THE TWO PILLARS OF RECOVERY

How to Work With the Laws of Nature and Stay Sober

2. The Nervous System and Behavior

Addiction — It's ***Not*** What You ***Think***

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2. Addiction — It's ***Not*** What You ***Think***

Addiction doesn't make sense. Why would you continue to use a substance when doing so is messing up your life? Do you *want* to ruin your body and relationships? Probably not. But addiction does happen and addiction does ruin bodies and relationships. The behavior of people caught up in addiction can be so self-defeating it defies logic—especially when the affected individual appears oblivious to the self-defeating part. To understand how this can be, it helps to know a few things about the human brain and other parts of our nervous system, along with their roles in causing our behavior. By the end of this chapter you will better understand what I meant in the first article when I said, "There is more to who you are and more to why you do the things you do than what meets your own mind."

If we were together now in a room with a chalkboard, I'd draw a sketch of the central nervous system (CNS), as I have for years with groups of patients and classes of graduate students. We could talk about the functions of the various parts of the CNS as I added them to the sketch using different colors of chalk. Even though scientific knowledge about the nervous system fills libraries, I would reassure you that you can make sense of it. Plus, my objectives for you in this article are modest. I'll provide a lot of information about the nervous system, but in the end all I ask is that you remember two basic principles. First, the brain can be thought of in terms of two major regions, which I call the thinking brain and the feeling brain. Second, when it comes to the origin of behavior, lower parts of the CNS can, and routinely do, act independently of higher parts. The meaning and significance of these principles will become clear as you read on.

Since we're not together with a chalkboard, I'll describe the nervous system. You can judge whether my words allow you to visualize the subject matter. On a busy inpatient unit I was becoming more and more frustrated with that day's challenges, but wasn't letting off steam or asking anyone for help. Finally a nurse turned to me with her hand on her hip and said, "Use your words!" I've done my best to use my words here.

If my words are not sufficient, or if you simply want to see illustrations of the nervous system, consider books in the Bibliography, such as *Neuroanatomy for Students of Behavioral Disorders* by Ronald Green and Robyn Ostrander (2009), *Drugs and the Brain* by Solomon Snyder (1986, also valuable for history), and *The Human Brain Book* by Rita Carter (2009), which comes with a DVD. But be forewarned: literature about the brain and the rest of the nervous system can be confusing when you are trying to learn the basics. Regions, functions, and terminology often overlap. And the frame of reference and labels of one author may be different from those of the next. You might, for example, be interested in learning more about the brain's limbic system. Along the way you encounter a fascinating discussion about a part of the brain called the hippocampus, but miss its relevance because the author didn't mention that the hippocampus is considered part of the limbic system.

When I think of the complexity of published information about the brain and the rest of the nervous system and how difficult it can be to put together, I sometimes imagine a children's book. The book begins with a picture of a bare room. When you turn a transparent page, it adds a rug and curtains. Turn another transparent page and it adds furniture. The next page brings a vase with flowers and pictures on the wall. The last transparent page adds people and pets. You may pick up a book or article about the nervous system and discover it's like picking up just one of the transparent pages from the children's book. The context and interrelationships are hard to figure out. My advice, if you delve into this literature, is to be patient—both with the literature and with yourself. Don't be intimidated. Build on what you know as far as you choose to go.

One graduate student, reflecting on his introduction to the structure and function of the brain, was so startled by the extent of unfamiliar information that he described his first class as "a sonic boom!" But as the course went on, even he became comfortable enough to collaborate on projects with other students and apply his new technical knowledge. Don't be intimidated. Just read on.

Nervous system structure and function

In order to understand the laws of nature that govern addiction and recovery—the neurobiology of behavior, the neurobiology of addiction, and the neurobiology of recovery—you will need basic knowledge of the nervous system. Here it is.

The central nervous system (CNS) consists of the brain and the spinal cord. The peripheral nervous system (PNS) extends outward from the CNS and consists of a symmetrical network of branching nerve tissue (nerve cells, nerve fibers, and supporting structures) that carry messages between the CNS and body organs, such as muscle, skin, heart, and intestines. Sensory fibers in the PNS carry messages *to* the CNS about the status of the body. Motor fibers in the PNS carry messages *from* the CNS that direct body actions.

