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Anatomy of an Emotional Hijacking

Life is a comedy for those who think and a tragedy for those who feel.

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It was a hot August afternoon in 1963, the same day that the Rev. Martin Luther King, Jr., gave his "I Have a Dream" speech to a civil rights march on Washington. On that day Richard Robles, a seasoned burglar who had just been paroled from a three-year sentence for the more than one hundred break-ins he had pulled to support a heroin habit, decided to do one more. He wanted to renounce crime, Robles later claimed, but he desperately needed money for his girlfriend and their three-year-old daughter.

The apartment he broke into that day belonged to two young women, twenty-one-year-old Janice Wylie, a researcher at *Newsweek* magazine, and twenty-three-year-old Emily Hoffert, a grade-school teacher. Though Robles chose the apartment on New York's swanky Upper East Side to burglarize because he thought no one would be there, Wylie was home. Threatening her with a knife, Robles tied her up. As he was leaving, Hoffert came home. To make good his escape, Robles began to tie her up, too.

As Robles tells the tale years later, while he was tying up Hoffert, Janice Wylie warned him he would not get away with this crime: She would remember his face and help the police track him down. Robles, who had promised himself this was to have been his last burglary, panicked at that, completely losing control. In a frenzy, he grabbed a soda bottle and clubbed the women until they were unconscious, then, awash in rage and fear, he slashed and stabbed them over and over with a kitchen knife. Looking back on that moment some twenty-five years later, Robles lamented, "I just went bananas. My head just exploded."

To this day Robles has lots of time to regret those few minutes of rage unleashed. At this writing he is still in prison, some three decades later, for what became known as the "Career Girl Murders."

Such emotional explosions are neural hijackings. At those moments, evidence suggests, a center in the limbic brain proclaims an emergency, recruiting the rest of the brain to its urgent agenda. The hijacking occurs in an instant, triggering this reaction crucial moments before the neocortex, the thinking brain, has had a chance to glimpse fully what is happening, let alone decide if it is a good idea. The hallmark of such a hijack is that once the moment passes, those so possessed have the sense of not knowing what came over them.

These hijacks are by no means isolated, horrific incidents that lead to brutal crimes like the Career Girl Murders. In less catastrophic form—but not necessarily less intense—they happen to us with fair frequency. Think back to the last time you "lost it," blowing up at someone—your spouse or child, or perhaps the driver of another car—to a degree that later, with some reflection and hindsight, seemed uncalled for. In all probability, that, too, was such a hijacking, a neural takeover which, as we shall see, originates in the amygdala, a center in the limbic brain.

Not all limbic hijackings are distressing. When a joke strikes someone as so uproarious that their laughter is almost explosive, that, too, is a limbic response. It is at work also in moments of intense joy: When Dan Jansen, after several heartbreaking failures to capture an Olympic Gold Medal for speed skating (which he had vowed to do for his dying sister), finally won the Gold in the 1,000-meter race in the 1994 Winter Olympics in Norway, his wife was so overcome by the excitement and happiness that she had to be rushed to emergency physicians at rinkside.

THE SEAT OF ALL PASSION

In humans the amygdala (from the Greek word for "almond") is an almond-shaped cluster of interconnected structures perched above the brainstem, near the bottom of the limbic ring. There are two amygdalas, one on each side of the brain, nestled toward the side of the head. The human amygdala is relatively large compared to that in any of our closest evolutionary cousins, the primates.

The hippocampus and the amygdala were the two key parts of the primitive "nose brain" that, in evolution, gave rise to the cortex and then the neocortex. To this day these limbic structures do much or most of the brain's learning and remembering; the amygdala is the specialist for emotional matters. If the amygdala is severed from the rest of the brain, the result is a striking inability to gauge the emotional significance of events; this condition is sometimes called "affective blindness."

Lacking emotional weight, encounters lose their hold. One young man whose amygdala had been surgically removed to control severe seizures became completely uninterested in people, preferring to sit in isolation with no human contact. While he was perfectly capable of conversation, he no longer recognized close friends, relatives, or even his mother, and remained impassive in the face of their anguish at his indifference. Without an amygdala he seemed to have lost all recognition of feeling, as well as any feeling about feelings.[1] The amygdala acts as a storehouse of emotional memory, and thus of significance itself; life without the amygdala is a life stripped of personal meanings.

