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Brainstorm

The Power and Purpose
of the Teenage Brain

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is both within us and between us and others—it is embodied and it is relational—then we can see how knowing about our body's brain and knowing about our relationships are both fundamental to strengthening our minds. In the pages that follow, we'll find important concepts that can help bring integration into our inner lives and our interpersonal lives. That's using mindsight to create a strong life for ourselves from the inside out.

PART II

Your Brain

A seventeen-year-old senior in high school, Katey looked terrified as her stomach was being pumped in the local hospital emergency room after a night of heavy drinking. She was writhing in pain from the emetic-induced vomiting, and still drunk from the seven shots of tequila and four glasses of wine she had consumed at an end-of-summer gathering that evening. At least that was her parents' version of what had occurred based on what Katey's friends had told them. For her part, Katey couldn't remember much of what had occurred that evening.

As it turns out, Katey brought the hard liquor to the party, shared it with her classmates, and even coaxed the host of the event—the daughter of the director of their school—into the drinking spree.

Katey was expelled from school the following week, which was the week she came in for her first therapy session. In speaking more with her about what happened, I learned that she had planned to “have fun” at the party even though it was at the home of the director of her school.

Katey knew how “off” it all sounded.

“What were you thinking before that party?” I asked her. She looked sheepish, glancing away with the beginnings of a smile appearing on her face. “What did you think might happen after the party when the school rules state that there is ‘zero tolerance’ for alcohol at school-related functions?” Katey looked at me, her eyes wide open and locked with mine, her half-smile widening, suggesting that perhaps her anxiety was increasing or that she was somewhat amused at the whole situation.

“Well . . .” she began, her smile now wide across her face. “I *did* think about it.” She paused and looked around the room as if someone might be listening, and then she turned back to me. “I knew what might happen, I guess, but the *fun* of getting completely smashed at the director’s own house just seemed like too much to turn down.” Her eyes shone with a sparkle of delight.

The fact that Katey herself admitted that she had “planned” what would happen at the party even in the face of knowledge about the potential outcomes resonates in recent studies revealing that teenagers usually have awareness of the risks of potentially dangerous behaviors. As teens we are often not oblivious to the negative consequences of our actions. Instead, even though the negative consequences—the cons—are fully known, we place more emphasis on the potential positive aspects—the PROS—of an experience: the thrill, the shared experience, the fun, the excitement of breaking the rules. That emphasis on the positive, we now know, is a result of shifts in the brain’s structure and function during the adolescent period.

Dopamine, Decisions, and the Drive for Reward

Katey’s enhanced focus on the positive was in fact a natural consequence of the increased reward drive in the adolescent brain. The brain is a collection of cells that communicate with one another using chemicals called neurotransmitters. During adolescence there is an increase in the activity of the neural circuits utilizing dopamine, a neurotransmitter central in creating our drive for reward. Starting in early adolescence and peaking midway through, this enhanced dopamine release causes adolescents to gravitate toward thrilling experiences and exhilarating sensations. Research even suggests that the baseline level of dopamine is lower—but its release in response to experience is higher—which can explain why teens may report a feeling of being “bored” unless they are engaging in some stimulating and novel activities. This enhanced natural dopamine release can give adolescents a powerful sense of being alive when they are engaged in life. It can also lead them to focus solely on the positive rewards they are sure are in store for them, while failing to notice or give value to the potential risks and downsides.

The brain’s increased drive for reward in adolescence manifests in teens’ lives in three important ways. One is simply increased *impulsiveness*, where behaviors occur without thoughtful reflection. In other words, impulse inspires action without any pause. Pausing enables us to think about other options beyond the immediate dopamine-driven impulse pounding on our minds. Telling that impulse to chill out takes time and energy, so it’s easier just not to do it. This said, with the drive for reward stronger and more pressing than ever when we are teens, taking the time needed for processing—for reflection and self-awareness—becomes very important. If any notion turns immediately into an action without reflection, we are

living our lives all gas pedal and no brakes. This can be very stressful for adolescents and the adults who care for them.

The good news is that such impulses can be put on hold if certain fibers in the higher part of the brain work to create a mental space between impulse and action. It is during the time of adolescence that these regulatory fibers begin to grow to counteract the revved-up “go” of the dopamine reward system. The result is a decrease in impulsivity. This is sometimes called “cognitive control” and is one important source of diminished danger and reduced risks as adolescents develop. As we’ll see shortly, there are ways to enhance the growth of those regulatory fibers that create a pause, and they can be developed at any age.

A second way in which increased dopamine release affects us during adolescence is the documented increase in our susceptibility to addiction. All behaviors and substances that are addictive involve the release of dopamine. As teens not only are we more likely to experiment with new experiences, we are also more prone to respond with a robust dopamine release that for some can become part of an addictive cycle. A drug, alcohol for example, can lead to release of dopamine, and we may feel compelled to ingest beer or wine or hard liquor. When the alcohol wears off, our dopamine plummets. We then are driven to use more of the substance that spiked our dopamine circuits. Studies reveal that foods with a high glycemic index—those, like processed foods or even the simple carbohydrates of potatoes or bread, that lead to a rapid rise in blood sugar—can also lead to rapid rises in our dopamine levels and activity in the reward circuits of the brain. Sadly, in the United States such addiction to foods with high caloric but low nutritional value is thought to be responsible for the dangerous epidemic of obesity in adolescents, a medical crisis created and reinforced by our society’s supplying us with just this type of addictive food. As with any addiction, we

continue to engage in the behavior despite knowing its negative impacts on our health. That’s the power of the dopamine reward centers.

A third type of behavior shaped by the increased reward drives of the adolescent brain is something called *hyperrationality*. This is how we think in literal, concrete terms. We examine just the facts of a situation and don’t see the big picture; we miss the setting or context in which those facts occur. With such literal thinking, as adolescents we can place more weight on the calculated benefits of an action than on the potential risks of that action. Studies reveal that as teens we are often fully aware of risks, and even at times overestimate the chance of something bad happening; we simply put more weight on the exciting potential benefits of our actions.

What happens with hyperrational thinking is not a lack of thought or reflection as happens with impulsivity, and it’s not a matter of merely being addicted to a particular behavior or something we are ingesting. Instead, this cognitive process comes from a brain calculation that places a lot of weight on the positive outcome and not much weight on possible negative results. By weight I mean that the evaluation centers of the brain downplay the significance of a negative outcome, while at the same time they amplify the significance given to a positive result. The scales that teens use to weigh out their options are biased in favor of the positive outcome. PROS far outweigh the cons, and quite simply, the risk seems worth it.

This positively biased scale can be activated especially when teens hang out with other teens or believe their friends will somehow observe their actions. The social and emotional context we experience as teens sets the stage for how our brains will process information. While that’s true for any person whatever their age, the influence of peers is especially strong during adolescence.

In other words, in Katey’s situation her brain focused on the re-

warding images of the thrill, the core of sensation seeking, and she disregarded the potential negatives. The emotional meaning of her actions was woven together with her ability to plan and she hyperrationally calculated that this was a PRO thing to do. Katey's behavior was not impulsive—she planned her evening long ago in a hyper-rational way.

As our teen years unfold, we move from the literal thinking of hyperrationality to the broader considerations called “gist thinking.” With gist thinking, we consider the larger context of a decision and use intuition to aim for positive values we care about rather than focusing primarily on the immediate dopamine-driven reward.

So as you can see, it is not as simple as saying that teens are just impulsive. And it's also not as simple as saying, “Oh, raging hormones,” as is sometimes stated. Research suggests that risky behaviors in adolescence have less to do with hormonal imbalances than with changes in our brain's dopamine reward system combined with the cortical architecture that supports hyperrational decision-making creating the positive bias that is dominant during the teen years.

When your dopamine circuitry is turned way up, it's like an amplifier with its gain turned up. Enhanced dopamine release drives us toward reward and satisfaction. The gain is turned up for how attention is drawn to the PROS, putting us at risk of deemphasizing the cons during these years.

Hyperrationality can be illustrated in the extreme example of Russian roulette, a game played with one bullet and six chambers of a pistol. You have five out of six chances to make the \$6 million offered to you if you win. That means, overall, if hundreds of people play this game, then the average you are most likely to get, statistically winning five out of six times, is five-sixths of \$6 million, which is \$5 million overall. Let's go for it! The problem is, of course, if you

are the one in six, you are dead. And for that one person in six, it is a hundred percent certain that life is over. You can see the challenge. It is true that “most likely” you'll get millions of dollars. If your brain circuits focus on that positive outcome, the PROS, and minimize the smaller chance of the risk, the cons, you'll take part in the activity. “Why not?” Yes, that seems like math gone mad. But to *not* jump into this probability assessment, the trap of “What is most likely to happen so I'll do it,” requires a gut feeling, the intuition that is the basis of gist thinking, that lifts you out of hyperrational calculations. With development and the growth of the brain, a gut feeling rises and we get a feeling that the Russian roulette game makes no sense.