The *brain* is generally described in three parts: the *cerebrum*, the *brain stem*, and the *cerebellum*. The cerebrum is at the top and is dome-shaped, with distinct left and right halves called hemispheres. A deep cleft—the midline fissure—separates the two hemispheres, but not completely. They are joined at the bottom by a wide, thick band of nerve fibers called the corpus callosum. The outermost layer of the cerebrum is the *cerebral cortex*. Its surface is all wrinkled. Arching over the top (under where the connecting band of your earphones would pass if you were privately listening to music) is a deep wrinkle in the cerebral cortex called the central sulcus. Slanted indentations on both sides of the cortex are called the lateral fissures. In front of the central sulcus are the frontal lobes. The foremost parts of the frontal lobes are called the prefrontal cortex (PFC). Two inner surfaces of the PFC, called the medial prefrontal cortex, face each other across the midline fissure. Below the lateral fissures are the temporal lobes. Behind the central sulcus are the parietal lobes. The rearmost tips of the cortex are the occipital lobes.

The cerebral cortex, in a way, is where we humans live. It supports our conscious thoughts, awareness, and decision-making. Different areas of the cortex support different types of awareness. The occipital lobes support vision. The temporal lobes support hearing, expression, and aspects of memory. The parietal lobes support our awareness of bodily sensations. The gyrus (or ridge) of parietal cortex located just behind the central sulcus has been mapped so we know where on this ridge of tissue a person experiences awareness of sensations from different parts of the body. For example, the brain experiences sensations from the foot deep in the midline fissure. It experiences sensations from the face just above the lateral fissure. The frontal lobes support intellectual activity and deliberate choices. The gyrus of frontal cortex just in front of the central sulcus is called the motor cortex. Cells in the motor cortex connect to muscles throughout the body and stimulate movement. This gyrus has also been mapped so we know which regions of the gyrus control muscle action in specific parts of the body. As with the sensory map, cells deep in the midline fissure stimulate muscles in the foot; cells in the gyrus above the lateral fissure stimulate muscles of the face. The PFC supports working memory, motivation, and the initiation and adjustment of behavior.

If you could see where nerve cell activity is concentrated in my brain as I engage in different activities (modern technology such as positron emission tomography, PET scans, can do this), you would see activity concentrated in my occipital lobes if I were looking at a word; in my parietal lobes if I were running my fingers over a carving of a word; in my temporal lobes if I were hearing a word; in my frontal lobes if I were writing a word; and in my prefrontal cortex if I were deciding what word to use.

Nerve fibers for sensation and muscle action cross over. Cells in the parietal cortex on the left side of my brain experience touch on the right side of my body. Cells in the motor cortex on the left side of my brain direct muscles on the right side of my body. That's why if the cerebral cortex on the *left* side of my brain were injured, say by a stroke, I would lose sensation and muscle strength on the *right* side of my body. Because I am a right-handed male, there is about a 95-percent likelihood that the left side of my brain is my dominant hemisphere and controls my speech. Following a stroke on the left side of my brain, I might be unable to talk even though I could think about what I wanted to say.

This description of brain anatomy and function may remind you of all that is said and written about "left brain-right brain" and the characterization of people as either "left brain" and rational and analytical or "right brain" and intuitive and synthesizing. Please don't let that distract you now. Aspects of the left brain-right brain discussion are controversial, and the topic will not come up in our discussion of the neurobiology of addiction and recovery until the sixth article in this series.

The outer, wrinkled layer of the cerebrum I just described is sometimes called the "new cortex" or neocortex. It is prominent in mammals and is much less developed in more primitive animals such as reptiles. Beneath the neocortex in mammals is an inner rim, or ring, of additional cortex called the limbic lobe or limbic cortex. This structure is also considered part of the cerebrum and corresponds roughly to the "old cortex" of more primitive animals. Among other things, the limbic lobe supports the sense of smell and, perhaps not surprisingly, the limbic anatomy is well developed in reptiles with large snouts, such as alligators.