More than affection is tied to the amygdala; all passion depends on it. Animals that have their amygdala removed or severed lack fear and rage, lose the urge to compete or cooperate, and no longer have any sense of their place in their kind's social order; emotion is blunted or absent. Tears, an emotional signal unique to humans, are triggered by the amygdala and a nearby structure, the cingulate gyrus; being held, stroked, or otherwise comforted soothes these same brain regions, stopping the sobs. Without an amygdala, there are no tears of sorrow to soothe.

Joseph LeDoux, a neuroscientist at the Center for Neural Science at New York University, was the first to discover the key role of the amygdala in the emotional brain.[2] LeDoux is part of a fresh breed of neuroscientists who draw on innovative methods and technologies that bring a previously unknown level of precision to mapping the brain at work, and so can lay bare mysteries of mind that earlier generations of scientists have found impenetrable. His findings on the circuitry of the emotional brain overthrow a long-standing notion about the limbic system, putting the amygdala at the center of the action and placing other limbic structures in very different roles.[3]

LeDoux's research explains how the amygdala can take control over what we do even as the thinking brain, the neocortex, is still coming to a decision. As we shall see, the workings of the amygdala and its interplay with the neocortex are at the heart of emotional intelligence.

THE NEURAL TRIPWIRE

Most intriguing for understanding the power of emotions in mental life are those moments of impassioned action that we later regret, once the dust has settled; the question is how we so easily become so irrational. Take, for example, a young woman who drove two hours to Boston to have brunch and spend the day with her boyfriend. During brunch he gave her a present she'd been wanting for months, a hard-to-find art print brought back from Spain. But her delight dissolved the moment she suggested that after brunch they go to a matinee of a movie she'd been wanting to see and her friend stunned her by saying he couldn't spend the day with her because he had Softball practice. Hurt and incredulous, she got up in tears, left the cafe, and, on impulse, threw the print in a garbage can. Months later, recounting the incident, it's not walking out she regrets, but the loss of the print.

It is in moments such as these—when impulsive feeling overrides the rational—that the newly discovered role for the amygdala is pivotal. Incoming signals from the senses let the amygdala scan every experience for trouble. This puts the amygdala in a powerful post in mental life, something like a psychological sentinel, challenging every situation, every perception, with but one kind of question in mind, the most primitive: "Is this something I hate? That hurts me? Something I fear?" If so—if the moment at hand somehow draws a "Yes"—the amygdala reacts instantaneously, like a neural tripwire, telegraphing a message of crisis to all parts of the brain.

In the brain's architecture, the amygdala is poised something like an alarm company where operators stand ready to send out emergency calls to the fire department, police, and a neighbor whenever a home security system signals trouble.

When it sounds an alarm of, say, fear, it sends urgent messages to every major part of the brain: it triggers the secretion of the body's fight-or-flight hormones, mobilizes the centers for movement, and activates the cardiovascular system, the muscles, and the gut.[4] Other circuits from the amygdala signal the secretion of emergency dollops of the hormone norepinephrine to heighten the reactivity of key brain areas, including those that make the senses more alert, in effect setting the brain on edge. Additional signals from the amygdala tell the brainstem to fix the face in a fearful expression, freeze unrelated movements the muscles had underway, speed heart rate and raise blood pressure, slow breathing. Others rivet attention on the source of the fear, and prepare the muscles to react accordingly. Simultaneously, cortical memory systems are shuffled to retrieve any knowledge relevant to the emergency at hand, taking precedence over other strands of thought.

And these are just part of a carefully coordinated array of changes the amygdala orchestrates as it commandeers areas throughout the brain (for a more detailed account, see Appendix C). The amygdala's extensive web of neural connections allows it, during an emotional emergency, to capture and drive much of the rest of the brain—including the rational mind.

THE EMOTIONAL SENTINEL

A friend tells of having been on vacation in England, and eating brunch at a canalside cafe. Taking a stroll afterward along the stone steps down to the canal, he suddenly saw a girl gazing at the water, her face frozen in fear. Before he knew quite why, he had jumped in the water—in his coat and tie. Only once he was in the water did he realize that the girl was staring in shock at a toddler who had fallen in—whom he was able to rescue.