Paradoxically, intuition plays a very important role in making good decisions. This is because our intuitions, or gut feelings and heartfelt sensations, tend to focus on positive values, like the benefit of staying in school or driving at the speed limit or keeping fit. Many teens can be too rational, and need to incorporate the non-rational input of their intuitive gut feelings and heartfelt sensations, feelings that enable them to focus on positive values versus mythical rewards that, in reality, are often just out of reach. Learning to experience life from this standpoint is not about inhibiting impulses like driving fast or eating junk food, but rather about embracing positive goals that intuitively mean something to us. Katey's behavior was not impulsive and it was not intuitive or gist-like. It was dopamine-driven and hyperrational. She needed to work on being more aware of what her intuitive gut and heart feelings could tell her about the potential downsides to reckless behavior.

Family, Friends, and Fooling Around

Another important factor that contributed to Katey's decision making is that she was quite preoccupied with how her friends would react if she pulled this escapade off, literally, under the school director's nose, and with his daughter, no less! Here we see another aspect of the teenage brain. On top of the emotional spark and drive for the reward of novelty, intense social engagement with peers is also part of the essence of adolescence. Unfortunately, risk behaviors often significantly increase in the company of peers, as demonstrated in experiments that have measured how teens do when driving on a simulated automobile program when alone and when with their friends.

My son's friend Benji, now in his mid-twenties, tells the story of when he lived in southern Spain with his family as a thirteen-year-old. A half-dozen boys of the same age were running around the cliffs near the beautiful coastal town where he was staying. One of the locals decided to jump the fifty feet or so off the edge of the cliff and into the sea. Then, one by one, the group dynamics lured each of them to jump. When Benji jumped, he may have been just a few feet over from where the others entered the water, he told me, or perhaps it was because none of the local boys had remembered to tell him, as apparently they knew, that he ought to bend his legs right after entering the water. Straight in he went, hurtling toward the bottom and hitting a rock beneath the surface, severely fracturing his right leg. Struggling to the surface with the shock of such a crushing injury, he was losing consciousness when he was rescued by two of the boys and carried a mile back to the town to be hospitalized for much of his remaining time in Spain that summer. If those boys were not there in the water, Benji would not have been telling me the story.

I asked Benji if he thought he would have jumped if he was on his own. "Are you out of your mind?" he said. "No way."

The collective process of being with our friends, or even imagining the impact on our friends, as in Katey's planning stage of her escapade, increases the drive toward reward, the drive toward novelty, and the drive to take risks, and these reduce the focus on weighing the potential risks. So with peers we are much more likely as teenagers to engage in behaviors that may work out most of the time, but if they don't, they may have serious, sometimes irreversible, consequences. Benji's and Katey's behaviors were not impulsive. They both had plenty of time to see what was in the offing and change course. Their decisions were a combination of reward drive, peer process, and hyperrational, non-gist thinking. That's the nature of risky behaviors emerging from the teenage brain.

So the two broad ways that risky behavior emerges in adolescence are hyperrationality, the downplaying of the cons of an action, and impulsivity, or simply flying off the handle, as we'll discuss later. Katey did not, and generally does not, show a tendency to be impulsive. Neither does Benji. In Katey's case, this is what drove her parents mad when they picked her up. Katey is not impulsive, so why such a seemingly impulsive act?

Hyperrationality combined with an increase in her dopamine drive is the cause. And sometimes there are other things at play, such as the dopamine-dependent onset of addiction, that are not limited to being an adolescent but may also be influencing such behaviors, as we'll discuss for Katey and adolescents in general regarding drug use and abuse in Part IV.

The Purpose of Adolescence

In recent years, surprising discoveries from brain imaging studies have revealed changes in the structure and function of the brain during adolescence. As we've seen, interpretations of these studies lead to a very different story than the old raging-hormone view of the teenage brain. A commonly stated but not quite accurate view often presented by the media is that the brain's master control center, the prefrontal cortex, at the forward part of the frontal lobe, is simply not mature until the end of adolescence. This "immaturity" of the brain's prefrontal cortex "explains immature teenage behavior." And this notion also explains why rental car companies generally won't let someone younger than twenty-five take out a car. But this simple story, while easy to grasp, is not quite consistent with the research findings and misses an essential issue.

Instead of viewing the adolescent stage of brain development as merely a process of maturation, of leaving behind outmoded or non-useful ways of thinking and transitioning to adult maturity, it is actually more accurate and more useful to see it as a vital and necessary part of our individual and our collective lives. Adolescence is not a stage to simply get over, it is a stage of life to cultivate well. This new and important take-home message, inspired by the emerging sciences, suggests that the changes that occur in the adolescent brain are not merely about "maturity" versus "immaturity," but rather are vitally important developmental changes that enable certain new abilities to emerge. These new abilities, as we've discussed, are crucial for both the individual and our species.

Why should this matter to us, whether we are teens, in our twenties, or older? It matters because if we see the adolescent period as

just a time to wade through, a time to endure, we'll miss out on taking very important steps to optimize the essence of adolescence. When we see our emotional spark, our social engagement, our novelty seeking, and our creative explorations as positive and necessary core aspects of who adolescents *are*—and who they might become as adults if they can cultivate these qualities well—this period becomes a time of great importance that should be not just survived but nurtured.

Yes, there are challenges in staying open to the "work" of adolescence. Important opportunities for expansion and development during this time can be associated with stress for teens and for the parents who love them. For example, the pushing away from family that adolescents tend to do can be seen as a necessary process enabling them to leave home. This courage to move out and away is created by the brain's reward circuits becoming increasingly active and inspiring teens to seek novelty even in the face of the unfamiliar as they move out into the world. After all, the familiar can be safe and predictable, while the unfamiliar can be unpredictable and filled with potential danger. One historical view for us as social mammals is that if older adolescents did not leave home and move away from local family members, our species would have too much chance of inbreeding and our genetics would suffer. And for our broader human story, adolescents' moving out and exploring the larger world allows our human family to be far more adaptive in the world as the generations unfold. Our individual and our collective lives depend on this adolescent push away.

Hard as it is for parents to worry about their teen's potentially risky behavior, the positive bias of hyper-rational thinking helps adolescents take on risks that they'll *need* to embrace if they are to leave the nest and explore the world. As we've seen, the drive to have in-

creased social connections can keep us safe as we associate with our adolescent peers who are also making the journey out into the unfamiliar world. Our increased sensitivity to our own heightened emotional states and to our peers' influence—our emotional spark and social engagement—are fundamental to this journey as well. Seeking out novelty and creating new ways of doing things also helps our species adapt to the ever-changing world. If the brain throughout the life span is indeed a “work in progress,” as recent studies suggest, then the work that occurs during adolescence is so much more than simply a process of moving from immaturity to maturity. The essence of adolescence enriches our lifelong journey to embrace life fully.

What we are coming to see is that there is a crucial set of brain changes during our adolescence creating new powers, new possibilities, and new purposes fueling the adolescent mind and relationships that simply did not exist like this in childhood. These positive potentials are often hidden from view and yet they can be uncovered and used more effectively and more wisely when we know how to find them and how to cultivate them. We can learn to use cutting-edge science to make the most of the adolescent period of life. It's a pay-it-forward investment for everyone involved.

For the teen, the growth of the body itself, with alterations in physiology, hormones, sexual organs, and the architectural changes in the brain, also can contribute to our understanding of adolescence as an important period of transformation. Changing emotions revolutionize how we feel as teens inside, making more complex the ways of processing information and our ideas about the self and others, and even creating huge developmental shifts and transitions in the inner sense of who we are and who we can become. This is how a sense of identity shifts and evolves throughout adolescence.

From the inside, these changes can become overwhelming, and

we may even lose our way, and feel that life is just “too much” to navigate at times. From the outside, such changes may at times seem like we are lost and “out of control.” Our adolescent years, a time of life filled with challenges that can strengthen who we are, can be challenging for sure. But the great news is that with increased self-awareness of our emotional and social lives, and with an increased understanding of the brain's structure and function, the powerful positive effects of the complex changes that occur during adolescence can be harnessed with the proper approach and understanding.