In mammals, structures in this inner region of the brain support a variety of behavioral and emotional expressions. However, the brain structures involved in these behavioral and emotional expressions include more than just the limbic *lobe*. Authors generally attribute these functions to the *limbic system*, which encompasses not only limbic lobe structures such as the olfactory cortex and hippocampus but also nearby parts of the neocortex, such as the amygdala. These inner brain structures have extensive neural connections with the prefrontal cortex, which is the region of the neocortex that supports executive functions such as experiencing expectations and making decisions.

Some authors view some or all of the PFC as part of the limbic system. The hippocampus is involved in emotional reactions, learning, and memory.

The amygdala plays a role in the sense of smell, but also generates emotions from perceptions and thoughts. Think for a moment about how certain aromas evoke particular memories and feelings. A friend of mine put this to use the first time she and her husband sold a house, though she had not heard of the amygdala at the time. If she possibly could, whenever the house was shown she would bake cookies just before the prospective buyers arrived. She created an atmosphere that made the house feel like home.

The amygdala is also associated with fear and is sometimes thought of as an alarm center in the brain. Some authors include the thalamus and hypothalamus in their definition of the limbic system but I prefer the convention of including them in the region called the brain stem.

I suppose we can only investigate and understand how human beings tick by breaking the nervous system down into separate regions and functions. But the reality is that it all *works* because of how *interconnected* everything is. The limbic system is laced to sensory and other input from below, and is laced above to areas throughout the neocortex. The limbic system serves as a link between emotion and cognition. Sometimes called the visceral brain, the limbic system is crucial to the survival of the individual because it supports activities such as feeding, fight, and flight. It is crucial to the survival of the species because it supports activities such as mating, procreation, and care of offspring.

The cerebellum is located at the rear of the brain, tucked under the occipital lobes. As with the cerebrum, the cerebellum has a wrinkled surface and anatomy experts describe it also in terms of hemispheres and lobes. Its forward surface is connected to the rear surface of the brain stem via multiple nerve fibers.

The cerbellum continues to grow well into a person’s early 20s. It is increasingly mentioned in discussions of the development and behavior of teenagers. There is evidence the cerebellum plays a role in activities of higher learning such as math, music, and advanced social skills.

The cerebellum also supports balance and coordination. When I’m standing still, my muscles are not really at rest. Constant give and take between muscle groups allow me to maintain posture. If I had a cerebellar stroke, you might try to position me on an examining table to check me out—but I would keep falling over.

We think of the motor cortex as *initiating* body movements, via nerve signals that activate muscle groups. *Coordinating* those body movements is the job of the cerebellum. Our cerebellum allows opposing muscle groups to contract and relax in balance with each other, making movements smooth and accurate. Without this function, movements become clumsy and disorganized. During a physical examination or sobriety test, you may have been asked to touch your nose, then the examiner’s fingertip, and then go back and forth. The examiner was testing the function of your cerebellum. To demonstrate the function of my cerebellum to groups of patients, I hold one arm to the side and slowly wave my forearm back and forth. I also offer to perform a few ballet moves, but (wisely) no group has taken me up on it.

Remove the petals and leaves from a flower and you are left with a knob of plant matter connected to a stalk. Remove the cerebral cortex and cerebellum from the CNS and you are left with a knob of nerve tissue, the brain stem, connected to a stalk, the spinal cord.

The shape of the brain stem is irregular, with both bulges and straight sections. It remotely resembles an upside down Coke bottle: a bulge at the top, the diencephalon; a straight section, the midbrain; another bulge, the pons; and finally a tapering neck, the medulla. The bulge at the top is made up of two structures, the thalamus and the hypothalamus. The thalamus is higher and larger than the hypothalamus. Its many nerve pathways relay detailed information to the cortex from all the body's senses except smell. The hypothalamus contains centers integral to emotional expressions including sexual behavior and rage. Hypothalamic centers also keep your body at a relatively stable temperature and regulate appetite. The hypothalamus is connected to, and controls, the pituitary gland, the "master gland" of the body's hormone system.