What made him jump in the water before he knew why? The answer, very likely, was his amygdala.

In one of the most telling discoveries about emotions of the last decade, LeDoux's work revealed how the architecture of the brain gives the amygdala a privileged position as an emotional sentinel, able to hijack the brain.[5] His research has shown that sensory signals from eye or ear travel first in the brain to the thalamus, and then—across a single synapse—to the amygdala; a second signal from the thalamus is routed to the neocortex—the thinking brain. This branching allows the amygdala to begin to respond *before* the neocortex, which mulls information through several levels of brain circuits before it fully perceives and finally initiates its more finely tailored response.

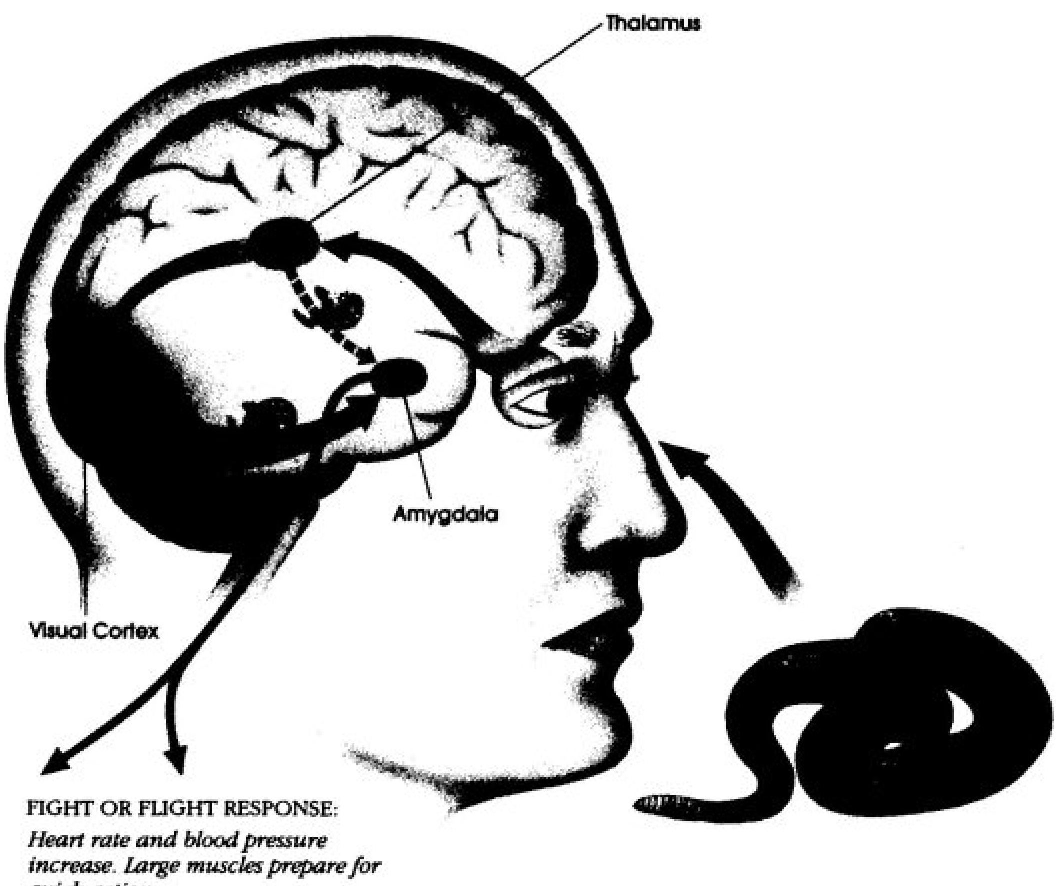
LeDoux's research is revolutionary for understanding emotional life because it is the first to work out neural pathways for feelings that bypass the neocortex. Those feelings that take the direct route through the amygdala include our most primitive and potent; this circuit does much to explain the power of emotion to overwhelm rationality.