Making Decisions

Throughout adolescence, different areas of the brain link together, a process we've discussed called “integration.” One outcome of integration is the growth of fibers of cognitive control that ultimately decrease impulsivity. As a result, adolescents are afforded more and more space in the mind to pause and consider other options of response than an initial impulse. Another outcome of this integrative growth is sharpened gist thinking, whereby the adolescent is able to rely more and more on intuition to see the larger picture of a situation and therefore make wiser decisions.

Let's see how a better focus on developing gist thinking in our earlier example of the car accident might have helped a teen make better decisions, decisions that could have saved a life. If the teen or his parents were able to acknowledge his longing for speed as a natural dopamine reward drive, then the urge could have been channeled in a constructive way. There are many options, including taking part in athletics where competition and speed and power are parts of the sport—racecar driving, running, bicycling, skiing—risky and adventurous activities that don't put innocent bystanders in harm's

way. For example, when my son was in his early teens, we'd spend hours on the weekends racing long skateboards down closed multi-level parking garages at the university where I work. When we'd get to the bottom, we'd take the elevator back up and race down again. Having helmets on and wearing hard gloves to keep our skin from scraping on the concrete as we made those sharp turns helped minimize the damage to our bodies, most of which I seemed to get, not him. There's nothing wrong with the drive for thrills—the issue is how to harness those drives so as to minimize harm to oneself or others. The idea here is to respect the dopamine-driven need for speed or other risky activities, but then channel this drive in helpful ways. If we can instill awareness of the positive sides of these drives, and then find constructive approaches to addressing them, tragic outcomes like my teacher's death might be avoided. Not only might Bill still be alive, but the young man would not have the burden of living with the feeling of responsibility for that accident.

Sadly, instead of addressing a potentially dangerous problem with their son, his parents may have unintentionally rewarded his earlier risky behavior with a brand-new car. So why wouldn't he try something dangerous again? That's how risky behavior without a negative consequence can reinforce itself to happen again and again. Many of us know of other examples of reckless teen behavior that went unaddressed: driving a car without a license and losing the ability to drive later on, taking the chance of having unprotected sex and risking getting a disease or getting pregnant, trying combinations of street drugs without knowing their potentially lethal effects, or getting a tattoo from a disreputable source and risk getting hepatitis. There are even more minor risks, like not taking the time to sleep before an exam because you are talking with friends on the phone late into the night, or getting lost in social media and posting an insulting com-

ment about someone's looks or a drunk party photo of yourself that a college admissions officer later sees. In all these situations the teen is seeing the PROS and de-emphasizing the risks. That's the positive bias of the adolescent mind.

Honoring the important and necessary changes in the adolescent mind and brain rather than disrespecting them is crucial for both teens and their parents. When we embrace these needed changes, when we offer teens the support and guidance they need instead of just throwing up our hands and thinking we're dealing with an "immature brain that simply needs to grow up," or "raging hormones in need of taming," we enable adolescents to develop vital new capacities that they can use to lead happier and healthier lives.

Gist thinking emerges with both experience and programmed brain development. In other words, the timing of the development of the brain is shaped by both experience-induced neural activation and by genetic information. Experience shapes the connections in the brain itself even if it cannot affect the general timing of such maturation. And studies suggest that gist thinking emerges from the growth of integration in our brains as teens. The timing may be in part genetically determined, but we can shape the degree of development of integration in our brains. Experience shapes our development during our adolescence and the rest of our lives. And experience can promote more integration in the brain, more connecting of its different parts so that they work in a coordinated manner. So how we set up our lives and the contexts we live in, what we do and whom we are with, can shape not only how the brain is activated but also how the brain will grow its integrative circuits. For these reasons, knowing the basics about the brain can be helpful in our lives because we can shape our brain's growth of integration in ways that are helpful for us now and for the future.

"Don't Do It" Doesn't Do It: The Power of Promoting the Positive

Gist thinking draws on the gut feeling and heartfelt sense of a positive value, of aiming *for* something rather than inhibiting something. So instead of trying to shut down an impulse by inhibiting it, adults with adolescents in their lives and adolescents themselves should focus on a positive factor to promote. Choosing not to get a tattoo at an unknown place because you value your health is very different from saying, "I won't do it because my mother told me not to." In contrast, hyperrational thinking considers the impulse and senses the reward drive to realize the positive thrill, the sensation-seeking speed-driven adrenaline rush of getting a tattoo with some friends. And it doesn't hurt that you are also breaking your parents' rules.

Public health advocates' efforts to reduce teen smoking are powerful examples of how appealing to the adolescent's emerging strength in terms of gist thinking can help promote healthy behaviors. The adolescent period is, as we've seen, a time of great vulnerability to becoming addicted to various substances, including cigarettes. It's not just that teens smoke more, but also that the changing teen brain itself is open to becoming addicted in part because of its enhanced dopamine response. If people are going to smoke cigarettes, they most likely start during their teenage years. The same is true with drug addiction. The most effective strategy to get adolescents to avoid smoking was not offering teens medical information or trying to frighten them with images of graveyards, two strategies that did nothing to reduce teens' taking up smoking or continuing to smoke. The strategy that worked was to inform them about how the adults who owned the cigarette companies were brainwashing them to smoke so that they could get their money. Rather than getting

teens to say no to smoking because some adult was frightening them into it, this strategy focused on the positive value of being strong in the face of manipulative adults out to get rich. When this embracing of how the adolescent mind worked was taken up by public health advocates, the rate of teen smoking dropped. Simply saying "Don't do it" wasn't enough. Aiming for a positive value, like not letting someone—especially an adult—brainwash you, worked.

Knowing about these understandable and genetically based changes in the teenage brain can help adults support the adolescent's need for pushing back on the adult status quo and the exploration of new possibilities. Encouraging the reflection on values and on gut instinct, not simply the inhibition of impulses, is the difference between turning down a compelling impulse and embracing a thoughtful belief and value.

Integrating Your Brain

In many ways, how we decide to do things in life reveals who we are at that moment. When we understand how the brain changes during our adolescence, we can understand how the decision-making process changes, too. The brain changes during this period in two dimensions. One is how it *reduces* the number of the brain's basic cells, the neurons, and their connections, the synapses. This decreasing of neurons and synapses is called "pruning" and appears to be genetically controlled, shaped by experience and intensified with stress. How can we tolerate losing some neurons? During childhood there is an overproduction of neurons and their synaptic connections. The blossoming of our neuronal populations begins in utero and extends to our prepubertal period, to about eleven years of age in girls and twelve and a half in boys. Some pruning begins early as

we learn and develop skills, but the removal of our overall number of neurons and their connections reaches its peak during the robust remodeling period of adolescence. In adolescence we prune those excess connections away, leaving the ones we've been using and discarding the ones we don't seem to need anymore.

Experience shapes which neural circuits—the neurons and their synaptic connections—will be pruned away. So if you want to have a musical skill, best to start it early, before the end of adolescence. And if you want to be a gold-medal Olympic athlete, best to start in your field before adolescence begins. Even if you're not aiming for athletic prowess, it's simply important to remember that your brain will respond to how you focus your attention in your activities. Attention streams energy and information through specific circuits and activates them. The more you use a circuit, the stronger it gets. The less you use a circuit, the more likely it may get pruned away during adolescence.

How you focus your attention throughout life, and especially during the adolescent period, plays an important role in shaping the growth of your brain. Attention maintains and strengthens existing connections, and as we'll see, it helps grow new connections and make those connections more effective. Our mindsight tools sections are all about learning to focus your mind's attention to integrate your brain's connections.

A second way the brain transforms during this period is that it lays down "myelin," a sheath covering the membranes among interlinked neurons. This myelin sheath enables the passage of the electrical flow, the "neuronal activations" among the remaining linked neurons, to allow faster and more synchronized information to flow. When that flow is fast and coordinated, it makes for a more effective and efficient process. As we learn specific skills and acquire knowl-

edge, we grow new connections and even new neurons. Once we've established these new synaptic linkages, we can lay down myelin to make that circuit quicker, more coordinated, and more effective.

These two fundamental changes—pruning and myelination—help the adolescent brain become more integrated. Integration, the linking of different parts, creates more coordination in the brain itself.

We develop gist thinking as this pruning and myelination creates integration in the brain.