The midbrain conveys sensory input from your spinal cord to other parts of your brain. It also contains nearly all the nerve cells in the CNS that use the chemical messenger dopamine to communicate with other nerve cells. These dopamine-releasing cells connect, by way of a major group of nerve fibers known as the median forebrain bundle, with such areas as the frontal lobe, the amygdala, and the hippocampus. The dopamine-releasing cells affect a broad range of functions including learning, working memory, motor control, and experiencing pleasure.

The lower of the two bulges of the brain stem, the pons, is where the cerebellum attaches to the brain stem. Besides linking the cerebellum with the cortex, the pons contains centers involved in facial expression and eye movements. The pons also contains clusters of cells on both the left and right known as the locus coeruleus. These cells contain more than 50 percent of the brain's supply of the chemical messenger norepinephrine (noradrenalin). The locus coeruleus plays a major role in stress responses and craving.

The medulla, or medulla oblongata, is the lowest section of the brain stem and, as it tapers, it blends into the spinal cord. The medulla contains centers that help regulate swallowing, breathing, and blood pressure. Centers in the medulla mediate reflexes that result in coughing, gagging, and vomiting.

One patient, a man in his twenties, displayed a special fondness for this lowest section of the brain stem. Over the course of two inpatient stays, he participated in three group discussions I led on the brain, behavior, and addiction. The man's diagnoses included alcohol dependence, bipolar disorder, and Tourette's disorder. You may be aware that some individuals with Tourette's disorder utter, sometimes shout, obscenities. But this occurs in less than 10 percent of cases. This young man was gentle, intelligent, and educated. One day he showed me a close-up photo he had taken of a wildflower and taught me its Latin name. No obscenities; but his impulse control was not the best. He had studied the brain and, even though I referred to the "medulla" in group discussion, he knew its full name. He not only knew the full name; he loved to pronounce it. At random moments during each of the groups he would smile and say "medulla oblongata" out loud.

The spinal cord is the long, slender continuation of the CNS that resembles the stalk of a flower. It is much thicker than the branches of the PNS, but is similarly composed of nerve cells, nerve fibers, and supporting structures. The spinal *cord* is distinct from the spinal *column*, which is the stack of bones and cartilage that helps hold us upright and surrounds and protects the spinal cord.

The spinal cord is an information pathway. It contains multiple kinds of nerve fibers and nerve cells arranged in circuits that convey signals to and from the brain. Sensory circuits relay information from the body *to* the brain (incoming) about touch, pain, temperature, and body position. Circuits *from* the brain (outgoing) direct activities of organs throughout the body. The outgoing circuits are sometimes called effector or motor nerves. Motor nerve connections are generally thought to activate muscle. They allow me, for example, to pick up a pencil when I want to write, which involves activation of *voluntary* muscles. Motor nerve connections also activate *involuntary* muscles. For example, without any thought on my part, motor nerve connections automatically increase muscle tension in the walls of my arteries to keep my blood pressure adequate when I stand up. But it can be confusing. Outgoing connections also direct my sweat glands to release moisture that will cool my skin in response to rising body temperature when I exercise. This last example is clearly an effector function but no muscle is involved. This activity might be called motor, however, when that term is used to refer to all effector functions, not just those involving voluntary and involuntary muscle.

Information flows both ways along telephone lines. In a traditional, hard-wired telephone exchange, residential and business telephones are connected to a central office by wires that join progressively larger bundles as they approach the central office. Central offices now are computerized and regional, though I remember when telephones had neither buttons nor dials and the central office was a woman from our neighborhood at a manual switchboard downtown. The entire nervous system can be compared to a telephone exchange, with the peripheral nervous system connecting nerve endings in sense organs, muscle, and other structures, via progressively larger bundles, to the spinal cord and, through it, to the brain. Most of the identifiable bundles of nerve tissue in the peripheral nervous system are “mixed.” That is, they contain both incoming and outgoing fibers—information flows both ways.

