Integrated Body-Mind-Spirit Social Work
Appendix II: The Brain, the Body and the Mind

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Overview of the Chapter

Introduction

The idea that the brain is the center of perception and behavior is not new. Several hundred years ago BCE, the Greek "father of medicine" Hippocrates and the scholars who preceded him guessed that thought and consciousness happen in the brain. Down through the centuries, neuroscientists have confirmed that the brain creates our thoughts. However, what we now are coming to understand through emerging neurosciences is how much our thoughts, experiences and behaviors *change* the brain, which in turn changes how we think, experience and behave, encountering and altering back and forth in an endless cycle.

As social workers, we have long known about the interplay between the environment and the individual; about the potential for stressors and for positive change. Our biopsychosocial model captures that relationship between the individual and the environment. Neuroscience[1] increasingly confirms that reciprocity.

"Biopsychosocial genomics" is a developing model for integrating brain science (particularly neuroplasticity) into this familiar social work lens:

> "…Neüroplasticity [sic] research describes how neurons within the brain proliferate and grow new connections across the life span, whereas psychosocial genomics describes the processes by which psychological and

> social experiences activate or deactivate genes, thereby driving the development of new neural pathways. The interplay of these sciences reflects a vision of humans as inherently resilient; psychosocial factors appear to stimulate gene expression within neurons, resulting in alterations to the structure and function of the brain. Discoveries from both fields reveal that experience and learning can contribute to positive change, even at the neurobiological and structural levels. (Garland, 2009).

What this teaches us as social workers is that the way a client has interacted with his or her world (and been acted upon by it), can change that client's brain. This is true not merely psychologically or emotionally, as we are used to thinking about those things in an abstract, metaphorical sort of way, but *directly arising* from the organ itself (the brain) and its extension (the nervous system and the body). Like a sort of physical Law of Karma, the trace of every pleasant, unpleasant, comforting or scary experience leaves its mark on the brain, and who we are is generated at least in part from those traces.

We will see how not every experience is equal: for example, the things we experience as newborns through the first two years of our lives (and, to a lesser extent, through the rest of childhood) have a more profound impact than the same kinds of events might in adulthood. This is why it makes sense to think about how the clients' brain developed, how that client attached to primary caregivers, what events have impacted him or her, and how all this is directly affecting how the client feels. Medications prescribed for many of our clients' ills may help to tamp down the effects of a malfunctioning brain (like an anti-anxiety drug) or to augment inadequate neural function (like an antidepressant), but they do not, to our current knowledge, change the brain permanently (Greenberg, 2013; van der Kolk, 2015). However, experience does, including the experience of psychotherapy (Schore, 2004; Cozolino, 2010). Psychotherapy focused on movement, breathing, mindfulness and emotionally corrective experiences (van der Kolk, 2015, Cozolino, 2010) are looking to make changes *with* and *to* the brain. Research indicates that neural integration can be directly improved with using psychotherapy and brain-body approaches such as mindfulness and bio-feedback, movement and rhythmic activities (van der Kolk, 2015; Perry, 2006; Porges, 2011).

I. Neuroanatomy: The Basics for Social Workers

As noted, our brains evolved and grew more specialized; different regions controlled different functions.

To describe the regions of the brain, here is a simple mnemonic from psychotherapist and author Bonnie Bradenoch: Fold your thumb across the palm of your hand, and then lightly close your fingers around it. You can say that your wrist and the heel of your palm roughly resemble the brainstem and diencephalon (although your wrist is disproportionately thick). Your thumb, in the center of your hand, is the limbic system in the center of your brain, and the back of your hand

and wrapped fingers are the cerebral cortex, a thin layer of cells starting from the back of your brain, covering the sides and extending down the front (adapted from Bradenoch, 2007).

The Triune Brain

In the 1970's, neurologist Norman MacLean offered a simple description of how the brain evolved in humans, and how it develops, in the same order, in the fetus. First is the "reptilian brain". Just as it sounds, this is the kind of brain that we had as ancient reptiles, and that reptiles have today. It is composed of a brainstem and diencephalon (some basic elements found in our limbic systems). The brainstem controls our autonomic functions (things you don't have conscious control over) and manages homeostatic systems to keep things running smoothly in the body, such as temperature regulation, digestion, elimination and sweating. The diencephalon is the bottom of our limbic system and includes the hypothalamus. This region regulates appetite, eating, and some basic learning: this is food, that is danger, and so on.