These more precise and efficient connections in the brain make for wiser judgment and discernments based not on the small details that are without a larger context but on the overall gist that sees the big picture. We use our intuition to guide our decisions as we aim for positive values, honoring what matters to us. That is gist thinking, one of the many things that the growth of integration in the brain during our adolescent years creates.

As we'll see, the very specific forms of change in the architecture of the brain enable us as adolescents to start to use judgment based on gist thinking, which is informed by experience and intuition rather than reliant on the reward drive and the literal calculations of our earlier years.

Think of it this way: With those neural connections from childhood that were so numerous, lots of details filled our minds. That's what we needed as children soaking up facts and figures from school. With adolescence, we have an increased reward drive and increased emotional reactions and increased sensitivity to social engagements. This combination means that we'll have lots of details still filling our minds before pruning, and intense emotions and heightened concern about our acceptance by peers will drive either impulsive behavior or reward-driven hyperrational decision-making that is based mainly on literal calculations. The upside of this period of functioning is the

positive bias we need to take the necessary risks to get ready to explore the world as adolescents. From a decision-making perspective, the process looks like this: Details without perspective from experience win the day as probabilities are assessed and the Russian roulette gun is fired. Chances are most likely that all will be fine. But sometimes it is not. Just think of some of the things you may have tried in your younger years, or what you are trying out now. When you think about those risks you took, you may even shake your head in disbelief that you actually did those things. If your gist thinking and intuitive wisdom are at work, you may reflect on those times and wonder what in the world you were thinking. Now you know.

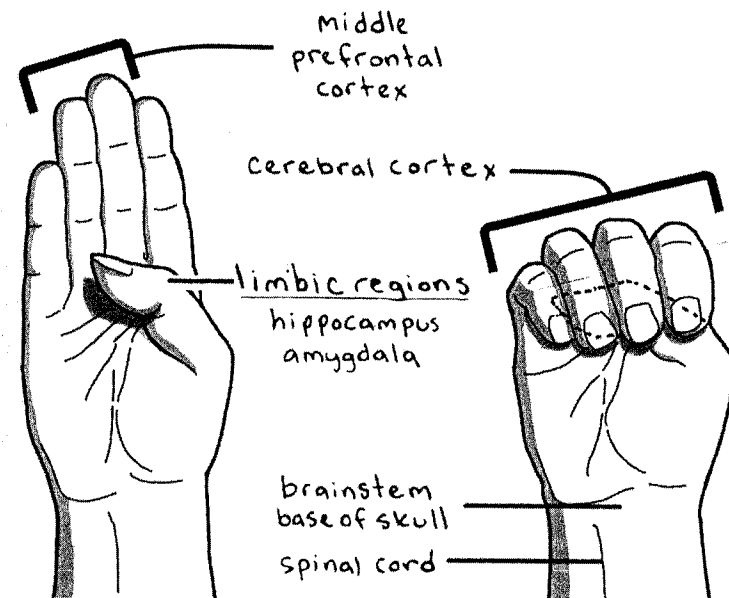
We can see why parents can be very concerned about the adolescent tendency to seek thrills. The tripling in accidental injuries and mortality during this otherwise very healthy period is not just in a parent's imagination; it is a statistical fact. It may be hard for you as an adolescent to have empathy for what your parents are facing, but in the big picture this understanding may be helpful not just for them but for you, too. When you communicate with your parents about these statistical matters, and then deal with your individual needs and plans, everyone can feel heard and more effective ways of coming to a decision can be created.

We need to increase our communication about these issues, honoring the healthy and necessary essential aspects of our adolescent years and learning to channel this power in more helpful ways. Knowing about the specific circuits in the brain that create this more integrated way of functioning can help us envision a more constructive approach to how we live and make our decisions as adolescents and as adults.

A Handy Model of the Brain

The reason to know some basic details about the brain is simple. When we know something about the parts of our brains, we can learn to direct our attention in new ways that help those parts work in a more coordinated and balanced way. What we know about the brain can help us grow our brains in integrative ways. That's it. And that's pretty useful.

We will look into the brain not only because it is what is chang-



Handy Model of the Brain

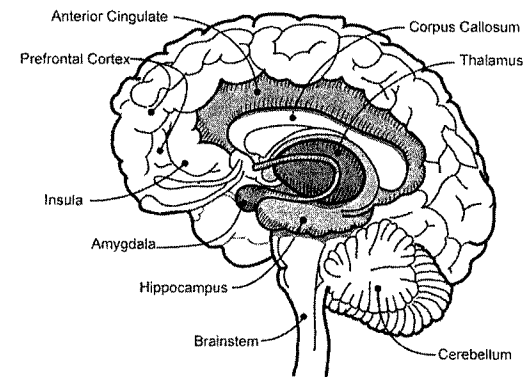
The brain in the palm of the hand. This "handy model" depicts the major regions of the brain: cerebral cortex in the fingers, limbic area in the thumb, and brainstem in the palm. The spinal cord is represented in the wrist. From Daniel J. Siegel, M.D., *The Developing Mind: How Relationships and the Brain Interact to Shape Who We Are*, copyright © 2012 by Mind Your Brain, Inc. Adapted with permission.

ing in us as adolescents, but also because knowing about it can help us optimize the opportunities of adolescence. This understanding can help you think, feel, and behave in ways that help you get along better in your life, feel better, and be more the person you want to be. We won't need a plastic model or big poster of the brain for this exploration. We're about to get to know a very handy model of the brain, one you can take with you wherever you go.

If you fold your thumb into your palm, and then fold the fingers over your thumb, you'll have facing you a useful hand model of the brain. Give it a try right now and let's see how these parts fit together. In this model the area of your fingernails facing you is just behind the face—and the back of your hand is where the back of the brain at the back of your head would be.

The highest part of the brain, represented by your fingers, is just under your scalp within your skull. This is the *cortex* or outer bark of the brain. We think and reflect, perceive and remember, plan and make decisions with our cortex. Awareness comes, in part, from what happens in the cortex, and so self-awareness comes from this cortical region. If you lift your fingers, you'll see below them the thumb, which represents the emotion-generating *limbic area* of the brain. The limbic area is in charge of a lot of things, including what motivates us, how we focus our attention, and how we remember things. Lift the thumb, and you'll find in your palm the lowest and oldest area of the brain, the *brainstem*. This ancient region is involved in keeping us awake or letting us sleep. And it's the part of the brain that can interact with the thumb region above it, the limbic area, to create reactive states of being angry or scared. Since the brainstem and limbic areas are below the cortex, we call these the "subcortical regions." Lift your fingers and put them back over the thumb and palm and you'll see how the cortex literally sits on top of these two subcortical regions.

The brain itself sits atop the spinal cord, represented by your wrist. Input from this neural tube within the backbone, along with other neural inputs from the body and from the body's organs such as the heart and intestines, enables the processes of our organs, muscles, and bones to directly influence the neural firings in the skull itself, neural activity within the subcortical and cortical parts of the brain. Not represented here directly is the *cerebellum*, which would be just behind the limbic area and plays an important role in balancing the body's motions and also balancing the interaction of our thoughts and feelings. A band of neurons, called the *corpus callosum*, links the left and right sides of the brain to each other and coordinates and balances their activities.



This is a leftward-facing model of the right side of the brain. The brainstem and the cerebellum are part of the "hindbrain" and regulate basic processes like heart rate and states of alertness. Connecting the two sides of the brain is a band of tissue called the corpus callosum. The amygdala and hippocampus, which are part of the old mammalian region called the limbic area, form the "midbrain" and help with functions such as emotional balance and memory processes. The cortex, also known as the "forebrain," makes representations or images of things. The front-most part of the cortex is the prefrontal cortex, which coordinates and balances the functions of many areas by linking input from the cortex, limbic area, brainstem, body, and social interactions. The insula is a circuit that connects bodily processes to the prefrontal area for self-awareness. From Daniel J. Siegel, M.D., *The Developing Mind*, 2nd edition, copyright © 2012 by Mind Your Brain Inc.

The cortex helps us be conscious in our lives, to think clearly about things, to assess a situation and reason through it, to remember other events, and to pause and reflect on what is going on. Those are a lot of important functions, and it's why the cortex, especially the front part, is called the executive region. It is the master control center that coordinates and balances the whole brain and the body itself.

The forward part of the cortex, the frontal lobe, develops a lot during infancy and toddlerhood, and it continues to grow during the remainder of childhood. When our adolescence begins, even more dramatic changes in this frontal region occur. The reason this area is so important is that it participates in the linkage of different neural regions to one another. In this way, the cortex has an integrative role as it coordinates and balances much of what happens throughout the brain, and even in the nervous system throughout the body as a whole.