You made it! You read my description of the structure and function of the nervous system. Don’t worry about a quiz. Just read on. You’re ready to think about where our behaviors originate.

The thinking brain and the feeling brain

I often refer to the cerebral cortex, with its self-awareness, language, and decision-making, as the thinking brain. Because this is where we live our conscious lives, we tend to overestimate the influence our deliberate choices have on our behavior. *Addiction doesn’t make sense because lower regions of the nervous system drive addictive behavior, and those lower regions are not necessarily controlled by what we think.*

I refer to the brain stem and limbic system collectively as the feeling brain. The "language" of the feeling brain includes emotions, sensations, and instinct. Conscious thoughts can trigger activity in the feeling brain, such as when I start to worry about something and then become mentally distracted and physically distressed due to fear. It works the other way also. Emotions can occur in the feeling brain and we become aware of them after the fact. For example, sweaty palms before a job interview tip me off that I really am nervous. Plus, a huge amount of what goes on in the feeling brain *never* reaches conscious awareness. More about that later.

My thinking brain/feeling brain terminology has limitations. First, the cerebral cortex, limbic system, and brain stem are so anatomically and functionally *interconnected* that I may misrepresent them by discussing them separately. Like musicians performing as a group, none of them could play their part to the greatest effect without the others. Second, the distinction may be confusing to someone who views feelings only as consciously recognized emotions. To be consistent with their view, I should say thinking brain and emotional brain rather than thinking brain and feeling brain. But to me, feelings are emotional realities that the individual may be aware of or not. Similarly, to me, craving or cravings are emotional realities—overpowering desires—that the individual may be aware of or not.

Those who think that feelings require self-conscious awareness may be the same people who maintain that lower animals don't have feelings at all. That position makes no sense to me. The brain of an alligator, with its prominent limbic lobe, is made to feel. In early 2009, a good friend and I spent three days in Georgia canoeing in the Okefenokee National Wildlife Refuge. We passed within a boat length of dozens of alligators. Distracted by the beauty of the swamp and our desire to photograph some of it, two separate times we drifted within a few feet of very large gators sunning on the edge of the narrow waterway. As we came close, each gator exhaled with a loud and menacing hiss. I have to believe they felt displeasure. We didn't linger to find out how the gators would express their feelings next.

Where does behavior come from?

Behavior results from activity in the central nervous system, and that activity can originate at several levels of the CNS. Some of our human behavior originates in the cerebral cortex and is deliberately chosen. Other human behavior originates at lower levels of the CNS and occurs with no conscious participation on our part whatsoever. Your current background on nervous system structure and function will allow us to look more closely at ways the CNS gives rise to behavior.

Behavior refers to the actions and reactions of an organism, often considered in relation to the organism's environment. You might think of my human behavior as any or all of my actions—whatever you might observe me *do*. Behavior includes things like talking, eating, driving, and dancing. It also includes breathing and body language, such as facial expressions, gestures, and where I position myself in relation to others in a room. We think of animal behavior, including human behavior, as originating in, and being directed by, the nervous system. *A basic principle of the origin of behavior that will help us understand addictive behaviors is that lower centers in the central nervous* *system can, and routinely do, act independently of higher centers.* I'll give a series of examples.

Pretend you're in a discussion group with me. The topic is "Brain, Behavior, and Addiction" and you are sitting by a window. I recruit you to cross your legs and help me demonstrate the knee jerk reflex. I pull out a red rubber reflex hammer and tap the tendon just below your kneecap. Your lower leg immediately kicks forward naturally and involuntarily. The action is so brisk that it startles you. We all agree that this reflex occurred without deliberate or conscious effort on your part.