The conventional view in neuroscience had been that the eye, ear, and other sensory organs transmit signals to the thalamus, and from there to sensory processing areas of the neocortex, where the signals are put together into objects as we perceive them. The signals are sorted for meanings so that the brain recognizes what each object is and what its presence means. From the neocortex, the old theory held, the signals are sent to the limbic brain, and from there the appropriate response radiates out through the brain and the rest of the body. That is the way it works much or most of the time—but LeDoux discovered a smaller bundle of neurons that leads directly from the thalamus to the amygdala, in addition to those going through the larger path of neurons to the cortex. This smaller and shorter pathway—something like a neural back alley—allows the amygdala to receive some direct inputs from the senses and start a response *before* they are fully registered by the neocortex.

This discovery overthrows the notion that the amygdala must depend entirely on signals from the neocortex to formulate its emotional reactions. The amygdala can trigger an emotional response via this emergency route even as a parallel reverberating circuit begins between the amygdala and neocortex. The amygdala can have us spring to action while the slightly slower—but more fully informed—neocortex unfolds its more refined plan for reaction.

LeDoux overturned the prevailing wisdom about the pathways traveled by emotions through his research on fear in animals. In a crucial experiment he destroyed the auditory cortex of rats, then exposed them to a tone paired with an electric shock. The rats quickly learned to fear the tone, even though the sound of the tone could not register in their neocortex. Instead, the sound took the direct route from ear to thalamus to amygdala, skipping all higher avenues. In short, the rats had learned an emotional reaction without any higher cortical involvement: The amygdala perceived, remembered, and orchestrated their fear independently.

"Anatomically the emotional system can act independently of the neocortex," LeDoux told me. "Some emotional reactions and emotional memories can be formed without any conscious, cognitive participation at all." The amygdala can house memories and response repertoires that we enact without quite realizing why we do so because the shortcut from thalamus to amygdala completely bypasses the neocortex. This bypass seems to allow the amygdala to be a repository for emotional impressions and memories that we have never known about in full awareness. LeDoux proposes that it is the amygdala's subterranean role in memory that explains, for example, a startling experiment in which people acquired a preference for oddly shaped geometric figures that had been flashed at them so quickly that they had no conscious awareness of having seen them at all![6]



A visual signal first goes from the retina to the thalamus, where it is translated into the language of the brain. Most of the message then goes *to the visual cortex, where it is analyzed and assessed for meaning and appropriate response; if that response is emotional, a signal goes to the amygdala to activate the emotional centers. But a smaller portion of the original signal goes straight from the thalamus to the amygdala in a quicker transmission, allowing a faster (though less precise) response. Thus the amygdala can trigger an emotional response before the cortical centers have fully understood what is happening.*

Other research has shown that in the first few milliseconds of our perceiving something we not only unconsciously comprehend what it is, but decide whether we like it or not; the "cognitive unconscious" presents our awareness with not just the identity of what we see, but an opinion about it.[7] Our emotions have a mind of their own, one which can hold views quite independently of our rational mind.

THE SPECIALIST IN EMOTIONAL MEMORY

Those unconscious opinions are emotional memories; their storehouse is the amygdala. Research by LeDoux and other neuroscientists now seems to suggest that the hippocampus, which has long been considered the key structure of the limbic system, is more involved in registering and making sense of perceptual patterns than with emotional reactions. The hippocampus's main input is in providing a keen memory of context, vital for emotional meaning; it is the hippocampus that recognizes the differing significance of, say, a bear in the zoo versus one in your backyard.

While the hippocampus remembers the dry facts, the amygdala retains the emotional flavor that goes with those facts. If we try to pass a car on a two-lane highway and narrowly miss having a head-on collision, the hippocampus retains the specifics of the incident, like what stretch of road we were on, who was with us, what the other car looked like. But it is the amygdala that everafter will send a surge of anxiety through us whenever we try to pass a car in similar circumstances. As LeDoux put it to me, "The hippocampus is crucial in recognizing a face as that of your cousin. But it is the amygdala that adds you don't really like her."

The brain uses a simple but cunning method to make emotional memories register with special potency: the very same neurochemical alerting systems that prime the body to react to life-threatening emergencies by fighting or fleeing also stamp the moment in memory with vividness.[8] Under stress (or anxiety, or presumably even the intense excitement of joy) a nerve running from the brain to the adrenal glands atop the kidneys triggers a secretion of the hormones epinephrine and norepinephrine, which surge through the body priming it for an emergency. These hormones activate receptors on the vagus nerve; while the vagus nerve carries messages from the brain to regulate the heart, it also carries signals back into the brain, triggered by epinephrine and norepinephrine. The amygdala is the main site in the brain where these signals go; they activate neurons within the amygdala to signal other brain regions to strengthen memory for what is happening.