As we'll see, the frontal areas of the cortex also link our own neural firing to the activity of other nervous systems, to other brains within other people. In this way, the frontal area is involved in both the shaping of our own internal mental processes such as thinking and decision making as well as the social processes such as empathy and moral behavior. So when we speak about changes in the adolescent brain, we'll see that many of these important changes involve increasing levels of integration, especially carried out in the cortex. This increased cortical integration enables such diverse abilities as cognitive control, emotional regulation, gist thinking, self-understanding and social functions to change and emerge throughout adolescence.

One of the central hubs that link the nodes of our larger cognitive, emotional, and social networks of circuits into a functional whole is in the frontal region of the cortex. A network contains

many different parts, or nodes, and a hub is the aspect of the network that links those different nodes to one another. A node in the nervous system, for example, might be collections of neurons in the limbic area or in the cortex. One important nervous system hub that links the nodes together is just behind the forehead. Because it is at the front of the frontal areas, it is called the prefrontal cortex. Notice how in your hand model this integrative prefrontal region, located at the ends of your fingers, your prefrontal-fingernail region, connects the cortex to the subcortical limbic-thumb and brainstem-palm regions. In addition, this prefrontal region links input from the body itself and from other people. Energy and information from the cortex, limbic area, brainstem, body, and social world are coordinated and balanced by the prefrontal region. It is this integrative role, connecting and coordinating many differentiated inputs, that makes the growth of the prefrontal cortex so central to our understanding of how we change and become more integrated as adolescents.

Adolescence as the Gateway to Creative Exploration

In a nutshell: The overall movement of the brain's development is to become more *integrated*. What that means is that areas will become more specialized and then interconnected to one another in more effective ways. That's what the pruning down of connections and the myelination of remaining connections create—the differentiation of specialized regions and then their coordinated linkage. The result of such a process is to have more efficient and specialized processing of information. This is consistent with our discussions of the gist-based thinking that sees through all the details to find the wisest

judgment about a situation. What are the basic ways such a transformation of thinking can occur? What are the basic units of the brain's structure that support such reconstructive and integrative changes in adolescence?

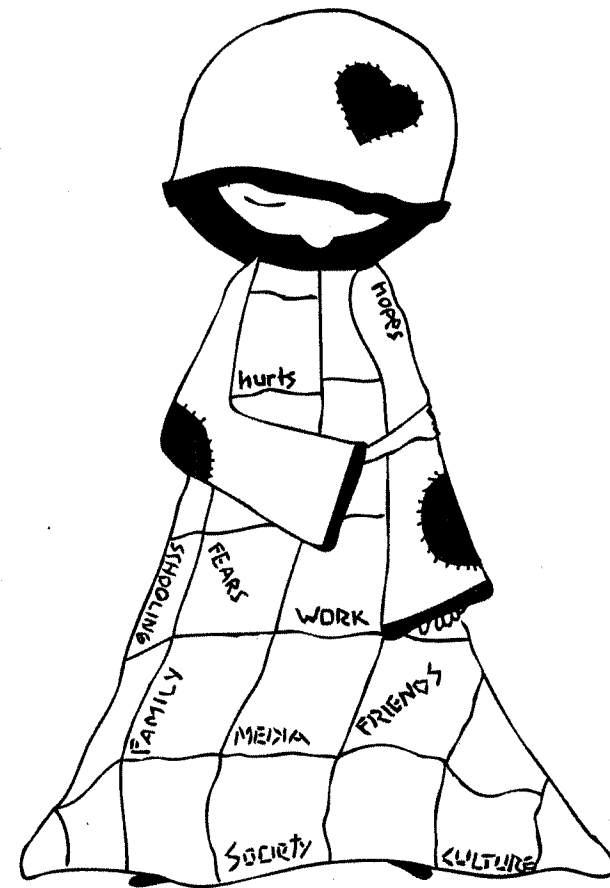
As we've seen, both our genes and our experiences contribute to how synaptic connections will form and interconnect the various parts of the network into circuits. What this means is that the changes in the brain will be due in part to genetic information we've inherited and in part to experiences we engage in. Experience streams energy flow through particular neurons and strengthens their connections with one another. It is important to know about our neuronal connections because they shape how we feel, think, reason, and make decisions.

Because this pruning and myelination restructures the brain's networks of connections, it is often called "remodeling." The remodeling changes in the integrative frontal areas of the cortex are responsible for the finding that as teens we begin to become aware of ourselves and to think about life in conceptual and abstract ways. Our emerging adolescent minds begin to consciously and creatively explore the deeper meanings of life, of friendships, of parents, of school, of everything. Even the ability to reflect on our own personalities emerges during the years of adolescence. While genes determine some of the timing of these changes, experience—what we think about, what we discuss with friends, how we spend our time—will help expand on this new way of thinking about the world. For example, some teens may not engage in such reflective thoughts or conversations with their friends or with their family. In this situation, their interpersonal experience of cultivating self-awareness may not be so well developed.

What we focus our attention on and what we spend time doing

directly stimulate the growth of those parts of the brain that carry out those functions.

Rather than the concrete way of thinking and the fact-based learning that dominates in children during the elementary school years, the learning curve for us as teens involves a focus on more complex concepts. Our literal experience of being aware of life ex-



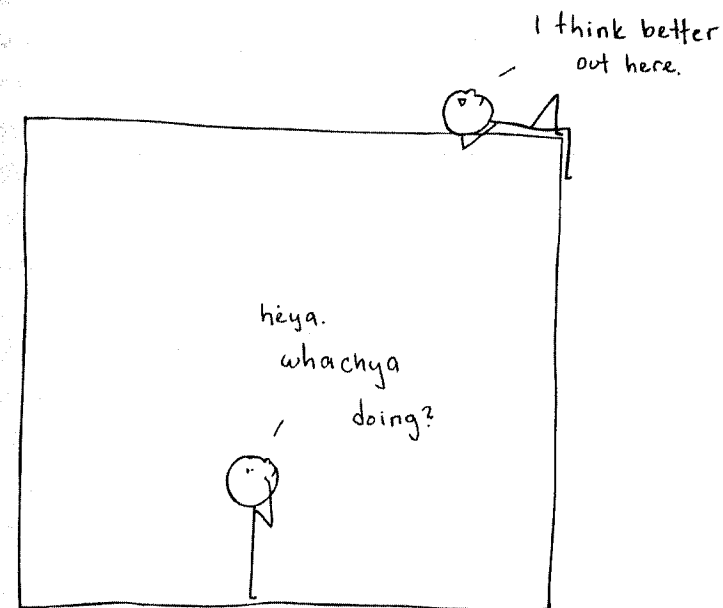
who's under there?

plodes with new visions of what is real, visions that in childhood may not have even crossed our minds. This is why adolescence is such an amazing time. The growth of the frontal lobes permits us to experience our human ability of knowing about knowing—of reflecting on how we think, how we feel, why we do what we do, and how we might do things differently. As Dorothy said in *The Wizard of Oz*, “We’re not in Kansas anymore.”

I remember that when I was a teen, this new awareness was overwhelming. I went from smiling a lot during my childhood to being more grumpy, more inward, more confused and pensive. When I first hit my teens, my father would ask me why I didn’t smile anymore, and I just didn’t know what to say to him. When I got older, I saw the film *Harold and Maude* with some friends and couldn’t stop thinking of Cat Stevens’s lyrics in the classic song “If You Want to Sing Out, Sing Out”: “Well, if you want to sing out, sing out. And if you want to be free, be free.” There were a million things I could be, the song said, and I could do whatever I wanted, I could make things come true. I used to sing it in my head, over and over; it played like an endless tape. When I listen to the song now as an adult, I can see that those lyrics capture the essence of our journey into those teen years. It’s a coming-of-age song, of letting adults go into the background as we create a new world as adolescents.

This emergence of the adolescent mind is our birthright as human beings.

Our species name is *Homo sapiens sapiens*. *Sapiens* means “knowing.” So with the double knowing we are the ones who not only know, but *know* we know. And this knowing we know emerges first in adolescence. Creative and conscious explorations of conceptual thinking and abstract reasoning enable the brain to approach old problems in new ways. A fifteen-year-old isn’t simply a ten-year-old with five additional years of experience. Brain development means



that as adolescents we can think in conceptual and abstract ways a ten-year-old cannot even imagine. One aspect of this exploration can be divergent thinking, a way of approaching problems creatively to “think outside the box.” We can approach problems in new ways, and we can approach our self-understanding in new ways never before possible. This creative exploration encompasses ways of perceiving and reasoning and problem solving with abstract capacities and thinking strategies and reflective capabilities that permit us to tackle life’s challenges in more innovative ways.