I explain how this leg movement (a behavior) results from a reflex arc. The tap on the tendon produces a slight, quick stretch of the thigh muscles. Specialized nerve endings within those muscles sense the stretch and respond by sending a nerve impulse to the spinal cord. The sensory nerves enter the rear of the spinal cord near its lower end. They connect directly to motor nerve cells located at the same level of the spinal cord, but toward its front side. As soon as the motor neurons are stimulated, they transmit a nerve impulse back to the thigh muscles, to structures called motor end plates. The motor end plates trigger the muscles to contract, the muscles tug on the tendon, and the lower leg kicks. All this happens very quickly and only a small segment of the spinal cord, representing a tiny portion of the central nervous system, is required for the behavior to take place. When the reflex occurs, the brain plays no role. A lower center has acted independently of higher centers.

But the brain and voluntary activity can become involved. Say I get carried away, repeatedly demonstrating your reflex arc and the wonders of the nervous system. You get annoyed. You decide to fake me out by tensing your thigh muscles, so when I next flourish my reflex hammer and tap your tendon, nothing happens. Higher centers are inhibiting the lower center from acting independently.

But it's not over.

Not so long ago, a young bull moose visited the hospital grounds right outside where you are sitting. A particularly kind nurse who was familiar with horses but not moose went outside and offered the moose an apple. The moose charged. Fortunately, the nurse was still close enough to the door to scurry back inside. You may or may not have heard this particular lore but without explanation I look over your shoulder and exclaim, "The moose is back!" You turn to look, I tap the tendon, and the reflex occurs again. Higher centers can temporarily inhibit the independent action of the lower center, but the lower center's ability to act endures.

After one of these groups, a woman in her twenties presented me with a cartoon of me conducting the group. She captured me chalk in hand, eyeglasses, dangling necktie, and pen in shirt pocket. I am also wearing a tutu and performing the threatened ballet move. Balanced on one toe, I say "The cerebellum controls…" while in a separate thought balloon I observe "There's that moose again!"

Did you think about your breathing in the last two minutes? Maybe you did if you are suffering from asthma or you meditate as you read, but otherwise probably not. Yet there's no doubt that if you are here on this page, you have been breathing all along. It's just that your cerebral cortex, your thinking brain, had nothing to do with it. Respiratory function is controlled by a center in the medulla. Like inhibiting your knee jerk, you can voluntarily take control of your breathing and hold your breath. But it does not even require a moose to get you breathing again; sooner or later you'll gasp as the medulla takes over. The lower center's ability to act—or *necessity to act*—endures.

More complicated behaviors, such as eating and sex, have been studied in rats, monkeys, and other animals. Some research involves making changes in animals' brains. Regardless of our personal views on animal research, the results can teach us. When scientists destroy a bit of brain tissue in one area of the hypothalamus, experimental animals eat voraciously and gain weight. When the scientists create similar lesions in a different area of the hypothalamus, they abolish appetite and animals lose weight. In male monkeys, when scientists create lesions in yet another area of the hypothalamus, the monkeys become indifferent to sex, no matter how alluring the female monkeys they are paired with. Lesions in a different hypothalamic area make male monkeys hypersexual. I recall reading an article years ago where the authors described one such hypersexual monkey running around the floor of the psychology laboratory trying to mount a chicken.

The image of the monkey chasing the chicken always piques the interest of patients. I admit I never interviewed that monkey, but I speculate that if I could, I would learn he wasn't enjoying himself. He might tell me he's not even attracted to chickens. It seems the chase took place as soon as the monkey caught sight of the chicken because, due to the way *his brain was changed*, the monkey had no alternative. The monkey's highly uncharacteristic sexual behavior was driven by his altered hypothalamus. In this example, a lower center has been permanently changed. It acts independently of higher centers and the higher centers can't do anything about it.

After empathizing with the plight of the monkey (I try not to think about the poor chicken), I ask patients if this situation reminds them of anything. Connections come quickly. "Yeah, my heroin habit." "Sure, it's like me and alcohol. I gotta drink, but I don't enjoy it any more."

As he was walking out of a group on this topic, a man in his twenties who was addicted to heroin said to himself, just loud enough for us all to hear, "It sure is a comfort to know that even a chicken can have a monkey on its back."

Does science really back this up?

Scientific study of the brain and behavior now makes it clear that our conscious minds don't "control" everything we do. Here is testimony from relevant expert witnesses.