This amygdala arousal seems to imprint in memory most moments of emotional arousal with an added degree of strength—that's why we are more likely, for example, to remember where we went on a first date, or what we were doing when we heard the news that the space shuttle *Challenger* had exploded. The more intense the amygdala arousal, the stronger the imprint; the experiences that scare or thrill us the most in life are among our most indelible memories. This means that, in effect, the brain has two memory systems, one for ordinary facts and one for emotionally charged ones. A special system for emotional memories makes excellent sense in evolution, of course, ensuring that animals would have particularly vivid memories of what threatens or pleases them. But emotional memories can be faulty guides to the present.

OUT-OF-DATE NEURAL ALARMS

One drawback of such neural alarms is that the urgent message the amygdala sends is sometimes, if not often, out-of-date—especially in the fluid social world we humans inhabit. As the repository for emotional memory, the amygdala scans experience, comparing what is happening now with what happened in the past. Its method of comparison is associative: when one key element of a present situation is similar to the past, it can call it a "match"—which is why this circuit is sloppy: it acts before there is full confirmation. It frantically commands that we react to the present in ways that were imprinted long ago, with thoughts, emotions, reactions learned in response to events perhaps only dimly similar, but close enough to alarm the amygdala.

Thus a former army nurse, traumatized by the relentless flood of ghastly wounds she once tended in wartime, is suddenly swept with a mix of dread, loathing, and panic—a repeat of her battlefield reaction triggered once again, years later, by the stench when she opens a closet door to find her toddler had stashed a stinking diaper there. A few spare elements of the situation is all that need seem similar to some past danger for the amygdala to trigger its emergency proclamation. The trouble is that along with the emotionally charged memories that have the power to trigger this crisis response can come equally outdated ways of responding to it.

The emotional brain's imprecision in such moments is added to by the fact that many potent emotional memories date from the first few years of life, in the relationship between an infant and its caretakers. This is especially true for traumatic events, like beatings or outright neglect. During this early period of life other brain structures, particularly the hippocampus, which is crucial for narrative memories, and the neocortex, seat of rational thought, have yet to become fully developed. In memory, the amygdala and hippocampus work hand-in-hand; each stores and retrieves its special information independently. While the hippocampus retrieves information, the amygdala determines if that information has any emotional valence. But the amygdala, which matures very quickly in the infant's brain, is much closer to fully formed at birth.

LeDoux turns to the role of the amygdala in childhood to support what has long been a basic tenet of psychoanalytic thought: that the interactions of life's earliest years lay down a set of emotional lessons based on the attunement and upsets in the contacts between infant and caretakers.[9] These emotional lessons are so potent and yet so difficult to understand from the vantage point of adult life because, believes LeDoux, they are stored in the amygdala as rough, wordless blueprints for emotional life. Since these earliest emotional memories are established at a time before infants have words for their experience, when these emotional memories are triggered in later life there is no matching set of articulated thoughts about the response that takes us over. One reason we can be so baffled by our emotional outbursts, then, is that they often date from a time early in our lives when things were bewildering and we did not yet have words for comprehending events. We may have the chaotic feelings, but not the words for the memories that formed them.

WHEN EMOTIONS ARE FAST AND SLOPPY

It was somewhere around three in the morning when a huge object came crashing through the ceiling in a far corner of my bedroom, spilling the contents of the attic into the room. In a second I leapt out of bed and ran out of the room, terrified the entire ceiling would cave in. Then, realizing I was safe, I cautiously peered back in the bedroom to see what had caused all the damage—only to discover that the sound I had taken to be the ceiling caving in was actually the fall of a tall pile of boxes my wife had stacked in the corner the day before while she sorted out her closet. Nothing had fallen from the attic: there was no attic. The ceiling was intact, and so was I.

