

# Chapter 1

## APPLYING NEUROSCIENCE

A client in the 20<sup>th</sup> century said, “I quit seeing my analyst because he was doing therapy behind my back.” Therapy of the 21<sup>st</sup> century can foster a greater alliance by lifting the veil of esoteric knowledge and sharing it with a client. By gaining a practical understanding of how the brain operates during therapy, clients can gain confidence in you and the motivation to do those things that make their brains operate at optimum levels to avoid needless anxiety and depression.

This book describes the brain-based common ground of psychological research and psychotherapeutic approaches. From this vantage point we can shed useless and purely theory-based approaches while retaining the common-factor ones that are supported by research. In other words, we are not looking to put old wine in new skins. Rather, it’s time to get rid of the vinegar while retaining the good wine. This effort requires that we replace the wineskins with clear glass to lift the veil revealing true knowledge.

Throughout this book, I offer suggestions on how to use the practical information from neuroscience to help your clients understand and deal with depression and anxiety. In doing so, I describe a robust body of neuroscience research that is consistent with evidence-based practices (EBPs) that can form the basis of therapy. The new developments in neuroscience have revealed what brain systems are over- or under-activated in people with various psychological disorders. The methods described in this book describe how to bring this information into the dialogue with clients.

Clients can learn to activate areas of their brains that have been underactivated and how to quiet down those areas that have been overactivated, so that they can live without being plagued by anxiety and/or depression. By learning more about their brains from you, clients can make better sense of the things they need to do to deal with excessive anxiety or depression. Therapy can offer a “brain tune-up” facilitated by information about the brain and research-tested approaches to resolving anxiety as well as depression.

Consider this book a multilevel user manual for the brain. On one level I describe how to help clients learn more about the brain in general, so that they can use their brains more effectively to ameliorate excessive anxiety and/or depression. On another level, I give suggestions on what you can literally say to

clients in sidebars titled “Client Education.” In sidebars labeled “Neuroscience,” I describe in more detail research underlying the running text.

## TEACHING PRACTICAL NEUROSCIENCE

A variety of new developments in neuroscience are significantly relevant to psychotherapy. These factors can be explained to clients and used to provide the context for suggestions that you make for behavioral change. Each of the next factors can be considered part of the wide body of information that can help guide therapy:

- Epigenetics
- Neuroplasticity
- Neurogenesis
- Affect asymmetry
- Prefrontal cortex, striatum, and habit formation
- Default mode network
- Psychoneuroimmunology

## Genes Need Not Be Destiny

I have encountered many clients over the last 40 years who are convinced that they are genetically determined to have an anxiety disorder or depression. They believed that their genes hardwired them for mental illness. During the last 10 years, I have introduced such clients to revolutionary new discoveries in the field referred to as epigenetics, which reveals that genes are not always destiny.

### NEUROSCIENCE

The rapidly evolving field of epigenetics, meaning “above the genome,” studies the gene–environment interaction that brings about the expression of the genes (which make up an individual’s phenotype). Epigenetics involves the study of the molecular process of methylation of cytosine bases in DNA and modifications of histones by acetylation.

There is a difference between the words “genotype” and “phenotype.” What clients do, including what they eat and their environment, can either influence the activation of genes or suppress genes from activating. Clients have control over their destiny by influencing their biology. Thus, they are not doomed to suffer from anxiety or depression. Since clients can turn on and off genes by changing their behavior, they can certainly do those things that will rewire the brain—practicing the brain-based therapeutic techniques you teach—to diminish the amount of anxiety or depression they experience.

## CLIENT EDUCATION

Genes are not destiny. What you do will have a profound effect on what genes are turned on or off. Even if you are genetically vulnerable to a particular illness or depression, you can do things to suppress the expression of those genes. In other words, your behavior can turn your genes on or off.

A wide variety of studies have shown that a person's biological parents can have less influence on her life than her adoptive parents. For example, children whose biological families had a history of violence were adopted into nonviolent families; as they grew up, only 13% of the adopted cohort expressed antisocial traits. In contrast, 45% of children from nonviolent biological origins adopted into families with aggressive histories became antisocial (Cadoret, Yates, Troughton, Woodworth, & Stewart, 1995).

The fact that behavior can have an effect on genetic structure occurs at the telomere level. Telomeres, which are the ends of the linear chromosomes, generally shorten with cell division and age. Their maintenance is fundamental to all healthy animals. The enzyme that adds nucleotides to telomere ends, called telomerase, has been linked to aging and aging-related diseases (Aubert & Lansdorp, 2008). Many growth hormones play important roles in telomerase activity while transforming growth factor beta (TGF- $\beta$ ) inhibits telomerase. Stress and depression have been associated with shorter telomere length; exercise has been associated with longer telomere length (Cherkas et al., 2008). In Chapter 2, I describe five fundamental lifestyle practices that, when not practiced on a regular basis, lead not only to anxiety and depression but also to the shortening of telomeres.

## Building New Neurons

One of the most exciting areas of neuroscience to share with clients is the brain's potential to grow new cells. The discovery of neurogenesis reversed what we thought we knew as recently as the 1980s. It had been assumed that we are all born with as many new brain cells as we will ever have and that healthy living protects those that we had not lost due to fever, head injury, or toxic assaults, such as alcohol and aging. We now know that it actually is possible to grow new neurons in specific areas of the brain throughout our lives. For example, new neurons arise in the olfactory bulbs in pregnant women, and neurogenesis can occur in the hippocampus, specifically in the dentate gyrus, as well as the prefronted cortex.

Neurogenesis is facilitated by various growth factors, referred to as neurotropic factors. Chief among them is brain-derived neurotropic factor (BDNF), which plays a crucial role in reinforcing neuroplasticity and neurogenesis. BDNF is like organic fertilizer; it helps consolidate the connections between neurons,

promotes the growth of myelin to make neurons fire more efficiently, and acts on stem cells in the hippocampus to grow into new neurons.

The factors that can decrease neurogenesis include aging and chronically high cortisol due to chronic stress or recurrent depression. It is no accident that one theory ascribes the development of depression to blocked neurogenesis. Major assaults to brain cells, such as radiation and traumatic brain injury, also decrease neurogenesis.

As described in later chapters, the integrity of the hippocampus is of supreme importance to mental health. The hippocampus contains many cortisol receptors. When there is a moderate increase of cortisol, in effect the hippocampus acts as a negative feedback mechanism, tamping down release of additional cortisol. Unfortunately, when it is flooded with excessive amounts of cortisol, the hippocampus can atrophy. The hippocampus is key to the acquisition of explicit memory (as discussed in Chapter 3). Since damage to the hippocampus impairs explicit memory, building new neurons there is vital to cognition, as well as for retaining the negative feedback function.

Clients can increase neurogenesis through aerobic exercise, fasting, consuming fewer calories than in the typical Western diet, and increasing consumption of omega-3 fatty acids. The most powerful method is aerobic exercise; its fundamental importance is discussed in Chapter 2.

## CLIENT EDUCATION

You can grow new neurons in the area of your brain that lays down new memories, called the hippocampus, to improve your memory capacity. New neurons develop by engaging in aerobic exercise and maintaining a healthy diet.

## Rewiring the Brain

Psychologists have long known that people who are plagued by psychological disorders, such as anxiety and depression, can learn to overcome these problems and go on to lead happy and productive lives. What we did not know until relatively recently was how those changes took place in the brain. A process known as neuroplasticity illustrates how the brain is not hardwired but rather soft-wired by experience.

The mere fact that neuroplasticity is possible can give hope to clients suffering from depression and/or anxiety. Perhaps they believed that their brains were hardwired to suffer from anxiety or that they will be depressed until they die. Learning that the brain can change so that they will no longer suffer can serve to motivate clients in therapy. The trick is how you explain that this can happen and what clients must do to make it happen. Since most clients have a hard time remembering the cumbersome term “neuroplasticity,” I use the phrase “rewire your brain” (Arden, 2010).

## CLIENT EDUCATION

Your brain is not hardwired but soft-wired. Our job together is to rewire you brain so that you no longer suffer from anxiety and depression.