In the textbook *Neurobiology*, Gordon Shepherd summarizes findings that indicate behaviors we might think of as voluntary can involve activity in lower centers of the brain *prior to* the activity in the motor cortex that stimulates muscle action. He states, "This means that when we try to formulate concepts of motor control, we need to free ourselves of the idea that higher functions are lodged exclusively in the cortex. The cortex is the necessary instrument of higher function, but it is an instrument played by programs fashioned from the interactions between centers throughout the central nervous system." (p 449) In *The Evolution of Consciousness: Of Darwin, Freud, and Cranial Fire – The Origins of the Way We Think*, Robert Ornstein reports: "New research shows that emotions have a separate system of nerve pathways, through the limbic system to the cortex, allowing emotional signals to avoid conscious control." (p 80)

Ornstein has his own ways of communicating that there is more to who we are and more to why we do the things we do than what meets our own minds. "…the commanding, controlling mental operating system (which might be called the self) is much more closely linked with emotions and the system of automatic bodyguards than with conscious thought and reason." (p 153) "…unconscious decisions for action go on constantly inside the head." (p 155) In that statement, Ornstein's juxtaposition of "unconscious" and "decisions" emphasizes his point. My personal favorite: "We're worse off than Freud thought, because many actions proceed without our knowing anything about them." (p 233)

So brain science explains how it can be that our behavior is not always chosen. It explains how primitive urges can bypass consciously held intentions that are opposed to those urges. It is now more understandable that you or I may consume a drink or other drug when our conscious intention is not to do so. It is also now more understandable that we may perceive the feelings of others, such as sadness or anger or fear—through the words they use and their body language—before they are aware of those feelings themselves. Words sometimes reveal the speaker's *true* intention if we remove "not" from what they say. For example, "I don't mean to interrupt" is obviously *un*true.

Our feeling brain and emotions are powerful and may give rise to behaviors that are dramatically self-defeating. However, they also give rise to behaviors that are creative and adaptive. In *The Undiscovered Self*, Swiss psychiatrist Carl Jung (1875-1961) recognized "powers slumbering in the psyche" as "forces and…images" that drive situations "towards construction or catastrophe." (p 107)

Antonio Damasio states he began writing his popular 1994 book, *Descartes' Error: Emotion, Reason, and the Human Brain*, "…to propose that reason may not be as pure as most of us think it is or wish it were, that emotions and feelings may not be intruders in the bastion of reason at all: they may be enmeshed in its networks, for worse *and* for better." (p *xii*) In his 2010 book, *Self Comes to Mind: Constructing the Conscious Brain*, Damasio deftly supports his view that human consciousness requires *both* "the highly developed cerebral cortex" *and* "the humble brain stem." (pp 241-242)

David Brooks, who writes on policy and politics for *The New York Times*, follows emerging neuroscience. He begins his 2011 book, *The Social Animal*, with the premise that "we are not primarily the products of our conscious thinking. We are primarily the products of thinking that happens below the level of awareness." (p *x*) Brooks anticipates that, as humans grow more aware of emotions and place greater value on relationships, our culture—maybe even the formation of policy—will *benefit*.

Accept how nature works

It is crucial to understand and accept that it is *normal* for us to act on our feelings. We are wired that way. Although we humans have long set ourselves apart from other animals by identifying ourselves as *rational* animals, it turns out we are often *rationalizing*. After we do something based on an unconscious feeling, we offer an explanation based on why we think we did it. For example, I say something sarcastic and hurt your feelings. You react, and I say I was only being funny. I have no insight that anger underlies my sarcasm.

Patients usually nod in agreement when I mention that people will sometimes flirt even before they realize they are attracted to someone. I may illustrate this with lyrics from the Bonnie Raitt song "Something to Talk About." From the singer's point of view—"We laugh just a little too loud / We stand just a little too close / We stare just a little too long"—a romance was blooming but she hadn't noticed until her friends pointed it out. It was hard for me to believe, but recently when I used this example on two separate occasions with women about age 20, neither had heard of the artist or the song. (Sorry, Bonnie.)