The changes in how we think and expansions in our awareness are because of the brain’s remodeling and are a healthy part of our adolescence. The reconstruction of the cortex enables conceptual thinking and creative explorations to emerge and blossom.

With this expanded capacity of consciousness, we are entering a potentially new way of approaching the world and how we fit into

it. Instead of the old pattern of just going along with earlier knowledge sponged up from adults when we were elementary school-aged children, as adolescents our brains now permit this new form of thinking that can challenge old ways of doing things. This new conceptual thinking even enables us to see that the old way of doing things embedded in our brains is just one approach—and we can now come up with another approach that may be just as good or perhaps even better.

The power of the adolescent mind emerges from these brain changes, which permit us to solve problems in new and innovative ways. We might even say that this is also the primary work and purpose of the adolescent period—the essence of adolescence.

As we've seen, many revolutionary ways of interpreting and shaping our world—in music and art and in the recent creation of our digital age—emerge during the emotionally vibrant, socially connected, novelty-seeking adolescent period. Adolescence is a golden age for innovation because it is during this time of growth and change that the brain's developmental shifts in the reward centers and in the cortex encourage creative thought and drive adolescents to explore the world in new ways.

So abstract and conceptual thinking, increased reward drive, and enhanced novelty seeking are three sources of the potential and passion for creative thought. These capacities need to be blended with disciplined study, naturally, to allow knowledge to inform innovation.

Yes, these years can be challenging to navigate because in addition to innovation, they also involve risk and rebellion, as we've seen. Impulsivity and hyperrational thinking enable us to drive too fast, take on unnecessary risks, and endanger ourselves and others. We jump off cliffs into the sea and get hurt. But there is a middle ground,

a place to honor the drive for novelty and the creation of new explorations. If we as adults push back severely against these natural changes, rejecting adolescents as they reject us, the result can be a shutting down of all communication between the generations.

The call is to increase empathetic understanding and respectful communicating, creating integration across the generations.

Just as when adolescent elephants are deprived of their male elders in a herd and then run wild and become destructive without the adults' presence, total isolation of adolescent humans from the adult community can be an unhelpful standoff. Technology's products—cars, synthesized drugs, weapons, the worldwide web—make the stakes higher. So an important lesson for adults and adolescents is this: Adolescents' pushing away is not the same as shutting completely out. If both sides of the generational divide understood each other more fully, perhaps these important years of innovation and transition could be navigated better, helping adolescents grow into the people they have the power and potential to become.

Our challenge, simply put, is to see the power and potential of the teenage brain and the emerging adolescent mind as assets rather than liabilities.

Creating Collaboration Across the Generations

In middle school, my son and his fourteen-year-old band mates once stacked up all the amplifiers in their music practice room to see how huge a “wall of sound” they could make with all the instruments being played at the same time through the same system. On the floor above the practice room were the school's administrative offices. Needless to say, the nearly shattered windows in the building were

an incentive for the head of the school to come down on my son and his friends with severe consequences. One of those consequences was to bar them from using the practice room for three months. The result was that those adolescents, not being able to have their creative outlet of music at school, started doing even more egregious things. The cycle of pushing back by the teens and then pushing back by the adults began. At a meeting, I suggested that the administrators, as the adults in the cycle, try to see through the vicious feedback loop and consider the drive for novelty and exploration that the amplifier-stacking experiment was really meant to be.

Fortunately, one of the administrators remembered her own brother's experience of a similar cascade of events. She suggested they try a different approach. The school administrators brought the band mates in, told them the negative effects of their actions, gave them back their privilege of using the practice room, and said they could keep that privilege if they didn't violate the basic rules of the school. All of their "conduct problem" behavior disappeared for the next five years.

The key to this creative solution was honoring the natural adolescent drive for innovation and the creation of new ways of doing things. Honoring does not mean setting no limits. It means acknowledging the intention behind the actions. Adolescence is all about experimentation. If adults shut that down, the passion for novelty will be thwarted, the teens will become disillusioned and disconnected, and no one will benefit. I felt grateful that those administrators could think in creative and collaborative ways, as they drew on the essence of their "inner teenager," to come up with a developmentally appropriate, behaviorally and psychologically effective plan. They understood that the waterfall was going to flow, so they used their adult skills to channel its path. It was a win-win situation for everyone. And the band went on to create and perform some really fine music.

Sometimes as adults we see the adolescent drive toward experimentation to create novelty as only a negative change, as only a problem, as a sign of teens being "crazy." As an adult and as a parent, I understand the idea behind this sentiment. But perpetuating the notion that these natural and healthy pushes toward novelty mean teens are only "out of their minds" is not a helpful message for anyone. We are moving out of our old minds and into new ones as adolescents, and our adolescent mind is full of positive power and the potential for creativity. And this power is something we all need to honor. The key as an adolescent or as an adult is to tap into that potential and help cultivate that power.

Vulnerability and Opportunity

Adolescence can be seen as a transformative period in which individuals go from being open to everything (in childhood) to becoming expert at a few things (in adulthood). We've seen that one aspect of this remodeling is pruning, or letting go of the connections in the brain that are not needed. Pruning in general can lead to important changes in how we function as teens—and sometimes it can unmask potential problems. This is why a number of mental health challenges, like mood difficulties such as depression and bipolar disorder, or thinking difficulties such as schizophrenia, may emerge more in adolescence than in childhood. Pruning, along with hormonal changes and alterations in how genes are expressed, shapes our neural activity and synaptic growth and makes the brain's functioning change dramatically during the teenage years.

If there is any vulnerability in the brain's makeup during childhood, adolescence can reveal those brain differences because of the paring down of the existing but insufficient number of neurons and

their connections. Such vulnerability may have a wide array of causes, from genetics to toxic exposures to adverse childhood experiences such as abuse or neglect. This developmental view proposes that the vulnerability of the adolescent period happens because the pruning of childhood circuits that may have been "at risk" leads to the unmasking of those deficiencies. The new activation of genes during adolescence, which shape how neurons grow and how they interact with other neurons, may also influence the vulnerability of a teenager's brain. Even if average pruning occurs, what remains may be insufficient to enable mood to be kept in balance or for thought to be coordinated with reality. If stress is high, this pruning process may be even more intense, and more of the at-risk circuits may be diminished in number and effectiveness. The result is the unmasking of underlying vulnerability during the pruning of adolescence. The brain's integrative growth will not occur optimally, and depending on which circuits are affected, impaired coordination and balance in the brain can happen.

During high school and the college years, major psychiatric disorders, such as depression, bipolar disorder, or schizophrenia, can express themselves for the first time, even in otherwise well-functioning individuals. When mood or thought becomes dysfunctional, filled with rigidity or chaos that disrupts adaptive functioning for long periods of time, it is possible that a teen is experiencing not simply the unavoidable intense emotions of adolescence but something more. Perhaps there is simply a period of impaired integration during remodeling in the brain that temporarily leads to such chaos and rigidity and further development may correct that impairment. But sometimes that onset of severe behavioral issues is the sign of a disorder that may be appearing and that needs evaluation and treatment, as with a mood disorder, a thought disorder, or an anxiety disorder

with obsessive-compulsive or panic behavior. Since some of these serious psychiatric conditions go along with suicidal thoughts and impulses, seeking help to figure out the significance of such changes in yourself, in your friend, or in your teen, can be extremely important. I myself have a friend whose daughter developed such a mood condition in college, and no one in the dorm helped her find support. She was just called "nuts" and became isolated, and no one reached out to help her until it was too late.

Naturally, with impaired integration in the brain, the mind will not be as flexible or as resilient. Sometimes that lack of integration can respond to therapy with a psychotherapist, sometimes it may also require a medication, but always it should begin with an open mind and a good evaluation. When your own mind stops working well, it can be very distressing for yourself and for others. And the stress of having a tumultuous mind can itself create more stress. Here, remodeling has uncovered an underlying vulnerability, and the dysfunction that ensues from the impaired integration may create its own intensification of the pruning process. This is why getting help can be very important to reduce stress and reduce excessive pruning. The key that is being explored now in research is how this pruning process, intensified by stress, may create inadequate ways in which the connections in the brain can function.