Clients often are surprised to learn of the sheer complexity of the brain, which contains roughly 100 billion neurons. Since neurons are social, they maintain, on average, 10,000 connections to other neurons. Neuroplasticity, as the name implies, means that neurons are malleable and plastic, in that they change based on learning experiences. Each of the connections between neurons actually consists of microscopic gaps called synapses, and learning establishes and strengthens synaptic relationships. Neurons communicate with one another by sending chemical messengers, of approximately 100 different types, including neurotransmitters, neuromodulators, and neurohormones, across the synapses. This rich cornucopia is partially dependent on a balanced diet. An impoverished diet produces impoverished neurochemistry and probably more anxiety and depressive symptoms. Although the subject of diet is taken up in more detail in Chapter 2, it is important to make clear that healthy brain chemistry is dependent on a healthy diet. Neuroplasticity requires soft and pliable cells that can change shape to facilitate new synaptic connections. A diet consisting of excessive bad fats and simple carbohydrates can result in rigid cell membranes that impair neuroplasticity.

## NEUROSCIENCE

A piece of brain tissue the size of a match tip contains approximately 1 billion synapses. The neurochemical activity between synapses potentiates neurons to fire; this is referred to as an action potential. Those neurons involved in perception fire up to 300 impulses per second. The two main neurotransmitters in the brain are glutamate and gamma-aminobutyric acid (GABA). They are the workhorses in the brain, and their effects take place in milliseconds. While glutamate is primarily activating, GABA is inhibiting.

The so-called white matter, composed of glial cells, is much more abundant; there is up to 10 to 15 times more white matter than neurons. Once thought to be nothing more than fat cells that glue the brain together, we now know that glial cells perform many critical functions in the brain, including communicating among themselves through calcium waves.

Explaining to clients how they acquire a new memory can serve as a good example of neuroplasticity. When they learn something new and practice recalling it, the more easily they can recall that information in the future. That is what studying is all about. When they practice the new skill, such as speaking in a foreign language, they are wiring their brains to remember that language's vocabulary and intonation and to conjugate verbs. The more they practice speaking the language, the greater the synaptic connections between groups of neurons that make those language skills possible.

## CLIENT EDUCATION

Rewiring your brain means that the more you practice a new skill, the more your brain changes to make that skill come easily.

Similarly, the brain-based solution to overcoming anxiety and depression involves neuroplasticity. Just as they can learn to speak a foreign language, clients can learn to not feel anxiety in situations that are not dangerous. Neuroplasticity makes it possible to learn to feel calm and enjoy life despite previously believing it was impossible.

The concept of “neuroplasticity” stems back to one of the field's founding fathers, Donald O. Hebb (1904–1985), who demonstrated that mental stimulation results in actual structural change to the brain. Hebb brought lab rats home for his children to play with and found that when those rats were back at the lab, they learned more quickly than cage-bound rats. They had developed bigger and heavier brains. A paraphrase from Hebb that has become a sort of mantra is “Neurons that fire together wire together.” In other words, once you get neurons to fire together to support a new behavior and perform that behavior repeatedly, those neurons will link together to make that behavior an enduring habit.

To understand how to ensure that their brains can rewire, clients should be informed that they need a moderate degree of discomfort. This means that they should not wait until they feel no anxiety before making changes. In fact, if they wait until they feel no anxiety before they make changes, the wait will be endless. A useful analogy is to old vinyl records, where a needle detected microscopic changes in the grooves on the record as it spun on a turntable. If the record was damaged, the needle would get stuck in the same groove and repeat the same phrase in the song over and over again. To get the needle to jump out of the too-deep groove, the listener had to get up off the couch and bump the needle. So too is it with the bad habits of anxiety and depression. Clients need to do what they do not feel comfortable doing in order to establish the new habit. In other words, they need to expose themselves to relatively safe but anxiety-provoking situations in order to feel calm and positive when in the same situation later.

Over 100 years ago, two psychologists, Robert M. Yerkes and John D. Dodson (1908) developed what has since been referred to as the Yerkes-Dodson law, which dictates that performance increases with physiological and mental arousal up to a point. When the arousal is too high or too low, performance decreases. This concept is best illustrated in what has been referred to as the inverted U-shape curve, which increases with moderate levels of arousal.

## CLIENT EDUCATION

To feel better, your job is to do what you don't feel like doing so that eventually you feel like doing it.

There are many ways to describe how the brain rewires with a moderate level of arousal. Consider explaining that it is always more difficult in the beginning. Then practice the mantra “Cells that fire together wire together” until it becomes truth. Making the rewiring possible requires that clients understand the need to get out of their comfort zones, much like bumping that needle on the record player. This process requires intensive, repetitive behavioral change.

Therapy based on the neuroplasticity of the brain does not emphasize prolonged focus on the identification and overactivation of sad memories; repetition of the same story with its associated negative emotions for the assumed benefit of catharsis is countertherapeutic. In fact, reliving the same sad memories over and over again makes stronger those sad memories and the feelings associated with them. The identification and activation of neural circuits is productive only to the degree that it enables later change-oriented interventions (Grawe, 2007). The goal is to facilitate positive change, altering the problem, and to establish neural circuits that construct a solution with repetition, new thoughts, behavioral patterns, and emotions.

## NEUROSCIENCE

Neuroplasticity involves several changes in the brain that result from learning, including the development of new synaptic connections, strengthening of connections through what has been called long-term potentiation (LTP), the growth of new dendrites (dendritogenesis), and neurogenesis (Buonomano & Merzenich, 1998). The changes in synaptic efficacy and LTP result from increases in receptor density, up-regulating their activity, greater glial cell availability, and changes in the shape and structure of synapses.

(continued)

*(continued)*

Neuroplasticity involves raising the levels of a variety of neurotransmitters. For example, the activating neurotransmitter glutamate, which is the brain's workhorse, needs a moderate boost to reach the specialized glutamate receptors the N-methyl-D-aspartate (NMDA) receptors to develop LTP so as to ensure that the neurons will fire together easily again later. Accessing the NMDA glutamate receptors is critical to kick off secondary messengers, facilitating LTP.

The opposite of LTP is long-term depression (LTD), not to be confused with the psychological disorder of depression. It refers to the fact that with no use, there is depressed activity among those synapses where there was previous activity. LTD of neural circuits associated with anxiety and depression is our goal in therapy. One way of framing LTD is to say "Neurons that fire out of sync lose their link."

The concept of "dosing" has long been discussed in the psychotherapy research literature in regard to how many sessions and what frequency of sessions therapists must provide to achieve efficacy. This discussion also includes the exposure paradigm, which relates to how many exposure sessions and what degree of intensity are needed. The Subjective Units of Distress Scale (SUDS) has been used to measure appropriate gradients of intensity. The issues of dosing and exposure can be understood within the context of neuroplasticity.

During the mid-20th century, Fritz Perls and colleagues introduced the concept of a "safe emergency" to describe feeling safe in the therapeutic relationship while being challenged to go beyond what feels safe (Perls, Hefferline, & Goodwin, 1951). Despite the importance of this concept, therapists have a rich tradition of cultivating only the safety part; the emergency side needs to be utilized in therapy. Of course, the safety of therapeutic alliance is paramount, but we also want to produce change.

## CLIENT EDUCATION

You need to get out of your comfort zone to rewire your brain. But don't worry: You can do it incrementally. Instead of diving off the high dive when you don't know how to swim, try jumping off the edge of the pool into the deep water, which is out of your comfort zone.

When clients tell you that they want to wait until they feel totally confident and calm before facing the challenge of dealing with anxiety, you can say that actually a moderate degree of anxiety and discomfort can work to rewire the brain so that they will no longer suffer from excessive anxiety. Of course, you



will be there to walk clients through it as their partner. Together you will work through incremental exposure exercises; although they will never feel totally ready to face the challenge, with sustained effort and practice, they will be able to master it eventually.