My leap from bed while half-asleep—which might have saved me from injury had it truly been the ceiling falling—illustrates the power of the amygdala to propel us to action in emergencies, vital moments before the neocortex has time to fully register what is actually going on. The emergency route from eye or ear to thalamus to amygdala is crucial: it saves time in an emergency, when an instantaneous response is required. But this circuit from thalamus to amygdala carries only a small portion of sensory messages, with the majority taking the main route up to the neocortex. So what registers in the amygdala via this express route is, at best, a rough signal, just enough for a warning. As LeDoux points out, "You don't need to know exactly what something is to know that it may be dangerous."[10]

The direct route has a vast advantage in brain time, which is reckoned in thousandths of a second. The amygdala in a rat can begin a response to a perception in as little as twelve milliseconds—twelve thousandths of a second. The route from thalamus to neocortex to amygdala takes about twice as long. Similar measurements have yet to be made in the human brain, but the rough ratio would likely hold.

In evolutionary terms, the survival value of this direct route would have been great, allowing a quick-response option that shaves a few critical milliseconds in reaction time to dangers. Those milliseconds could well have saved the lives of our protomammalian ancestors in such numbers that this arrangement is now featured in every mammalian brain, including yours and mine. In fact, while this circuit may play a relatively limited role in human mental life, largely restricted to emotional crises, much of the mental life of birds, fish, and reptiles revolves around it, since their very survival depends on constantly scanning for predators or prey. "This primitive, minor brain system in mammals is the main brain system in non-mammals," says LeDoux. "It offers a very rapid way to turn on emotions. But it's a quick-and-dirty process; the cells are fast, but not very precise."

Such imprecision in, say, a squirrel, is fine, since it leads to erring on the side of safety, springing away at the first sign of anything that might signal a looming enemy, or springing toward a hint of something edible. But in human emotional life that imprecision can have disastrous consequences for our relationships, since it means, figuratively speaking, we can spring at or away from the wrong thing—or person. (Consider, for example, the waitress who dropped a tray of six dinners when she glimpsed a woman with a huge, curly mane of red hair—exactly like the woman her ex-husband had left her for.)

Such inchoate emotional mistakes are based on feeling prior to thought. LeDoux calls it "precognitive emotion," a reaction based on neural bits and pieces of sensory information that have not been fully sorted out and integrated into a recognizable object. It's a very raw form of sensory information, something like a neural *Name That Tune,* where, instead of snap judgments of melody being made on the basis of just a few notes, a whole perception is grasped on the basis of the first few tentative parts. If the amygdala senses a sensory pattern of import emerging, it jumps to a conclusion, triggering its reactions before there is full confirming evidence—or any confirmation at all.

Small wonder we can have so little insight into the murk of our more explosive emotions, especially while they still hold us in thrall. The amygdala can react in a delirium of rage or fear before the cortex knows what is going on because such raw emotion is triggered independent of, and prior to, thought.

THE EMOTIONAL MANAGER

A friend's six-year-old daughter Jessica was spending her first night ever sleeping over at a playmate's, and it was unclear who was more nervous about it, mother or daughter. While the mother tried not to let Jessica see the intense anxiety she felt, her tension peaked near midnight that night, as she was getting ready for bed and heard the phone ring. Dropping her toothbrush, she raced to the phone, her heart pounding, images of Jessica in terrible distress racing through her mind.

The mother snatched the receiver, and blurted, "Jessica!" into the phone —only to hear a woman's voice say, "Oh, I think this must be a wrong number...."

At that, the mother recovered her composure, and in a polite, measured tone, asked, "What number were you calling?"

While the amygdala is at work in priming an anxious, impulsive reaction, another part of the emotional brain allows for a more fitting, corrective response. The brain's clamper switch for the amygdala's surges appears to lie at the other end of a major circuit to the neocortex, in the prefrontal lobes just behind the forehead. The prefrontal cortex seems to be at work when someone is fearful or enraged, but stifles or controls the feeling in order to deal more effectively with the situation at hand, or when a reappraisal calls for a completely different response, as with the worried mother on the phone. This neocortical area of the brain brings a more analytic or appropriate response to our emotional impulses, modulating the amygdala and other limbic areas.

