobile class. Mammals scurried into the gap and bred like the rabbits they were to become. Sixty-five million years later, the Age of Mammals is still in full swing.

High school biology draws the distinction between reptile and mammal along somatic lines: mammals sprout hair rather than



The limbic brain.

scales; they are self-heating, while reptiles rely on the sun to regulate body temperature; they give birth to babies, not eggs. But MacLean pointed out that this classification overlooks a major brain difference. As mammals split off from the reptilian line, a fresh neural structure blossomed within their skulls. This brand-new brain transformed not just the mechanics of reproduction but also the organismic *orientation* toward offspring. Detachment and disinterest mark the parental attitude of the typical reptile, while mammals can enter into subtle and elaborate interactions with their young.

Mammals bear their young live; they nurse, defend, and rear them while they are immature. Mammals, in other words, *take care of their own.* Rearing and caretaking are so familiar to humans that we are apt to take them for granted, but these capacities were once novel—a revolution in social evolution. The most common reaction a reptile has to its young is indifference; it lays its eggs and walks (or slithers) away. Mammals form close-knit, mutually nurturant social groups—families—in which members spend time touching and caring for one another. Parents nourish and safeguard their young, and each other, from the hostile world outside their group. A mammal will risk and sometimes lose its life to protect a child or mate from attack. A garter snake or a salamander watches the death of its kin with an unblinking eye.

The limbic brain also permits mammals to sing to their children. Vocal communication between a mammal and offspring is universal. Remove a mother from her litter of kittens or puppies and they begin an incessant yowling—the *separation cry*—whose shrill distress drills into the ear of any normal human being. But take a baby Komodo dragon away from its scaly progenitor, and it stays quiet. Immature Komodos do not broadcast their presence because Komodo adults are avid cannibals. A lifesaving vacuum of silence stretches between a reptilian mother and young. Advertising vulnerability makes sense only for those animals whose brains can conceive of a parental protector.

And mammals can *play* with one another, an activity unique to animals possessing limbic hardware. Anyone who has joined a dog in a tug-of-war over an old sneaker, and has let the shoe go, knows what follows—he trots back. Mutual *tugging* is what he desires, not the shoe. The same dog appreciates the essential delight of keep-away played with a sock (doesn't want to keep the sock), and his heart warms to go-fetch—the improbably joyous celebration of making an object go exactly nowhere. What in the world do activities like this accomplish? The dog isn't finding food, isn't mating, isn't rearing pups, and isn't doing anything obviously linked to survival or propagation. So why do all kinds of mammals want to frolic, gambol, tumble, and roughhouse? For a mute mammal, play is physical poetry: it provides the permissible way, as Robert Frost said poems do, of saying one thing and meaning another. By the grace of their limbic brains, mammals find such exultant metaphor irresistible.

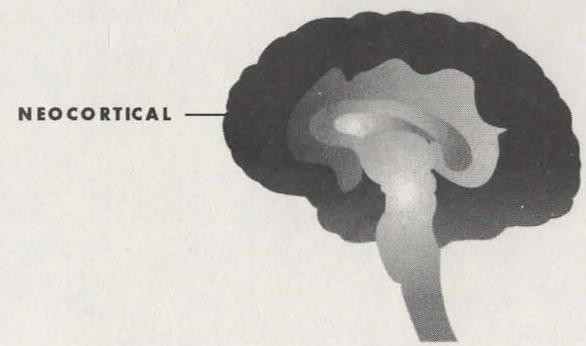
The Newest Brain

The *neocortex* (from the Greek for "new" and the Latin for "rind," or "bark") is the last and, in humans, the largest of the three brains.

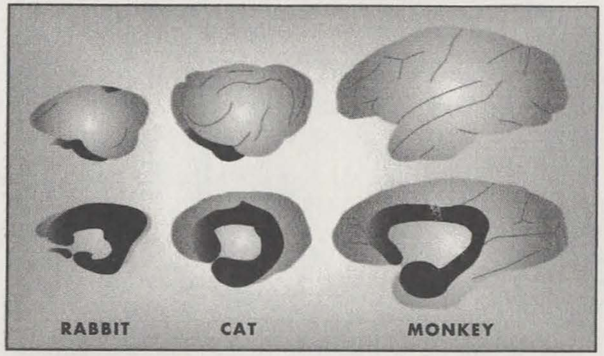
Mammals that evolved long ago, like the opossum (so old that it retained the marsupial's trademark pouch), have only a thin skin of neocortex covering the older sub-brains. Neocortical size has grown in mammals of recent origin, so that dogs and cats have more, and monkeys, more still. In human beings, the neocortex has ballooned to massive proportions.

The human neocortex is two symmetrical sheets, each the size of a large, thick linen napkin, and each crumpled for better cramming into the small oblate shell of the skull. Like most of the brain, the neocortex is a warehouse of secrets and unanswered questions. Nevertheless, science has made some progress at mapping the functions and capacities of this massed neuronal army. Speaking, writing, planning, and reasoning all originate in the neocortex. So do the experience of our senses, what we know as awareness, and our conscious motor control, what we know as will.