What I call the feeling brain, the brain stem and limbic system, has a great deal to do with who we are and why we do the things we do. The motor cortex directs muscle action. But circuits deeper in the brain are concerned with muscle action also; particularly when we repeat actions we have done before. Because of changes in my feeling brain and cerebellum, it is not possible for me to *unlearn* how to ride a bike. Such changes contribute to the muscle memory cultivated by athletes and to patterns of social behavior.

Tian Dayton is a clinical psychologist and psychodrama trainer. She emphasizes, "Our limbic system sets the mind's emotional tone and stores our highly charged emotional memories." A female patient in her fifties provides an example of how those emotional memories can be expressed. I met her when she was in treatment for alcoholism, but her alcoholism is incidental to the story. This woman had been married four times and all four husbands were alcoholic. What do you immediately suspect? If you suspect the woman's father was alcoholic, you are correct. She had her own explanations for why she was attracted to each of the men she married, and saw them as different from one another in important ways. But there is a strong possibility she was reenacting aspects of her relationship with her father in her relationships with her husbands.

The most important actions of addictive substances are in the feeling brain, which is where addictive behaviors originate. Article 3 in this series discusses this in detail; articles 4 and 5 discuss what to do about it. In this article about the origins of behavior, it is sufficient to acknowledge that *when a person becomes addicted, their brain changes at a primitive level. In addition to natural drives to satisfy hunger, thirst, and sex, they now have a drive to consume alcohol or other drugs*.

A twenty-five year old woman in treatment for alcohol dependence explained, "I have a passion for alcohol." Just like people may act out of passion without thinking beforehand about the action and its consequences, people may act on addiction without thinking beforehand about the action and its consequences. And just like people may act out of passion against their better judgment, people may act on addiction against their better judgment. Whether the drive is based on passion or addiction, lower centers of our brain can act independently of higher centers, even if the higher centers recognize that the actions are self-defeating.

A brain scientist once likened the relationship between the thinking brain and feeling brain to the relationship between a rider and horse. The major power in this duo is the horse, which fits with what Ornstein and Damasio say about the potent role of emotion in our sense of self and our decision-making.

I ask patients, "What determines where a rider and horse go together?" The most common immediate answer is, "The rider, of course." People who reflect more on the question, or who actually ride horses, answer “The interaction between them” or “The skill of the rider.” Even a professional jockey can be thrown, but skilled riders usually work things out with the horse to the rider’s satisfaction. I am not at all skilled with horses. The last time I rode a horse, he took me for a ride. I was travelling fast above a gravel road; falling off was not an option. The reins were no help, so I clutched the saddle with both hands and clamped my legs around the horse. Riders have since told me that squeezing a horse with your legs tells the horse to go faster. We got back to the barn, the animal stopped, I jumped off, and I haven’t been on a horse since.

Picture being up on a horse, riding along, but not knowing the horse is there. As weird as that sounds, it’s very much like the situation of people (whether they have an addiction or not) who are not attuned to their feelings and have no idea of the existence and power of their emotional memories. A male patient in his twenties, on only the second day of my work with him, was infuriated with me. His counselor promptly took the patient and me into a quiet room. She said to the patient, “You can’t possibly know Dr. Kane well enough to be this mad at him. What else could be going on?” It turned out I reminded the patient of a former teacher who had been a close support but who ended up treating the patient badly.

If, as human beings, we’d rather not always be taken for a ride by our feelings, emotional memories, and addictions; we need to understand how we are built and how we operate. We need to accept and take into account our lower centers and their enduring ability to act independently of our conscious higher centers. Riding lessons could make me more adept with horses. We may need the equivalent of riding lessons to become more adept with ourselves, to better integrate our conscious selves with all we are, and ultimately to lead safer and more satisfying lives. For example, psychotherapy can make us more attuned to our feelings and emotional memories. If we are addicted, then working with an addiction counselor or Twelve-Step sponsor can help us pay better attention to the details of recovery management. Without help, we risk perpetuating our problems and unwittingly making them worse, like me squeezing the horse with my legs.