Ordinarily the prefrontal areas govern our emotional reactions from the start. The largest projection of sensory information from the thalamus, remember, goes not to the amygdala, but to the neocortex and its many centers for taking in and making sense of what is being perceived; that information and our response to it is coordinated by the prefrontal lobes, the seat of planning and organizing actions toward a goal, including emotional ones. In the neocortex a cascading series of circuits registers and analyzes that information, comprehends it, and, through the prefrontal lobes, orchestrates a reaction. If in the process an emotional response is called for, the prefrontal lobes dictate it, working hand-in-hand with the amygdala and other circuits in the emotional brain.

This progression, which allows for discernment in emotional response, is the standard arrangement, with the significant exception of emotional emergencies. When an emotion triggers, within moments the prefrontal lobes perform what amounts to a risk/benefit ratio of myriad possible reactions, and bet that one of them is best.[11] For animals, when to attack, when to run. And for we humans . . . when to attack, when to run—and also, when to placate, persuade, seek sympathy, stonewall, provoke guilt, whine, put on a facade of bravado, be contemptuous—and so on, through the whole repertoire of emotional wiles.

The neocortical response is slower in brain time than the hijack mechanism because it involves more circuitry. It can also be more judicious and considered, since more thought precedes feeling. When we register a loss and become sad, or feel happy after a triumph, or mull over something someone has said or done and then get hurt or angry, the neocortex is at work.

Just as with the amygdala, absent the workings of the prefrontal lobes, much of emotional life would fall away; lacking an understanding that something merits an emotional response, none comes. This role of the prefrontal lobes in emotions has been suspected by neurologists since the advent in the 1940s of that rather desperate—and sadly misguided—surgical "cure" for mental illness: the prefrontal lobotomy, which (often sloppily) removed part of the prefrontal lobes or otherwise cut connections between the prefrontal cortex and the lower brain. In the days before any effective medications for mental illness, the lobotomy was hailed as the answer to grave emotional distress—sever the links between the prefrontal lobes and the rest of the brain, and patients' distress was "relieved." Unfortunately, the cost was that most of patients' emotional lives seemed to vanish, too. The key circuitry had been destroyed.

Emotional hijackings presumably involve two dynamics: triggering of the amygdala and a failure to activate the neocortical processes that usually keep emotional response in balance—or a recruitment of the neocortical zones to the emotional urgency. [12] At these moments the rational mind is swamped by the emotional. One way the prefrontal cortex acts as an efficient manager of emotion—weighing reactions before acting—is by dampening the signals for activation sent out by the amygdala and other limbic centers—something like a parent who stops an impulsive child from grabbing and tells the child to ask properly (or wait) for what it wants instead.[13]

The key “off switch” for distressing emotion seems to be the left prefrontal lobe. Neuropsychologists studying moods in patients with injuries to parts of the frontal lobes have determined that one of the tasks of the left frontal lobe is to act as a neural thermostat, regulating unpleasant emotions. The right prefrontal lobes are a seat of negative feelings like fear and aggression, while the left lobes keep those raw emotions in check, probably by inhibiting the right lobe.[14] In one group of stroke patients, for example, those whose lesions were in the left prefrontal cortex were prone to catastrophic worries and fears; those with lesions on the right were "unduly cheerful"; during neurological exams they joked around and were so laid back they clearly did not care how well they did.[15] And then there was the case of the happy husband: a man whose right prefrontal lobe had been partially removed in surgery for a brain malformation. His wife told physicians that after the operation he underwent a dramatic personality change, becoming less easily upset and, she was happy to say, more affectionate.[16]

The left prefrontal lobe, in short, seems to be part of a neural circuit that can switch off, or at least dampen down, all but the strongest negative surges of emotion. If the amygdala often acts as an emergency trigger, the left prefrontal lobe appears to be part of the brain's “off switch” for disturbing emotion: the amygdala proposes, the prefrontal lobe disposes. These prefrontal-limbic connections are crucial in mental life far beyond fine-tuning emotion; they are essential for navigating us through the decisions that matter most in life.

HARMONIZING EMOTION AND THOUGHT

The connections between the amygdala (and related limbic structures) and the neocortex are the hub of the battles or cooperative treaties struck between head and heart, thought and feeling. This circuitry explains why emotion is so crucial to effective thought, both in making wise decisions and in simply allowing us to think clearly.