You can describe many provocative and well-known illustrations of neuroplasticity to clients to help them understand that practice is key. For example, London cabdrivers go through a rigorous training program called “the Knowledge” that can take up to four years. Researchers at University College London examined the brains of these cabbies and found that the longer they were on the job, the larger the size of their posterior right hippocampus, which lays down spatial-based memories (Maguire et al., 2000). Because cabbies must learn the highly complicated map of London, the posterior right hippocampus helps them develop a sort of GPS system in their brains. The point of this illustration is that when a particular area of the brain gets used in a use-it-or-lose-it manner, that part becomes larger due to neuroplasticity.

A variety of other example may resonate with clients. Adults who juggled three balls for three months were found to have increased gray matter in the brain areas making this type of agility possible (specifically the midtemporal area and left posterior intraparietal sulcus). Then, after months of little or no juggling, the gray matter in the area decreased and approached baseline values (Draginski et al., 2004). The critical point raised by this study is that not only does the area necessary to develop the specified skill get larger with practice, but when it is not used, it goes back to its earlier size. In other words, the lose-it factor of the use-it-or-lose-it concept occurs with a lack of consistent exercise. Other skills also have illustrated specific neuroplastic changes to the brain. Musicians such as violinists who use specific fingers to play their instruments showed enlarged areas of their somatosensory strips associated with those fingers (Pantev, Roberts, Schulz, Engelen, & Ross, 2001). Blind Braille readers showed enlarged cortical areas associated with their reading finger compared to blind non-Braille readers and to sighted people (Pascual-Leone & Torres, 1993).

Clients often need practical descriptions of how to get started and what degree of rigor is necessary to make neuroplasticity work for them. To increase neuroplasticity, clients must challenge themselves with tasks that are of sufficient difficulty and of increasing difficulty as they master each level. To make the tasks of sufficient intensity, clients can engage in a few learning sessions each day, with at least three learning sessions each week for several weeks. This degree of rigor is very much like when people are bodybuilding: They need to lift more weight than they can easily lift, with three reps of 10, three times per week, over the course of several weeks. Only then are recognizable changes apparent in muscle mass.

Another point to highlight regarding how to produce neuroplasticity concerns a heightened degree of attention. Attention and maintaining alertness involves a variety of neurotransmitters. For example, moderate activation of the neurotransmitter norepinephrine (NE) is optimal at moderate levels, as illustrated by the

inverse U. Too little or too much NE impairs new learning. NE is one of the many neurotransmitters involved in anxiety disorders and, in the extreme, panic attacks. However, a moderate level of NE keeps people focused, and capable of challenging themselves to deal with the bad habits of anxiety so that they can rewire their brains.

## NEUROSCIENCE

Not enough NE fails to activate the prefrontal cortex (PFC); too much turns it off. In fact, different types of NE receptors are involved in turning the PFC on and off. In a panic attack, as occurs when the brain gets flooded with an excess amount of NE, the alpha 1 receptors are turned on while the PFC is turned off. In this case, the amygdala hijacks the PFC, promoting anxiety-laced decisions without adequate prefrontal activity. A moderate degree of NE hitting the alpha 2A receptors is optimum to keep clients alert, in command of their mood, and able to benefit from neuroplasticity. Clients need to learn to get out of their comfort zone, which will raise their levels of NE, turn on their PFCs, and rewire their brains.

## Emotion and the Hemispheres

Most clients are surprised to learn that the two brain hemispheres process emotion differently. Some people are already aware that their right hemisphere includes talents in seeing the big picture, the general gist of a situation, visuospatial perceptions, and the ability to locate where they are in space. They also may know that their left hemisphere is talented at details, routinized behaviors, and language.

## NEUROSCIENCE

Both hemispheres of the brain contain all four lobes of the cortex: frontal, temporal, parietal, and occipital. For example, the primary areas in both frontal lobes are involved in movement. The parietal lobe is specialized for spatial and sensory skills; the temporal lobe is specialized in auditory skills; the frontal lobe with movement, and the occipital lobe is specialized in vision skills. Although each lobe is specialized in certain functions, each also is part of the right or the left hemisphere, which reflect the general talents of each hemisphere.

Although the two hemispheres represent functional asymmetries, some of their functions have been overgeneralized in popular culture. The truth is that both hemispheres, when working together, play vital roles in adaptive life. The role of the right hemisphere in the perception of the big picture is facilitated by long myelinated axons linking distant regions of the brain. The right hemisphere is involved in early stages of learning. The left hemisphere is involved in routinization and activates once information is learned. When a person is faced with problems to solve, the left hemisphere makes it more likely for him or her to arrive at known solutions that worked in the past.

Psychologist Richard Davidson, of the University of Wisconsin, Madison, has shown that a person's affective style is related to his or her set point, which is the ratio of activity between the right and left PFC. Davidson has proposed that the set point represents the range of our default emotional tone. The set point is represented by the ratio of neural activity between the right and left hemispheres, which is slightly skewed to the right or left (Davidson & Irwin, 1999). Whether a person suffers a great injury that results in paralysis or wins the lottery, within a year or two the person's emotional tone will settle back to the set point that existed before, to hover around being generally positive if skewed to the left or negative if skewed to the right.

Particular neural activation patterns are associated with a particular mood status, so that when people are anxious or distressed, their amygdala and right PFC (R-PFC) activate more than the left. In contrast, when they are in a positive mood, those areas are relatively inactive while the left PFC (L-PFC) activates. In general, more activation of the left prefrontal area is associated with upbeat mood states and positive emotional set points while more right-side activity is associated with being easily upset and suffering from periodic anxiety and/or depression.

## CLIENT EDUCATION

Your right and left front part of your brain process emotion differently. When there is more activity in your right front part than your left, you tend to experience more anxiety and depression.

Clients who are overly anxious tend to have hyperactivity in the right PFC relative to the left (Davidson, Pizzagalli, Nitschke, & Putnam, 2002). Accordingly, such clients have a shortage of positive feelings and little behavior directed toward the attainment of positive goals. In fact, research has consistently shown that people who suffer from anxiety disorders and depression have overactive

R-PFCs and underactive L-PFCs. To make these distinctions relevant to behavior and practical, explain that the R-PFC is involved in avoidant and withdrawal behaviors while the L-PFC is involved in “approach” behaviors. These contrasting tendencies reveal important information about anxiety and depression as well as what to do about them. The immediate paradox to address is that when clients avoid what makes them anxious, they make their already overactive R-PFCs even more overactive, which ironically makes them even more anxious and depressed. When people approach what makes them anxious, they activate their L-PFCs, which are better able to control the amygdala’s overactivity.

Another way to explain the functional differences between the right and left PFC is to stress that since the R-PFC is oriented toward the big picture, when it is overactivated, people may feel overwhelmed by everything. The L-PFC, in contrast, focuses on the details—the small picture. When the L-PFC is activated, people are approaching life and engaged in behaviors to accomplish goals and experience positive feelings.

## CLIENT EDUCATION

When you are overwhelmed with anxiety or depression, it is best to shift from the big picture to the small and do something that approaches a goal in a piecemeal, incremental manner.

## NEUROSCIENCE

The right dorsolateral prefrontal cortex (R-DLPFC) is associated with avoidance/withdrawal behaviors while the left dorsolateral prefrontal cortex (L-DLPFC) is associated with approach behaviors. The left orbitofrontal cortex (L-OFC) is associated with positive emotions while the right OFC (R-OFC) is associated with negative emotions.

There are also significant functional affect asymmetries associated with the amygdala. For example, greater activation of the left amygdala is associated with pleasant stimuli and reduced depression (Davidson et al., 2002). In contrast, greater activation of the right amygdala or an enlarged right amygdala is associated with anxiety disorders. Criminals who have committed affectively charged violent crimes have increased activity in the right amygdala and right hemispheres in general. As an illustration of the role of the right hemisphere in social perception as well as anxiety, surgical removal of the right amygdala has been shown to decrease a person’s ability to recognize fear in faces.