The neocortical orchestration of our experiential world sometimes leads to surprising disjunctures of consciousness, the optical illusions of the self. Damage to the visual neocortex can produce the phenomenon of *blindsight*, wherein a patient reveals the erroneous impression of his own sightlessness. Although the world appears to his sensibility as a uniform and ceaseless night, if he is



The neocortical brain.



The brains of a rabbit, cat, and monkey. The neocortex has expanded in mammals of recent origin, while the size of the limbic brain has changed little. (From *The Triune Brain in Evolution* by Paul D. MacLean, 1990. Reprinted with permission of Plenum Press.)

forced to guess the location of a moving light he is correct far more often than chance permits—confirming to the external observer occult powers of vision that remain forever hidden from the patient himself. The delightful chronicles of Oliver Sacks include not only the man who mistook his wife for a hat, but also the man who mistook his own leg for a disembodied horror, and the woman who departed the bilateral universe by forgetting the concept of "left." All are examples of neocortical processing gone astray.

As a human being moves through the day, he is blissfully unaware of the prodigious feats of coordination that underlie the simplest acts. Reaching for a cup of coffee, allowing a greeting to roll off the tongue, glancing up Fifth Avenue to hail a taxi—all require the shortening of millions of tiny muscle fibers in a sequence of exquisite complexity. The cascade that culminates in skeletal muscle contraction begins in the neocortex, or at least we think it does. People who suffer the demise of their motor cortex (often by stroke) lose the ability to move parts of their body at will. If nearby neurons can take over some control of those abandoned but otherwise healthy muscles, a person may regain a limited capacity

to command them. The motor cortex thus emerges as a clear candidate for the seat of volition.

Tracing the initiation of movement further back into the tangled undergrowth of the neural jungle soon reveals the brain's propensity for frustrating such facile conceptions as a neat locus of control. Recordings of encephalographic electrical waves show, amid their jagged spikes and hieroglyph swirls, a signature downward dip signifying that a neuronal mandate for motion is under way: the so-called *readiness wave.* While the motor cortex produces motion, the readiness wave appears to signal intent. So we should look here for will. When experimenters placed their subjects in front of a clock, however, they found that the conscious experience of a decision to move occurs *after* the readiness wave has already passed. What we feel as the conscious spark of resolve in this case proves to be an afterthought, not the majestic nexus of initiative we might imagine. Just where and how the early glimmers of intention coalesce, like glittering dust motes into the swirling jinni of action, remains beyond the ken of today's science. The more we discover, the more we find that we do not know. As E. E. Cummings observed: Always a more beautiful answer that asks a more beautiful question.

While the neocortex may not supply a simple push button for free will, small neocortical lesions can produce specific control deficits—the inability to move an arm, to speak, even to focus attention. The functions of the older brains are involuntary. The modulation of the blood's sodium concentration by the reptilian brain, for example, occurs without a whisper of intent. So does the startle response to a big bang—even with ample and detailed warning, nobody can suppress flinching at a loud noise.

Another gift that the neocortex bestows is the skill of *abstraction:* every task that calls for symbolic representation, strategy, planning, or problem-solving has its headquarters in the neocortical brain. That geography engenders the close relationship between neocortex and conventional intelligence. Provided one corrects for body weight, species that are better problem solvers always have more neocortex than their less ingenious fellows. Human beings have the largest neocortex-to-brain ratio of any creature, an inequitable proportion that confers upon us our capacity to reason. Capacious neocortical abstraction also underlies the uniquely human gift of spoken and written language, in which meaningless squawks and squiggles stand for real people, objects, and actions. Language is the grandest and perhaps the most useful abstraction we have.

The power to symbolize arose not to grant the gift of gab but because it can keep an animal alive. Abstraction invents the possibility of a mental future. Because it can travel into the realm of the hypothetical, the neocortical brain can envision where and how a plan ends, allowing its possessor to strategize—rehearse and refine without betraying his intention prematurely, thereby allowing fictive mistakes whose corporeal counterparts he could not afford. The neurophysiologist W. H. Calvin has proposed that the cerebral neocortex originally developed to serve ballistic movements—complicated, one-shot actions that occur too rapidly to be modified as they uncoil, requiring planned precision. The modern Homo sapiens on the verge of shooting a crumpled paper ball into a distant wastebasket or lobbing keys to an acquaintance may experience today that moment of imaginative hesitancy before release, the preliminary, practice demitoss that sharpens aim. A talent for visualizing what-ifs may better someone's rock-throwing as much as his skill at chess. The former aptitude is what secured for the neocortex a lasting place.

Many people conceive of evolution as an upward staircase, an unfolding sequence that produces ever more advanced organisms. From this perspective, the advantages of the neocortex—speech, reason, abstraction—would naturally be judged the highest attributes of human nature. But the vertical conceptualization of evolution is fallacious. Evolution is a kaleidoscope, not a pyramid: the shapes and variety of species are constantly shifting, but there is no basis for assigning supremacy, no pinnacle toward which the system is moving. Five hundred million years ago, every species was either adapted to that world or changing to become so. The same is true today. We are free to label ourselves the end product of evolution not because it is so, but because we exist *now.* Expunge this temperocentrist bias, and the neocortical brain is not the most advanced of the three, but simply the most recent.