Clearly, early interventions to create a stable life experience for the individual and reduce stress are essential to support the healthy growth of the brain during this period of change and development. This is not an "all-or-none" proposition in which a genetic vulnerability always becomes a psychiatric disorder. The reality is far more complex. Even identical twins who share the same genetic makeup do not have one hundred percent probability that both of them will develop a disorder. Experience plays a big role in how the brain de-

velops, even in the face of genetic or other risk factors. We can look at genes and other important variables as some of the many factors that contribute to a larger picture of brain growth. Genes may influence some aspects of neural growth, but there is a much fuller set of factors that contribute to our well-being than genetics alone. How the mind unfolds, how relationships are supportive, how people feel a sense of belonging to a larger group all influence how the brain achieves and maintains integrative development at the root of our pathway toward health.

During adolescence, the pruning and myelination and the remodeling that they create happen primarily in the cortical regions. While one of those areas is the prefrontal cortex, it is important to keep in mind that this most forward part of the frontal cortex is not super-special by itself; it is more accurate to say that the prefrontal region and related areas are important because they coordinate and balance other regions of the brain. In this way, we can say that the prefrontal cortex is integrative as it links differentiated areas to one another. This integration enables the “whole to be greater than the sum of its parts.” With this integration we achieve more complex and useful functions. As we’ve seen, examples of these include self-awareness, empathy, emotional balance, and flexibility.

As the prefrontal region serves as a master integrative hub, what some might call a master control center or an executive region, its rewiring during the adolescent period permits a more extensive form of integration to be achieved in the transition from childhood to adulthood. As we’ve noted earlier, this hub is both for the networks within the brain and body as a whole, and for the networks of interconnecting brains we call relationships. Here we see how the integration of our inner networks and our interpersonal networks shapes our experience of mind. The mind is embodied within us and it is embedded between us. Our mind is within us and between us.

The Remodeling Brain and Flipping Our Lids

Under the active influence of various drugs including alcohol, our minds can stop functioning well because our prefrontal region is no longer able to carry out its coordination and balance of the streams of information from within our bodies and from the outside world. While various drugs can shut off our brain’s integrative functioning in the short run and chronic drug usage can distort that coordination and balance in our lives in the long run, we can also be prone to losing integration in other ways that don’t involve drug use. Sometimes we can simply “flip our lids” and have the prefrontal integrative fibers of our brains stop coordinating our whole system. Since the prefrontal area is in a state of reconstruction during adolescence, it may be especially prone at certain times to temporarily lose its integrative functioning in linking separate areas to one another.

Even when we are developing well, sometimes during this remodeling period the prefrontal region’s ability to carry out the coordination and balance of its integrative role may not function optimally. Remodeling in the brain is a necessary part of its development and builds integration through the adolescent years. This remodeling involves different phases, with females and males undergoing pruning and myelination in different regions at different times. And remodeling is energy consuming. But while trajectories do differ between the genders, where this remodeling process ultimately ends up is actually quite similar across the genders.

The brain functions in a state-dependent way, meaning that while it is in a calm state, certain integrative functions may work well and efficiently. But in other situations, those same functions may not work so well. For many of us, by the middle of adolescence, when we are away from our peers and our emotions are in balance

we can be as efficient as adults. But under settings with increased emotion or in the presence of peers, reasoning can become skewed. The context we are in and the internal emotional state of our minds directly shape how sensitive we are to losing certain functions. This can be interpreted as being “too emotional” or “too swayed by peers,” but another view is that our emotional sensitivity and interest in peers is adaptive. This is not immaturity but a necessary step in human development. We need to listen to our peers in order to become a part of that vital survival group as we leave our family home.

From a family point of view, this increased emotionality and social influence can become disruptive to life at home. An extreme form of this is when we get really agitated and “flip our lids” or “fly off the handle.” Such a state of non-integration can happen abruptly in anyone, but in our early adolescence we may be especially prone to being this way under certain conditions, as when our parents interrupt us when they know we are busy, or when a friend does not call even though she said she would.

If you put your hand model together and then suddenly lift up your fingers, you’ll see the anatomic way we can symbolize how we lose the integrative role of the prefrontal cortex. Without the calming influence of that cortical region, sudden outbursts of limbic lava and bursts of reactivity—the ancient reactions of fight, flight, freeze, or faint—can emerge suddenly, sometimes without warning to anyone. These are our early, primitive, subcortical reactions to threat. Since the cortex is a center for awareness, these lower brain areas can become active without our conscious mind’s knowing what is stirring deep inside the brain. Then *wham!* Out comes a set of reactions we didn’t even know were cooking inside us. Sound familiar? It happened to me a lot when I was a young teen. And it can certainly happen to us as adults, too. It is at these moments when a vulnerable prefrontal cortex is not at the top of its game monitoring and manag-

ing the subcortical world that such “low road” reactions can erupt. If we haven’t slept well, haven’t eaten, are under pressure, or feel some underlying emotional agitation, the prefrontal cortex’s calming influences may not work so well and we can flip our lids. Adolescent or adult, this is a part of being human.



Now, when it comes to teenagers, this flipping one’s lid is often seen as being a “crazy teenager.” But let’s make an agreement not to call this crazy; let’s call it what it is—remodeling and shifts in integration. In a construction site, sometimes the previously working plumbing and electricity are temporarily disabled. We don’t have to call that a faulty building—it’s just a reconstruction project. Remodeling has its inevitable downsides, for sure. For a short time, or for bursts of time, those utilities on the construction site are off-line. No effective electricity, no plumbing, no workable staircase. These are all temporary shifts in what works well. The good news is that remodeling is a process that will create new and improved ways of functioning. Remodeling is necessary to adapt the structure of our neural foundation to adjust to new needs, and remodeling in adolescence is necessary to adapt our human family to the new needs of a

changing world. New levels of integration are being created and new capacities are being established and strengthened. Remodeling constructs new integration.

That said, sometimes the remodeling comes with challenging ways of thinking and feeling and interacting that are par for the course in neural remodeling.

The reconstruction zone of the prefrontal cortex in particular means that many of the functions that this frontal area of the brain enables through its integrative role—balancing emotions, planning for the future, having insight and empathy—are more easily thrown off-line with intense emotions and peer influence. They may be more fragile, more easily disrupted, than they will be in the years ahead. In fact, one of my friends, whose son is a few years younger than my son, once said that it felt like night and day when his son went from nineteen to twenty years of age. After his son completed his first year of college, my friend told me that he “seemed to have returned to the world of normal human interactions.” Now what did he mean by that? His son’s balancing of emotions had been turned off, planning for the future was not happening, insight into himself—or empathy for others—seemed not to have been displayed, at least to this young man’s dad. How can we make sense of this common experience?

When you understand that the prefrontal region is necessary for each of these important functions to occur, then you can understand why the change toward a settling in after some intense periods of remodeling feels so different—likely because the remodeling period is stabilizing and the prefrontal region can do its thing.

What is that thing exactly? This region coordinates and balances the whole brain with the whole body, and even our inner networks with the social world. Yes, this region behind the forehead connects all the parts of the brain in the skull to one another, and links those functions to what is going on in the body (signals from the

heart, intestines, muscles). Then those connected signals are woven together with the input from other people. That’s a lot of integration, the linkage of different parts. So as adolescents we need to cut ourselves some slack, and as adults we need to give respect to the remodeling adolescents are going through. That doesn’t mean the shop is closed, it means we make adjustments for the fact that the adolescent mind is shaped, at times, by a construction zone.

Adolescence Builds Integration in the Brain

Take a look at your hand model of the brain. Put your limbic-thumb area over your brainstem-palm area. Those are the lower parts of the brain, the ones that generate emotion and reactivity and reward drive, among other things. Now put your fingers over your thumb, and take a look at the middle two fingernails. This is the prefrontal region. Notice how when you lift up your fingers-cortex and put them back down, you can see how this prefrontal-fingernail area is connected to the cortex; it sits on top of the limbic-thumb, and also connects directly to the brainstem-palm. In addition, signals from the body itself—from muscles and bones, from the intestines and heart—all come up to this prefrontal region, too. And if that was not enough, this prefrontal region also makes maps of what is going on inside other people’s nervous systems. That’s right! The prefrontal region maps the social world. It is this prefrontal area that creates our mindsight maps of you for empathy and of us for morality, as well as a mindsight map of me for insight.