Although the effect asymmetry distinction generally applies to most people, there are some gender-related differences. It is noteworthy that the two hemispheres are not exactly symmetrical. A degree of asymmetry

is evident, especially in men. Where the R-PFC is wider, thicker, and protrudes over the L-PFC while the left occipital lobe is wider than and protrudes over the right occipital lobe.

Even the representation of reward and punishment shows affective asymmetry, with the left medial region of the PFC responding more strongly to rewards and the right one to punishment (O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001). Approaching goals is associated with the DLPFC. Hyperactivity of the R-PFC appears to be a negative prognostic indicator for responding to a selective serotonin reuptake inhibitor (Bruder et al., 2001). Patients who respond better have less right-side dominance.

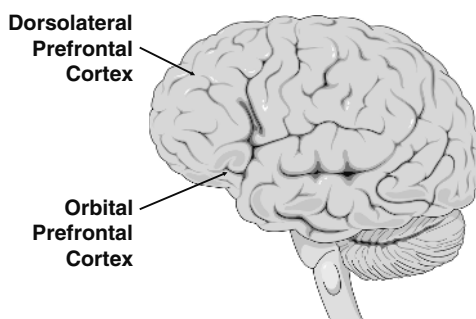
There are neurochemical asymmetries as well. For example, while dopamine (DA) appears relatively more active in the left hemisphere, NE appears to be more active in the right hemisphere. This is particularly relevant in clients seeking help with anxiety. Increases in NE are associated with anxiety disorders and posttraumatic stress disorder (PTSD), consistent with right-hemisphere overactivation. There are other asymmetries, including in estrogen receptors, which are more prevalent in the right hemisphere.

## Activating the Brain's Brain

Every discussion with clients about the brain requires a major focus on the PFC. The PFC represents the apex of brain evolution and allows our species to ask questions such as “What is thought?” Effective psychotherapy by necessity involves the PFC. It functions as the “executive” brain or executive control center, the brain's brain. Without the PFC, there would be no civilization. People would be totally, instead of partially, ruled by their emotions.

One way to illustrate the central importance of the PFC in affect regulation is to highlight how teenagers struggle to contain their emotions. Because the PFC is the last brain structure to myelinate, teens are in the process of developing identity, insight, and a sense of self as competent and independent individuals. Since many adult clients have difficulty with the same challenges, teaching them about PFC development can be an effective way to hone in on the skills that need practice.

The skills of two parts of the PFC that are important to describe are the DLPFC and the OFC (see Figure 1.1). When the OFC is working well, it provides affect regulation and is enhanced by the social skills of empathy, attachment, warmth, and love. As discussed in Chapter 2, clients who were abused or had insecure attachment tend to lack these talents. Fortunately, therapy and very positive intimate relationships can rebuild the OFC. The OFC plays a major role in the affect regulation because of its connections with the amygdala. It is more involved in



**Figure 1.1** Two key areas of the prefrontal cortex, the dorsolateral prefrontal cortex and the orbital frontal cortex.

emotion than some other areas traditionally considered part of the so-called limbic system. For that reason, I agree with neuroscientist Joseph LeDoux (LeDoux, & Schiller, 2009) that it is best to discard the term “limbic system.” The amygdala, which is discussed in greater detail in Chapter 4, plays a major role in stress and the development of anxiety. Since the OFC maintains significant connections to the amygdala, it can neutralize needless anxiety if the client’s descending connections are strong. If the OFC is undeveloped and the ascending connections dominate, the amygdala can hijack the PFC and generate anxiety-laced thoughts.

## CLIENT EDUCATION

With sustained practice, you can train the more advanced part of your brain to neutralize irrational anxiety generated by the more primitive part of your brain.

The DLPFC is the most advanced part of the brain evolutionarily. It does not fully myelinate until approximately age 25. It is involved in many executive functions including attention, problem solving, and working memory. The eminent psychologist George Miller noted that an individual can hold in mind 7, plus or minus 2, pieces of information for 20 to 30 seconds (Miller, 1956). The DLPFC is involved in working memory, which keeps thoughts and plans in mind while following through with the task. One way to describe working memory is to say “When you walk into a room and forget what you had in mind to do in there, your DLPFC was not doing its job.” The DLPFC also plays an important role in regulating follow-through on anxiety and depression, reducing behaviors.

When the PFC in general is impaired, executive functions falter. When specific areas of the PFC falter, such as when there are deficits in the OFC and DLPFC, different types of executive functions can be impaired. This was first illustrated by the most famous neurology patient in history, Phineas Gage, who

lost his OFC when a steel rod shot into his right eye and through it. Once well-mannered and polite, he became disinhibited and rude. When he saw a woman he wanted, he grabbed her, and he said what he felt like saying, with no forethought or concern about the consequences. Many people with OFC deficits are in the criminal justice system, convicted of assault and other violent offenses. An OFC deficit that is highlighted in Chapter 5 includes being insensitive to ambiguity. The picture is quite different with DLPFC deficits, which include pseudodepression, marked by a lack of spontaneity and of affect rather than negative affect. In other words, people with DLPFC deficits look depressed but deny depression when asked.

One way to assess whether and in what way clients suffer from PFC deficits is to assess their types of attention problems. OFC impairments often result in attention-deficit/hyperactivity disorder (ADHD), where the problem involves difficulty with affect regulation. Because the DLPFC is highly involved in working memory, deficits result in a higher incidence of attention-deficit disorder (ADD). Here the difficulty is in maintaining attention and following through on the execution and the completion of goals.

ADD and ADHD are overdiagnosed and do not represent discrete disorders but rather a spectrum of executive function problems. Brown (2005) identified six executive functions that, when impaired, can result in attention problems. They include:

1. Activation—organizing, prioritizing, and activating to work (versus impulsive or procrastinating);
2. Focus—sustaining and shifting attention to tasks
3. Regulating alertness—sustaining effort and processing speed (versus drowsiness and running out of energy);
4. Managing frustration— affect regulation and modulating emotions (versus affective lability);
5. Memory—utilizing working memory and accessing recall; and
6. Action—monitoring and self-regulating action (acting without sufficient forethought).

## NEUROSCIENCE

The far front portion of the PFC, referred to as the anterior PFC, is critical for juggling more than one concurrent behavioral task or mental plan. The anterior PFC has more dendritic spines per cell and rich spine density, making it able to integrate a broad range of inputs (Ramnani & Owen, 2004). It is bidirectionally interconnected with the heteromodal association regions of the posterior cortex. These interconnections makes the anterior PFC adept at integrating outcomes of several cognitive operations in the context of a superordinate goal.

## Habits: Developing Good Ones and Breaking Bad Ones

Habits are by nature automatic behaviors that we perform repeatedly without engaging conscious awareness. Many habits help us navigate through the day and accomplish goals, such as driving a car to work or typing an email. As such, they are part of our procedural memory, discussed in Chapter 2. Habits are driven by the striatum, a subcortical area in the basal ganglia. A variety of habits are not practical, including those that are extremely disturbing, such as the compulsive behaviors associated with obsessive-compulsive disorder (OCD), which are described in Chapter 8.

Many clients state that they derive enjoyment from only a limited number of activities. They report feeling stuck in bad habits because of assumed hardwired limitations. You can help them understand that the development of a habit is actually soft wired and part of the reward circuit. Because the reward circuits can drive behavior faster decisions made by an impaired PFC, it can be very difficult to inhibit a habit behavior driven by the reward circuits, once they have been triggered. These circuits are activated when presented with opportunities for immediate reward. One of the goals of therapy, therefore, is to help clients increase the range of positive habits that they can employ to reap rewards.

### CLIENT EDUCATION

Your bad habits are not hardwired into your brain but are soft wired because you have repeated them over and over again. If you practice, you can develop new, positive habits.