Take the power of emotions to disrupt thinking itself. Neuroscientists use the term "working memory" for the capacity of attention that holds in mind the facts essential for completing a given task or problem, whether it be the ideal features one seeks in a house while touring several prospects, or the elements of a reasoning problem on a test. The prefrontal cortex is the brain region responsible for working memory.[17] But circuits from the limbic brain to the prefrontal lobes mean that the signals of strong emotion—anxiety, anger, and the like—can create neural static, sabotaging the ability of the prefrontal lobe to maintain working memory. That is why when we are emotionally upset we say we "just can't think straight"—and why continual emotional distress can create deficits in a child's intellectual abilities, crippling the capacity to learn.

These deficits, if more subtle, are not always tapped by IQ testing, though they show up through more targeted neuropsychological measures, as well as in a child's continual agitation and impulsivity. In one study, for example, primary school boys who had above-average IQ scores but nevertheless were doing poorly in school were found via these neuropsychological tests to have impaired frontal cortex functioning.[18] They also were impulsive and anxious, often disruptive and in trouble—suggesting faulty prefrontal control over their limbic urges. Despite their intellectual potential, these are the children at highest risk for problems like academic failure, alcoholism, and criminality—not because their intellect is deficient, but because their control over their emotional life is impaired. The emotional brain, quite separate from those cortical areas tapped by IQ tests, controls rage and compassion alike. These emotional circuits are sculpted by experience throughout childhood—and we leave those experiences utterly to chance at our peril.

Consider, too, the role of emotions in even the most "rational" decision-making. In work with far-reaching implications for understanding mental life, Dr. Antonio Damasio, a neurologist at the University of Iowa College of Medicine, has made careful studies of just what is impaired in patients with damage to the prefrontal-amygdala circuit.[19] Their decision-making is terribly flawed—and yet they show no deterioration at all in IQ or any cognitive ability. Despite their intact intelligence, they make disastrous choices in business and their personal lives, and can even obsess endlessly over a decision so simple as when to make an appointment.

Dr. Damasio argues that their decisions are so bad because they have lost access to their *emotional* learning. As the meeting point between thought and emotion, the prefrontal-amygdala circuit is a crucial doorway to the repository for the likes and dislikes we acquire over the course of a lifetime. Cut off from emotional memory in the amygdala, whatever the neocortex mulls over no longer triggers the emotional reactions that have been associated with it in the past—everything takes on a gray neutrality. A stimulus, be it a favorite pet or a detested acquaintance, no longer triggers either attraction or aversion; these patients have "forgotten" all such emotional lessons because they no longer have access to where they are stored in the amygdala.

Evidence like this leads Dr. Damasio to the counter-intuitive position that feelings are typically *indispensable for* rational decisions; they point us in the proper direction, where dry logic can then be of best use. While the world often confronts us with an unwieldy array of choices (How should you invest your retirement savings? Whom should you marry?), the emotional learning that life has given us (such as the memory of a disastrous investment or a painful breakup) sends signals that streamline the decision by eliminating some options and highlighting others at the outset. In this way, Dr. Damasio argues, the emotional brain is as involved in reasoning as is the thinking brain.

The emotions, then, matter for rationality. In the dance of feeling and thought the emotional faculty guides our moment-to-moment decisions, working hand-in-hand with the rational mind, enabling—or disabling—thought itself. Likewise, the thinking brain plays an executive role in our emotions—except in those moments when emotions surge out of control and the emotional brain runs rampant.

In a sense we have two brains, two minds—and two different kinds of intelligence: rational and emotional. How we do in life is determined by both—it is not just IQ, but *emotional* intelligence that matters. Indeed, intellect cannot work at its best without emotional intelligence. Ordinarily the complementarity of limbic system and neocortex, amygdala and prefrontal lobes, means each is a full partner in mental life. When these partners interact well, emotional intelligence rises—as does intellectual ability.

This turns the old understanding of the tension between reason and feeling on its head: it is not that we want to do away with emotion and put reason in its place, as Erasmus had it, but instead find the intelligent balance of the two. The old paradigm held an ideal of reason freed of the pull of emotion. The new paradigm urges us to harmonize head and heart. To do that well in our lives means we must first understand more exactly what it means to use emotion intelligently.