So let’s review this now with your hand model in mind. Five separate areas of information flow are coordinated and balanced by the prefrontal region. Here they are. The cortex. The limbic area. The brainstem. The body proper. And the social world. When these

separate sources of information flow are linked together, we call that “integration.” And integration is what creates the master functions of self-awareness, reflection, planning, decision making, empathy, and even morality—thinking about the larger social good.

When the prefrontal region achieves a new state of being remodeled, those important functions become more dependable and stronger. Integration can now happen more consistently and reliably. Brain, body, and social world are woven together into one whole by the prefrontal cortex. Knowing about how this prefrontal remodeling happens can help us as adolescents and as adults not only to understand better what is going on inside the brain but to do something about it that is constructive, as we’ll soon see. In fact, the mindsight practices we’ll explore throughout the book can promote the growth of these integrative regions of the brain. Yes, it turns out that we can cultivate the growth of the integrative fibers of the prefrontal cortex. Positive interactions with others and self-reflection are two ways to increase prefrontal integration. That’s right: You can grow those fibers if you choose to learn how to do that!

The Emotional Lower Brain

Did you know that along with these prefrontal changes, the lower brain areas below the cortex (your limbic-thumb and brainstem-palm in the hand model) are more active in adolescents than they are in children or in adults? What this means is that emotions can arise rapidly and intensely without the calming influences of the prefrontal cortex. The prefrontal region can send soothing circuits, called “inhibitory fibers,” down to these lower areas and keep their firing calmed.

Brain scans reveal that when teens are shown a neutral face in

a photograph, a major area of the limbic region, the amygdala, becomes activated, whereas in adults the same photograph merely activates the reasoning prefrontal cortex. The result for teens can be an inner sense of conviction that even another person’s neutral response is filled with hostility and he cannot be trusted. A blank expression or a bump in the hallway can be interpreted as intentional, and a teen may respond with an irritated remark even if the look or bump was completely innocent. Knowing this scientific finding has helped me as a parent to understand the often intense reactions of my own adolescents to statements I made that, in my view, were pretty neutral, but they experienced as aggressive.

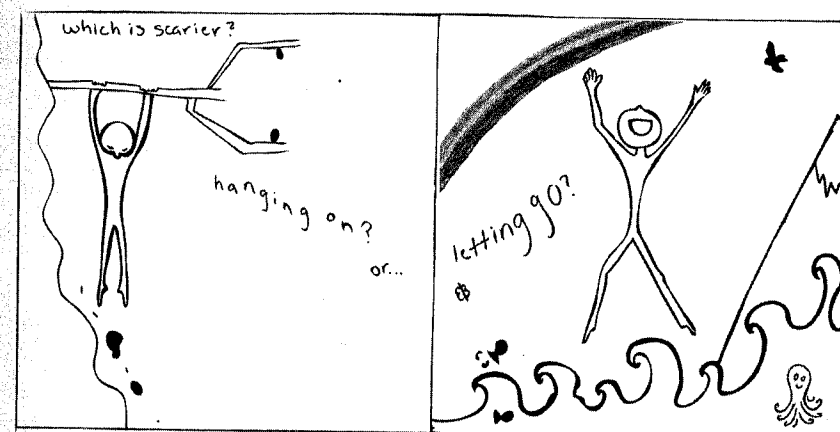
There are two routes that send information to the amygdala. One is a slow route, in which the higher cortex sifts through information, reasons, reflects, and then informs the amygdala in a calm and rational way. There’s a second route, one that bypasses the cortex and simply sends incoming streams of perception directly to the amygdala. This is the fast route. Studies of adolescents reveal that even under calm conditions, the fast route to amygdala activation often occurs more readily in teens than in adults; the slow route is used more in adults. What this means is that the intense emotions of a pure amygdala response may rise up even when nothing is shutting off the cortex, as when we’ve flipped our lids in an agitated, chaotic state or in a shutdown, rigid state. As teens we may simply have a more immediate emotional response that is not filtered by cortical reasoning. That’s the fast route in action. This is what we mean, in part, when we say that adolescence is a period of more emotional intensity, more emotional spark. The fast route to the amygdala is more readily activated during this period than it ever was, or ever will be.

For all of us, as teenagers or adults, when intense emotions erupt in our minds, we need to learn to feel them and deal with them. As Fred Rogers used to say on television, if feelings are mentionable,

they can become manageable. As we have seen in the Mindsight Tools #1, we can use the notion of “Name it to tame it.” Learning to deal with emotions means being aware of them and modifying them inside us so that we can think clearly. Sometimes we can name it to tame it and help balance our brain’s emotional intensity by putting words to what we feel. If we say the name of an emotion inside our own minds, it can help. There are even some brain studies that show how this naming process can activate the prefrontal cortex and calm the limbic amygdala! Learning to manage our emotions in adolescence is an important part of becoming independent of our parents and becoming strong in life. In the mindsight tools sections, we’ll explore the many helpful emotion-balancing strategies that can support our growth in this way during adolescence and beyond.

Hardwired for Adventure and Connection

When we compare our own adolescent period with the similar transition of other animals, we find some amazing parallels. In *Zoobi-quity*, a book on the subject of how we have a lot in common with our animal cousins, Barbara Natterson-Horowitz and Kathryn Bowers write: “A similarly lowered risk threshold—indeed, a new *pleasure* in risk taking—likely propels nearly grown birds out of nests, hyenas out of communal dens, dolphins, elephants, horses, and otters into peer groups, and human teens into malls and college dorms. As we’ve seen, having a brain that makes you feel less afraid enables, perhaps encourages, encounters with threats and competitors that are crucial to your safety and success. The biology of decreased fear, greater interest in novelty, and impulsivity serve a purpose across species. In fact, it could be that the only thing more dangerous than taking risks in adolescence is *not* taking them.”



Indeed, the natural process of moving away from the nest is filled with risk. The risk of not taking risks that Natterson-Horowitz and Bowers are referring to is that the individual will not be able to take the chances needed to leave the nest, and with such stagnation our species will not survive. Risk breathes new life into rigid ways of doing things. We can see that deep in our brain’s structure, we may have the urge to take on risky behaviors that can feel as if they are matters of life or death. For the health of our family across the generations, they are essential. And for our species as a whole, they in fact *are* a matter of our survival. The adolescent brain sets up a positive bias, emphasizing the PROS and majorly de-emphasizing the cons in order to preserve our human family.

We might be driven as well to connect with our peers, who are also moving out into the world, because in groups we can find the safety of belonging. More eyes to watch for predators, more compatriots to join in our shared journey away from home, more companions to connect to as we create a new world that is necessary for the survival of our species.

I once had a patient come into my office with his pants’ waistline beneath his rear end. It was quite the fashion a few years back (it may

still be), and it puzzled me. I couldn't stop myself from asking about it. So with curiosity, but also I believe quite respectfully, I asked, "Why do you wear your pants below your butt like that?" I'll never forget his frank response: "I need to wear these pants like this so I can be like everyone else who is trying to be different. I am trying to be like everybody else who is trying not to be like everyone else." Exactly.

So that helps us understand the situation. Teens often feel that they need one another much more than they need adults. Adolescents are our future, and it is through their courage and their sometimes outrageous but creative efforts "not to be like everyone else" that our species has been adaptive. If we are to survive on this fragile and magnificent planet, we are going to need all the ingenuity of the rebellious adolescent mind to find solutions to the grave problems that our and previous adult generations have created in this world.

As a parent, I have tried to take to heart these lessons from science about adolescence. I take a deep breath and try to remind myself the best I can that their push-back behavior is embedded not just in *their* brains but in all *our* DNA. Their push back now was our push back then, when we were adolescents. With this universal human quality in mind, the challenge at a minimum is to find a way to help adolescents navigate these years without seriously harming themselves or others. That can be a foundational goal: *At least do no harm*. After that, everything is icing on the cake. But naturally we can start there and have much greater expectations. Another central goal is to keep the lines of communication as open as they can be. This view sets a framework that can help the most challenging situations become a bit more manageable and make this period a time of collaboration as best we can across the generations.

MINDSIGHT TOOLS #2

Time-In

Want to create integration in your brain? Taking time to reflect inwardly is the science-proven way to do that. I call this taking "time-in."

We've been discussing how an integrated brain gives you a strong mind and enables you to have healthy relationships with others. If you are interested in developing integration in your own brain, taking time-in to focus your attention on your internal world has been shown in research to grow those important prefrontal fibers that integrate your life. This mind-sight tool will teach you how to grow the integrative fibers of your brain by learning how to focus your attention in very practical ways.