Clients can develop new habits by first kindling activity in the PFC through deciding to do something different, which serves to break them out of autopilot. However, since clients may have great difficulty changing their behavior merely from gaining insight and “knowing better,” they need to be motivated to change. To set the conditions so that they can develop the motivation to modify their behavior, they need to make changes to the daily environment to support the new behavior pattern. Clients can be informed that the neural infrastructure for motivation includes the nucleus accumbens, which represents a key part of the reward circuit. When the ventral tegmental area (VTA) signals the availability and expected value of opportunities to obtain immediate rewards, it provides DA to the nucleus accumbens. When medium spiny (MS) neurons in the nucleus accumbens receive increased levels of DA, they become stronger and can restrain the automatic (habit) activity of the striatum. However, when MS neurons are weak, the striatum becomes uninhibited and behaves automatically so that it is harder to restrain habits. With conscious and sustained attention, the PFC can block habit behaviors generated by the striatal autopilot system.



Productive behaviors that are also enjoyable increase the strength of MS neurons. These circuits underlie ability to inhibit old habits and motivate clients to continue to engage in new behaviors. However, when opportunities for gratification are slim, MS neurons become weak, and old habits are difficult to inhibit. When clients' lives are enriched with the opportunity to take care of immediate needs and solve problems, so that they cultivate a greater range of pleasurable activities, their MS neurons become powerful enough to inhibit the drive toward immediate gratification to old habits by engaging in new productive behaviors.

Since much of the success of psychotherapy is dependent on client motivation, it is interesting to note that the nucleus accumbens and the amygdala are in close proximity and comprise a significant part of the motivational system underlying positive and negative reinforcement. The nucleus accumbens integrates incoming sensory information, evaluates emotional memory coming from the amygdala, influences decisions made by the PFC regarding motivated behavior, and results in either "go" or "stop" behavior (Hoebel, Rada, Mark, & Pothos, 1999). If clients feel that the result of their behavior will be positive, those synapses mediated by DA strengthen, and the associated motivation to engage in that behavior again increases.

With your guidance, clients can build the motivation to develop a wider range of gratifying experiences. Since the reward system in the brain uses DA as one of its neurotransmitters, DA neurons encode the expected value of an opportunity. The greater clients' expectations about the opportunity, the faster the neurons fire. The intensity is commensurate to the expected benefits. Clients may benefit from learning that these DA-containing VTA neurons fire when tempted by the possibility of quick pleasures. This means that clients run the risk of acting on those cravings even though they may be self-destructive in the long term, as is the case of many addictive behaviors.

## NEUROSCIENCE

The speed of firing of DA neurons varies. Slow, constant firing allows them to damp down expectations when the opportunity was overestimated. Firing speeds up if the promise of rewards is high or if the situation is particularly tempting, especially based on prior rewards. How much neurons in the nucleus accumbens fire at the time of engaging in an activity predicts whether clients will repeat the activity. The firing rate of the VTA's DA neurons indicates the value of reward opportunities; the faster the rate of firing, the greater the anticipated reward. The amount of DA the VTA neurons release provides a measure of the number and value of opportunities clients encountered recently. The sum total of rewarding experiences modifies clients' MS neurons and general vulnerability to opportunities to succumb to immediate gratification.

(continued)

*(continued)*

The MS neurons have special dynamic receptors, referred to as D2 receptors, that fire more readily and are harder to turn off when DA hits them (Dong et al., 2006). The total value of the recently experienced opportunity gets translated into the strength or excitability of the MS neurons (Trafton & Gifford, 2008). As clients push themselves to encounter more rewarding opportunities, turning off the MS neurons becomes more difficult. As these MS neurons inhibit the enactment of habitual immediate gratification-seeking behaviors, strengthening MS neurons reduce impulsivity and enactment of shortsighted habits. This means that it becomes easier for clients to avoid repeating bad habits and to try more varied, pleasurable, or productive activities.

By strengthening the MS neurons through increasing the variety of pleasurable behaviors, clients are better able to break bad habits. This is because the MS neurons are inhibitory; they turn off the striatum circuits. The end result is that the automatic habits that the striatum memorized are inhibited in favor of the acquisition of new behaviors. This process represents a viable method to break bad habits.

You can inform clients that they can rewire their brains to expand the range of activities that give them a sense of satisfaction and pleasure by trying out and behaving as if new activities were indeed fun. Tell them that the more they practice these behaviors, the easier it will be to break the bad habit of deriving pleasure from only one behavior. As new healthy and pleasurable behaviors are trained into the habit circuits, they will become easier to do and will be triggered more frequently than unhealthful behaviors.

## CLIENT EDUCATION

The Alcoholics Anonymous and Narcotics Anonymous sayings “Fake it until you make it” and “Act as if” carry the wisdom that to acquire a new positive habit by doing it when you don’t feel like it, you will eventually feel like it.

With habits, good and bad, there exists a dynamic neurochemistry. For the destructive habits such as addiction, a variety of neurotransmitters are at play. The addictive process, whether in regard to drugs and alcohol or a behavior, such as gambling, involves an increase in the firing rate of DA neurons. The brain looks for cues to predict the availability of the reward and increases its estimation of how pleasurable taking the drug or engaging in the behavior will be. The firing rate of the DA circuits increases each time clients take the drug or engage in the behavior until eventually their DA neurons cannot fire any faster. To keep

comparisons between natural rewards and drug rewards to scale, their brains are forced to start reducing DA neuron firing in response to natural rewards. Eventually, every association with the drug or behavior will serve as a craving cue. A burst of DA neurons fire, fueling clients' anticipation of a reward and the greater likelihood that they will behave in some way to achieve the reward.

## NEUROSCIENCE

DA is one of the most widely studied neurotransmitters associated with addiction and has been implicated in many mood-altering substances. The DA hypothesis states that drugs of abuse involve the release of DA in the mesolimbic DA system, especially to the nucleus accumbens. For this reason, DA has been overgeneralized as the pleasure neurotransmitter and more appropriately understood as associated with the anticipation of pleasure. It is at the heart of all reinforcing behaviors and has been called the currency of reward. It signals survival importance as well because of its role in motivation.

Addiction to drugs such as cocaine relies on glutamate as well as DA. For example, mice that had been genetically altered to lack glutamate receptors do not addictively use cocaine, even though it has the same effect on their dopaminergic systems as it does with mice that are not genetically altered. For all these reasons, glutamate may be related to drug seeking (motivation) and drug memories, and may be implicated in relapse.

As noted earlier, glutamate is the principal activating neurotransmitter in the brain and is considered the brain's workhorse. It is associated with learning, memory, and motivation through its critical role in neuroplasticity. The NMDA receptors are glutamate receptors that are activated by a moderate burst of glutamate, which facilitates LTP. Glutamate, therefore, helps the brain to adapt to the environment; often referred to as key in neuroadaptation. The glutamate system maintains projections to the orbitofrontal cortex (OFC) and therefore plays a role in executive functions, especially affect regulation.

One confusing experience, for both client and therapist, occurs when symptoms get worse instead of better after a period of intense psychotherapeutic work. Because most behaviors, whether good or bad, are reinforced in some way, when the reward does not occur, there often is an "extinction burst" where the bad behavior escalates the first few times the reward is not received. Clients need to be informed that the extinction burst is just that, a burst, a last gasp of a habit soon to be broken. If clients hang on and do not fall back into what had been too easy in the past, they can break the pull of the bad habit.

## CLIENT EDUCATION

Rewiring your brain to change bad habits into good habits often includes the confusing experience of briefly feeling worse before you feel better. To feel better on a regular basis, you must ride through a brief period of feeling worse.

### Default Mode Network

Although many therapists hate to admit it, occasionally they space out and daydream during sessions. Clients fade off too, but their tendency generates more concern and all sorts of interpretations, such as “Is he resistant to interpretation?” or “Has she shut down?” While these interpretations may be spot on, a variety of other factors are operative that do not necessarily involve resistance. The truth is that all humans spend a great deal of time spacing out. This tendency has been associated with a pattern of brain activity known as the default mode network (DMN). Up to 30% of our waking hours are spent in the DMN, daydreaming, ruminating and in self-referential thought. To illustrate how much energy is being used in the DMN, only 5% more brain energy is used to pay attention above the baseline (DMN) when something in the present environment captures your attention. The DMN increases activity when the DLPFC is not engaged, and you and/or clients may be stressed, bored, not experiencing novelty, or simply tired.