THE TROUBLE WITH TRIPLES

Evolution's stuttering process has fashioned a brain that is fragmented and inharmonious, and to some degree composed of players with competing interests. Critics of MacLean's triune model have disparaged its deliberate separation of intellect and emotion as unfashionable Romanticism. While the three brains differ in lineage and function, however, no one has argued for neurological autonomy. Each brain has evolved to interdigitate with its cranial cohabitants, and the lines between them, like dusk and dawn, are more shaded transitions than surgical demarcations. But it is one thing to say that night gives way to day and day fades into night, and it is quite another to declare light and dark equivalent. The cleavage between reason and passion is an ancient theme but no anachronism; it has endured because it speaks to the deep human experience of a divided mind.

The scientific basis for separating neocortical from limbic brain matter rests on solid neuroanatomical, cellular, and empirical grounds. As viewed through the microscope, limbic areas exhibit a far more primitive cellular organization than their neocortical counterparts. Certain radiographic dyes selectively stain limbic structures, thus painting the molecular dissimilarity between the two brains in clean, vivid strokes. One researcher made an antibody that binds to cells of the hippocampus—a limbic component—and found that those same fluorescent markers stuck to *all* parts of the limbic brain, lighting it up like a biological Christmas tree, without coloring the neocortex at all. Large doses of some medications destroy limbic tissue while leaving the neocortex unscathed, a sharpshooting feat enabled by evolutionary divergence in the chemical composition of limbic and neocortical cell membranes.

Nor is there much room for doubt that nurturance, social communion, communication, and play have their home in limbic territory. Remove a mother hamster's whole neocortex and she can still raise her pups, but even slight limbic damage devastates her maternal abilities. Limbic lesions in monkeys can obliterate the entire awareness of others. After a limbic lobotomy, one impaired monkey stepped on his outraged peers as if treading on a log or a rock, and took food out of their hands with the nonchalance of one oblivious to their very existence. MacLean replicated the same loss of social faculties in rodents. After limbic ablation, adult hamsters ignored the calls and cries of their young; a limbectomized pup would repeatedly walk on top of the others "as though they did not exist." In addition to erasing the recognition of others, removing limbic tissue robbed these mammals of responsiveness to the playful overtures of normal littermates.

In humans, the neocortical capacity for thought can easily obscure other, more occult mental activities. Indeed, the blazing obviousness of cogitation opens the way to a pancognitive fallacy: I think, therefore everything I am is *thinking.* But in the words of a neocortical brain as mighty as Einstein's: "We should take care not to make the intellect our god; it has, of course, powerful muscles, but no personality. It cannot lead; it can only serve."

The swirling interactions of humanity's three brains, like the shuttling of cups in a shell game, deftly disguise the rules of emotional life and the nature of love. Because people are most aware of the verbal, rational part of their brains, they assume that every part of their mind should be amenable to the pressure of argument and will. Not so. Words, good ideas, and logic mean nothing to at least two brains out of three. Much of one's mind does not take orders. "From modern neuroanatomy," writes a pair of neuroscience researchers, "it is apparent that the entire neocortex of humans continues to be regulated by the paralimbic regions from which it evolved." The novelist Gene Wolfe makes an identical, albeit lovelier, observation:

> *We say, "I will," and "I will not," and imagine ourselves (though we obey the orders of some prosaic person every day) our own masters, when the truth is that our masters are sleeping. One wakes within us, and we are ridden like beasts, though the rider is but some hitherto unguessed part of ourselves.*

The scientist and artist both speak to the turmoil that comes from having a triune brain. A person cannot direct his emotional life in the way he bids his motor system to reach for a cup. He cannot will himself to *want* the right thing, or to *love* the right person, or to *be* happy after a disappointment, or even to be happy in happy times. People lack this capacity not through a deficiency of discipline but because the jurisdiction of will is limited to the latest brain and to those functions within its purview. Emotional life can be influenced, but it cannot be commanded. Our society's love affair with mechanical devices that respond at a button-touch ill prepares us to deal with the unruly organic mind that dwells within. Anything that does not comply must be broken or poorly designed, people now suppose, including their hearts.

Only the latest of the three brains traffics in logic and reason, and it alone can utilize the abstract symbols we know as words. The emotional brain, although inarticulate and unreasoning, can be expressive and intuitive. Like the art it is responsible for inspiring, the limbic brain can move us in ways beyond logic that have only the most inexact translations in a language the neocortex can comprehend.

The verbal rendition of emotional material thus demands a difficult transmutation. And so people must strain to force a strong feeling into the straitjacket of verbal expression. Often, as emotionality rises, so do sputtering, gesticulation, and mute frustration. Poetry, a bridge between the neocortical and limbic brains, is simultaneously improbable and powerful. Frost wrote that a poem "begins as a lump in the throat, a sense of wrong, a homesickness, a love sickness. It is never a thought to begin with."

Neither does love begin with a thought. Anatomical mismatch prevents intellectual talons from grasping love as surely as it foils a person who tries to eat soup with a fork. To understand love we must start with the feelings—and that is where the next chapter begins.