## NEUROSCIENCE

The areas of the brain identified as active in the DMN include the medial parietal area with the posterior cingulate and adjacent precuneus, which are involved in remembering events in our lives. Also involved is the medial PFC (mPFC), including the ventral ACC, which is involved in imagining what others are thinking as well as our own emotional state. Collectively this network is critical to our sense of self.

A variety of DMN patterns of neural activity have been associated with various psychological disorders. One of the malfunctions in the DMN includes schizophrenia, which includes a defective mPFC resulting in impaired self-reflection, whereby clients may not be sure where their own thoughts come from. With depressed clients, the DMN may generate obsessive ruminations about negative experiences that occurred in the past.

The DMN also can be the source of creative thought or insights, such as putting together concepts generated by discussions in therapy. Therapists have long asked such questions as “Where did you just go?” or “What are you reflecting on

right now?” Accordingly, you can help clients make their DMNs useful by encouraging them to reflect on what they just imagined or ruminated about or what ideas were just generated. In this way, you can teach clients to use the DLPFC to focus on what the present moment has to do with where they had been.

Rewiring the brain requires stepping out of the DMN and activating the PFC to direct the desired behavioral change. Since it can be difficult to remember how to make changes that rewire the brain, you can teach clients a mnemonic recipe for feeding the brain, namely FEED.

- F—for focus. This involves turning on the PFC, a part of the brain critical for learning anything new. When clients focus on the here and now, they engage working memory and DLPFC connections with the hippocampus for the acquisition of long-term memory.
- E—for effort. Clients must make the effort to do what they do not feel like doing. If they continue to do what they felt like doing, they would do what they have always done out of habit. Like an old record player, if the record is damaged, the same record track is repeated over and over again. Clients must “bump the needle.”
- E—for effortlessness. Effortlessness occurs after a new habit has been developed. Not only will clients repeat the new skill, behavior, mood, and/or memory, but their brains will require less work to repeat it.
- D—for determination. Determination to stay in practice is critical, because if the acquired skill is not practiced, the brain too loses the connections, just like muscles that atrophy with too little use.

## Therapeutic Brain Networks

Introducing the systems of the social brain provides the context for describing the importance of relationships, including the therapeutic relationship. More than half a century ago, Carl Rogers astutely described many of the characteristics of building an effective alliance. He highlighted the importance of active listening, pacing, and reflection, which led the way to generations of therapists, including even Heinz Kohut from the psychoanalytic perspective (who did not give Rogers the credit he deserved). In chemical dependency treatment programs, Bill Miller used a Rogerian-inspired motivational interviewing technique to work around resistance and generate motivation. Outcome management studies are now called evidence-based outcomes to highlight the importance of the alliance.

Although he did not know about the social brain networks in the brain that make the alliance possible, Rogers argued that clients naturally get better with the corrective influence of positive relationships. We may conceptualize the neural networks that makes the alliance possible as the therapeutic brain. These networks comprise the safe part of the safe emergency.

Since much of the thrust of this book is to lift the veil of esoteric knowledge and discard useless theory so that therapy can be transparent, understandable to clients, and effective, describing the therapeutic brain will add yet another point

of clarification. This description highlights the therapeutic relationship between you and your clients but also sensitizes clients to their relationships with other people.

Consistent with the focus on the dynamic qualities of the therapeutic relationship, in recent years there has been an increased interest in attachment throughout the life cycle. The therapeutic relationship taps into the unique ways each of us have learned to engage in relationships. The manner in which we engage one another depends on the therapeutic brain networks, those same networks that also make therapy possible.

The neural circuits making up the therapeutic brain system include the cingulate cortex, the OFC, the amygdala, the insula, and facial expression modules. Let us start with the cingulate cortex, which is the gyrus just above the corpus callosum. The very front part is called the anterior cingulate cortex (ACC); it integrates cognitive and emotional information from the cortex (Bush, Luu, & Posner, 2000).

## CLIENT EDUCATION

Your anterior cingulate cortex makes it possible for you to feel the pain of another person and express authentic empathy.

Our ancestors traveled in bands where members had to work together for survival; rejection or ostracism could result in death. The ACC evolved with physical and social pain functions because banishment could result in pain and ultimate death (Eisenberger & Lieberman, 2004). Feeling rejected, excluded, or ostracized activates the ACC, which acts as a sort of alarm system for both emotional and physical pain.

## NEUROSCIENCE

The cingulate cortex, so named because of its ringlike shape, circles around the corpus callosum. The ACC is involved in emotions, in executive behaviors, and in concentration and inhibition of competing responses that would make concentration and executive behaviors difficult. Impairment in the ACC has been correlated with traumatic disorders.

The ACC is active when detecting emotional signals from self and others (Critchley et al., 2004). The dorsal (top) ACC activates when fear of rejection occurs (Eisenberger & Lieberman, 2004). It is also activated when someone we love experiences pain or social ridicule. Overall, the ACC serves as part of the neural basis for cooperation. Damage to it results in reduced empathy and/or maternal behavior.

One way to introduce the insula is to ask clients if they ever had gut feelings about the emotional state of another person. The reason that they have these feelings is because the insula serves as a conduit between subcortical areas and the cortex. The insula draws on information from body areas, as well as from the amygdala and hippocampus. As an illustration of how the insula can be sensitive to internal body states, a series of studies examined the brains of Tibetan meditators. The longer the monks practiced meditation, the larger their insulas, due to neuroplasticity. It also links the mirror neuron system (discussed below) with body states. Based on all of these socially focused skills, some researchers have developed an insula hypothesis of empathy (Carr, Iacoboni, Dubeau, Mazziotta, & Lenzi, 2003). Accordingly, the insula is one of the brain areas associated with empathy (Iacoboni & Lenzi, 2002). It is a key intersection in the brain, positioned between the frontal cortex and other limbic areas (Iacoboni, 2003). The insula also works with the PFC to interpret and regulate emotional experiences.

## CLIENT EDUCATION

Have you ever had a gut feeling about what another person might be feeling? That intuition is made possible by a part of your brain called the insula.

Mirror neurons were initially discovered in macaque monkeys when researchers learned that specific neurons fire to replicate what another individual is doing (Rizzolatti & Arbib, 1998). For example, when a person observes someone move her arm but does not move her arm herself, neurons in her own brain fire as if she were moving her arm. One theory suggests that mirror neurons have garnered considerable attention in the mainstream press as well as in pop psychological models. It is important, however, to focus on what science can support. Mirror neurons were critical for our evolutionary development, because they helped one individual predict the goal-directed behavior of another. This skill provided an adaptive advantage to stay safe from potential danger if an observed individual meant harm. When perceiving positive emotion, mirror neurons are associated with the capacity to experience empathy (Iacobini, 2003; Miller, 2005). Mirror neurons are found in various areas of the PFC, posterior parietal lobe, superior temporal sulcus, insula, and cingulate cortex, all areas that are associated with social brain networks.

Like mirror neurons, another type of socially sensitive neuron is found in abundance in humans but largely absent in most other species. Named for its spindly shape, so-called spindle cells were first identified by Constantin von Economo (1929), who noted that their long axons allow them to communicate with other neurons over relatively long distances. They are found in the OFC,

insula, and ACC, especially in the right hemisphere, and are rich in serotonin and DA receptors. Spindle cells respond extremely quickly to socially and emotionally evocative interactions, providing for greater behavioral flexibility to deal with complex social environments. They are involved in making snap judgments and solving complex problems in emotionally charged social situations.

Spindle cells start their migration to portions of the OFC and ACC when people are about 4 months of age. How richly and where they connect with other cells depends on the interpersonal environment the child experiences. A warm and loving family atmosphere promotes strong and healthy connections while family stress with poor bonding results in weak connections (Allman, Erwin, Nimchinsky, & Hof, 2001). During development, they are vulnerable to neglect, abuse, and trauma, which results in deficits in subsequent social intuition.

## NEUROSCIENCE

There also appears to be hemispheric asymmetry in talent for detecting emotions. The right hemisphere is adept at intuiting emotions of other people, independent of the personal significance of those other people (Etcoff, 1989). In fact, the right hemisphere is so perceptive at detecting emotion that some researchers have considered patients with aphasia as having an edge at lie detection (Etcoff, Ekman, Frank, Magee, & Torreano, 1992). This point is based on the fact that aphasia is generally associated with damage in the left hemisphere, leaving the right hemisphere dominant.

Since information from the right ear is processed by the left hemisphere and information from the left ear is processed by the right hemisphere, listening to someone speak with the right ear is associated with decoding the meaning of the words. In contrast, listening with the left ear decodes information and the emotional inflection in the speaker's voice. Those who respond well to cognitive-behavioral therapy (CBT) to alleviate depression tend to favor right-ear processing relative to those who do not respond to CBT and do not respond to right-ear processing (Bruder et al., 1997).

The mirror neuron system (MNS) contributes to the feeling of emotional empathy. In contrast, the area at the junction of the temporal and parietal lobes, called the temporoparietal junction (TPJ), contributes to feeling cognitive empathy. Cognitive empathy involves knowing intellectually what another person is enduring.

As therapists, we need to balance our MNS and TPJ empathy systems. While our MNS allows us to “feel” what our clients feel emotionally, through



monitoring our own gut reactions to clients, we can convey emotional empathy. We also can “understand” our clients through our TPJ system by maintaining cognitive empathy without being engulfed in feelings of rage or hopelessness.

When putting many of these skills together, psychologists have described the socially intuitive skill referred to as the theory of mind (TOM), which represents the ability to look at another individual and develop a hypothesis about what he or she might be thinking. This ability is largely absent in people with autism spectrum disorders (ASD).

The social brain systems that contribute to the TOM include the amygdala, the insula, the right temporal parietal junction, and the anterior cingulate (Siegal & Varley, 2002). It appears that there is some asymmetry, with the R-OFC involved in decoding mental states and the L-OFC involved in reasoning about those states (Sabbagh, 2004). Finally, there are three major brain areas associated with the TOM, including the mPFC for self-related mental states, the superior temporal sulcus for goals and outcome, and the inferior frontal area for actions and goals (Frith & Frith, 2001). The TOM is particularly important when looking at an individual whose expression is neutral or somewhat ambiguous.

## **Working with Facial Expressions**

Paul Eckman (1990), expanding on the pioneering work of Charles Darwin a century earlier on emotional expression as seen in the face, meticulously developed a cross-culture taxonomy of facial expressions. The subtleties of facial expressions are quite significant in an integrative approach to psychotherapy. Facial expressions represent a window through which you and clients communicate on a nonconscious level, utilizing many of the therapeutic brain networks.

We view objects and faces with different brain systems. The facial-reading systems include the amygdala, fusiform gyrus, and supertemporal gyrus (Gauthier, Skudlarski, Gore, & Anderson, 2000). We can read faces when they are right-side up but not when they are upside-down (Kilts, Egan, Gideon, Ely, & Hoffman, 2003). When we view faces upside-down, we view them as objects and are unable to read their emotional content. ASD clients read faces as if they were viewing objects.

By using your facial expressions, you can model and influence client facial expressions and mood and change their mood through their MNS. Your expression of emotion occurs through the laterality of affect in the brain as well as the face. The feedback system is bidirectional: within you, within a client, and between the two of you.

Let us break this down level by level. Since the right field of vision for both eyes sends information to the left hemisphere of the brain and the left field of vision sends information to the right hemisphere of the brain, when looking at a client's face, your left field of vision is looking at the right side of the face, which is controlled by the client's left hemisphere. Since the client's left hemisphere is

associated with positive emotion, your right hemisphere (which is more talented than your left at reading emotions) is picking up on whether the client may be experiencing positive emotion. Since the client is doing the same thing with you, both of you are sharing a significant amount of emotional information below conscious awareness. In other words, you are nonconsciously sharing one another's mood.

Contracting muscles on the left side of the face activates right-hemisphere and negative bias, such as with a smirk. Researchers have attempted to identify all the factors associated with an authentic smile and have noted that bilateral smiles elevate L-PFC and positive moods. In addition to the symmetry in the lower part of the face, researchers have focused on the area around the eyes. Guillaume Duchenne (1806–1875) identified the orbicularis oculi muscle around the eyes. An authentic smile, or what has been dubbed a D smile (with a bow to Duchenne), involves crinkling or crow's feet around the eyes. Non-D smiles (no crinkling around the eyes) possibly mask negative states and are more likely to be asymmetrical in the lower part of the face. While D smiles are associated with left-PFC activation and involve positive emotion, non-D smiles involve R-PFC activation and negative emotion (Ekman, 2007).

Smiling kindles positive moods, both when expressed and when witnessed. Perceiving the smiles of others triggers the release of DA (Depue & Morrone-Strupinsky, 2005). Even presenting smiles for a fraction of a second followed by neutral stimulus increases the positive reaction to that stimulus (Dimburg & Ohman, 1996). In the past, it was assumed that if a person smiles or even laughs during a stressful situation, it is reflected as incongruence in the psyche. Yet smiling during periods of stress decreases cardiovascular arousal back to baseline levels (Fredrickson & Levenson, 1998).

Ekman and his colleagues (1990) have shown that a variety of facial expressions have been identified across cultures, and these expressions cannot be totally inhibited. Dubbed “microexpressions,” they essentially leak out for a fraction of a second. Therapists can be trained to detect microexpressions consciously. You and your clients are already detecting many of these microexpressions on a non-conscious level. Pulling the information into conscious awareness can enhance your detection of client moods.

Laughter is indeed good medicine, not only in general but also in therapy. Laughing triggers multiple physiological benefits. Breathing out, as is the case with laughter, triggers the vagal nerve and the parasympathetic nervous system, increasing relaxation. One way to explain the benefit of laughing to clients is to note that when they laugh, it is all exhaling, which accesses the parasympathetic nervous system. This is in contrast to breathing in, which is more like a gasp and accesses the sympathetic nervous system. Laughing also exercises and relaxes the muscles and lowers overall heart rate and blood pressure (Kuhn, 1994; Pearce, 2004). Laughter decreases overall stress by a variety of routes, by lowering cortisol levels and by providing a boost to the immune system, such as through increasing natural killer cell activity (Berk et al., 1988; Takahashi et al., 2001). From an

epigenetic perspective, laughter has been shown to alter gene expression as well as increase longevity and improve cognitive function (Hayashi et al., 2006; Yoder & Haude, 1995). Not surprisingly, laughter stimulates the DA reward system (Mobbs, Greicius, Abdel-Azim, Menon, & Reiss, 2003). When clients do not feel like laughing because they are too anxious or depressed, motivate them to “fake it to make it” by practicing with them and by suggesting that they practice through watching funny movies with friends.

## CLIENT EDUCATION

The saying “laughter is good medicine” is true. It *is* good medicine. The more you practice laughing, the more likely you will feel like laughing, and the more likely you will feel good.

Kindling laughter circuits activates the supplementary motor area (SMA). From the SMA to the insula and then to the amygdala, this network of neural activity together enhances overall well-being. When sharing a laugh with clients, both of you experience mirth and shared understanding as well as a psychological boost from humor. Sharing humor has been shown to aid in reducing anxiety, stress, and depression (Deaner & McConatha, 1993; Wooten, 1996; Yovetich, Alexander, & Hudak, 1990). Humor has been shown to boost self-esteem, energy, hope, and sense of empowerment (Bellert, 1989; Martin, Kuiper, Olinger, & Dance, 1993; Wooten, 1996).

## Pulling Practical Neuroscience Together

Kindling all the therapeutic brain networks just described not only enhances the alliance, reduces anxiety and depression, and boosts the immune system, it also enhances the placebo effect. Significant literature has accumulated on the benefits of the placebo effect in the amelioration of medical problems. Maximizing the placebo effect includes combining good listening skills, empathetic attention, gaze attunement, appropriate touch, communication style (language and prosody), welcoming physical appearance, physical proximity, and asymmetrical power dynamics between therapist–client (Kradin, 2008).

Effective therapy taps into all the social brain networks by enhancing close and trusting relationships, the same networks that drive secure attachment. Neuroplasticity can be optimized through the activation of the therapeutic brain networks with moderate states of arousal that clients experience when challenged. When you provide this multimodal input, clients enhance neuroplasticity, including glutamate and its NMDA receptors. Insights that you offer in therapy are best if they provide a means for the activation of affect and cognition. Traditionally, therapy has focused on the co-construction of new narratives,

which has worked to reconsolidate memories that code in meaning and factor in a sense of self-confidence and resiliency.

Understanding the importance of activating their social brain networks helps motivate clients to expand their social support system networks, even when they do not want to do so. These networks are intricately entwined with those underlying a positive sense of well-being. Social support, including therapy, kindles not only the social brain networks but also the reward systems in the brain. Specifically, the empathetic networks involving the ACC, insula, and MNS work together with DA neurons which are associated within the circuit involving the nucleus accumbens to code the feeling of and the anticipation of pleasure. Clients often strive to please their therapists, in part to activate the social brain networks. The same social brain networks are operative for clients in groups when they feel supported and understood by peers and strive to repeat the experience by coming back to the next group session.

Unfortunately, this system works to reinforce negative behaviors as well. Secondary gain can be powerful when clients receive a great deal of support and attention for being depressed or anxious. This type of reward encourages client brains to repeat the state that preceded getting the reward. Essentially, when they receive rewards when they feel bad, they will be paradoxically and implicitly encouraged to feel bad again, even if those feelings or behaviors hurt them over the long term.

Informing clients that these activity-defendant social brain networks must be continually kindled to maximize mental health can increase their motivation to engage in social activity. These social brain networks can be introduced as critical parts of the mental health system. The polyvagal system includes not only nerves that extend to many of the organs in the thoracic cavity but also the muscles in the lower part of the face. By engaging in mutually supportive relationships, clients can regulate their heart rates. This social engagement system allows both clients and their companions, engaged in a conversation, to read the gut feelings of the other by intuiting the other's emotional state through mirror neurons and spindle cells. By practicing empathy and emotional intuition, attachment skills can be maximized, earning clients a greater sense of internal security. The safe emergency allows the client to transform old, maladaptive habits into adaptive behavior, positive moods, and resiliency. Because psychotherapy requires neuroplasticity, the introduction of safe states of mind and new behaviors that are sufficiently practiced enough entrain the brain to establish enduring traits.

The challenge is to keep clients' brain bias toward their PFCs and hippocampal networks instead of amygdala-dominated states. Dynamic stability, resiliency, and affect regulation involves "self"-organization, borrowing a term from complexity theory to facilitate a leap to a higher level of mastery. Considering the affect asymmetry and the ratio of activity in each hemisphere, therapy involves bumping the set point so that clients' R-PFCs do not dominate. Finally, given that clients, like most people, can spend 30% of waking hours in DMN, helping them make this network useful involves teaching them

to engage their PFCs to bring to consciousness those thoughts, daydreams, and ruminations and to develop insight into how they relate to solutions in the current circumstances.

The neurodynamics of the brain cannot be coherently modeled after the simplistic and outdated Pax Medica perspective. While Pax Medica employs linear causes and effects, it is clear that the brain is a complex system characterized by nonlinear change. As complex self-organizing systems, humans tend toward increasing complexity. Optimally, we maintain continuity and flexibility while we need new inputs to expand, just as a lake maintains fresh water, unlike a stagnant pond. Our brains exist in chaotic but stable states. In far-from-equilibrium conditions, as when a person's life is in flux, there is sensitive receptivity to small changes in life that can later result in large changes. In other words, clients are more receptive to making changes when their lives are in upheaval.

Since clients need a safe emergency to change, they need the support and sense of safety that the therapeutic relationship provides through the social brain networks while at the same time the encouragement to step out of their comfort zone so that they can produce neuroplastic change in the brain. Changes in clients' experience create changes in their brain biology, while the inverse is also true: Changes in their brain biology affect experience.

Following a rich, initially philosophical and now scientific tradition beginning with Heraclitus (550 BCE) who pronounced "Everything flows and nothing stays. . . . You cannot step in the same river twice," complexity theory has emerged as a multidisciplinary field of inquiry that examines how complex systems change. Humans are certainly complex systems, and for that reason, change in humans occurs nonlinearly. After a period of far-from-equilibrium conditions—essentially a period of turbulence in clients' lives—they can leap to a higher level of organization.

## NEUROSCIENCE

Psychology can borrow the term "attractors" from complexity and chaos theory to represent how emotions act as attractors because they "motivate" clients to act. While strong attractors require little energy, weak attractors require energy and effort. Similarly, neural networks that require the smallest energy expenditure occur effortlessly. Lasting psychological change usually occurs after a new habit has been learned, such as feeling confident in the face of stress.

After a client achieves good coping skills, he uses less energy to deal with a stressful situation. Durable affect regulation can be seen as a type of "self"-organization. This means that the client can grow and adapt to

(continued)

*(continued)*

more complex situations. Therapy is potentially most advantageous as you look for and find periods of flux (readiness for change). When those “far-from-equilibrium” conditions occur, you can introduce a thought or stir a feeling that can trigger a ripple effect, leading to a change of plans. States of mind (in Complexity Theory weak attractors) can become enduring traits (strong attractors) through practice and neuroplasticity. Brain-based therapy strives to induce repeated states (weak attractors) such as positive moods, which, when repeated often enough through neuroplasticity, become traits (or strong attractors).

Meaning is biopsychosocial. It comes from the relative compatibility of biological and psychological states, and the interpersonal experience. Because these states co-exist in varying degrees in the flow of time, meaning too varies. While there is a general degree of continuity, there is a natural tension between stability and change. Ideally, through development of “self”-organization, the client’s sense of self-identity, there is a nonlinear progression in meaning to leaps to higher levels of organization in the client’s sense of self-identity.

You can assist clients to disinhibit the expression of adaptive patterns that have already been developed but are rarely implemented (Aleksandrowicz & Levine, 2005). In other words, you can help strengthen those neural networks that support adaptive behaviors and weaken those that inhibit those behaviors.

## NEUROSCIENCE

During the last 25 years, evidence has been building that psychotherapy changes the brain. For example, psychotherapy and its effects on the brain show:

- Reduced amygdalar activity in treated clients with phobias (Straube, Glauer, Dilger, Mentzel, & Miltner, 2006), panic (Prasko et al., 2004), and social phobias (Furmark et al., 2002).
- Reduced frontal activity in treated clients with depression (Goldapple et al., 2004).
- Increased ACC activation in clients with PTSD (Felmingham et al., 2007).
- Increased hippocampal activity in people with depression (Goldapple et al., 2004).
- Decreased caudate activity in clients with OCD (Baxter et al., 1992).

One of the main conceptual shifts offered by brain-based therapy includes teaching people about their brains to boost their confidence in therapy. No longer does therapy need to rely solely on clients' trust in therapists. This trust can be built on by adding science instead of merely theory in the rationale for promoting insight and behavioral change. By explaining the brain networks involved in anxiety and depression, as well as how to remediate dysregulation of these networks, you can foster greater trust and confidence. This approach is similar in one respect to narrative therapy, where the therapist helps clients externalize the problem to reduce stigma while it encourages the alliance and discourages resistance.

Like a brain tune-up led by you, the therapist, you can say, "This is our common project." Clients can be encouraged to make specific behavioral changes to rewire their brains. When they invariably note that they are feeling not quite ready and fully confident that they can face the challenge of making the behavioral change, you may note: "To rewire your brain, you will need to do some things you don't feel like doing." If clients request delaying the changes until they feel less anxiety, you may respond by saying "Moderate anxiety is a good thing. It helps neuroplasticity." Then, to provide the "safe" part of the safe emergency, you may say, "Don't worry, I'll be there with you as your partner."