Next in our evolution came what Maclean refers to as the "paleo-mammalian brain", or "old mammal-brain". Small mammals have the reptile brain but added a bigger, more varied limbic system on top of it. This brain does more things, learns more and in a more detailed way, remembers more, and it can sort things into finer categories: go here for food, not there; bright colors equal poison, baby faces should be cared for. One important advance of this brain was *bonding*: this new and improved limbic system added pleasure and connection to what was previously a binary, yes/no way of experiencing the world. Sensations of physical closeness interpreted in the paleo-mammalian brain are now more finely articulated and coded in the brain, with a release of reward chemicals accompanying them. Chemically speaking, in the mammal brain, connection equals pleasure. Adult mammals, unlike reptiles, stress themselves and make themselves vulnerable to predators, all to stay and care for their young. Reptiles heedlessly slither off as soon as their eggs are laid. This, of course, is because reptile babies hatch as fully formed and autonomous, if tiny, versions of their adult selves. Mammal babies are barely functional. What would make an adult mammal stress and endanger itself for a still-forming baby mammal? What makes a baby mammal cling tightly to its warm, furry mother, and then spend the rest of its life seeking some of that closeness with siblings, neighbors, mates, and offspring? It's in the delight of warmth, safety, and comfort. Thus, mammals find strength in close-knit families, are more adaptable to varying conditions, can learn and remember food-gathering strategies, and cooperate and communicate with one another in societies that become increasingly complex as evolution progresses.

Now for the neo-mammalian brain. This brain is one of the defining traits of advanced, "new" mammals. The cortex, on top of and encasing the limbic system, is the most sophisticated yet. Its cortices (cortexes) can generate internal images, prepare for future events, speak, and modulate subjective experiences to conform to its environment. This brain creates meaning out of abstract symbols far removed from the reality they reference. All this, and that's not the only thing that has changed. All the way back down to the diencephalon, the earlier, older parts of the brain have expanded and specialized their functions even further, so that they can interact with the later-arriving structures like the cortices (MacLean, in Cozolino, 2010).

The brain system works in sub-systems, including the ones we've discussed so far, and that means that parts of the brain have to talk to each other fluently and efficiently. The brain also needs to be able to activate and suppress different areas at different times. For example, if the cortex doesn't have lots of neural fibers - pathways for electrical impulses to travel - extending to the limbic system, it can't control the amygdala. We will discuss this in greater detail when we examine neural integration later in this chapter.

The Brain: Up and Down

The Brainstem/Diencephalon is located in the lower, back part of the brain. It includes in its core the Reticular System (RS) and controls "the four A's" of states of consciousness: Awake, Asleep, Arousal and Attention. (Heller, 2002). Many social work clients with chronic sleep/wake problems are likely to have some dysfunction in this system. This region controls bodily functions (following the dictates of the hippocampus for rhythm) such as digestion, perspiration, breathing, reflexes and elimination. The brainstem is where we see the least amount of plasticity and the least experiential change. This makes sense. You wouldn't want your brain to change the basic blueprint of how you regulate and maintain your breathing - that function should be well-established and unaffected by your environment as much as possible. A functioning brainstem is the minimal requirement for viability, and when it is not functioning the brain is said to be dead. In fact, the quickest means of execution is to sever the brain from the body at the brainstem in the back of the head.

The Limbic System

Evolutionarily the "paleo-mammalian brain", this area is made up of a number of substructures including the thalamus, hypothalamus, amygdala and hippocampus, among others. For our purposes here, we will talk mostly about the amygdala and the hippocampus.

Attachment, emotional evaluation and expression (inner and outer experience of feelings), autobiographical and factual memory are all concerns of the limbic system. This area also appraises meaning (Siegel, 2007; Cozolino, 2010).

- *The Hippocampus*

Located under the cortex, this structure starts at the bottom of the limbic system and curves around to the top, looking a little like a seahorse's tail, which is where the name "hippocampus" comes from. The hippocampus helps to code and retrieve factual or "explicit" memories such as information and events. It communicates with the brainstem to regulate the functions the brainstem controls, setting circadian rhythms which dictate sleep, appetite, digestion and blood pressure. The hippocampus interacts with the amygdala (more on that shortly) by helping to give context to what is happening, and as van der Kolk would say, “knits” incoming sensory information into a coherent, continuous story. This capacity helps us to soothe ourselves when our environment is stressful; the hippocampus gives context to what is happening. This will come up again when we discuss neural integration. These two functions soothe and regulate emotions by placing them in time and space by accessing short-term memory (in the cortex).

When we are calm, sensory input from the amygdala activates the hippocampus, and senses, emotions, memory and continuous awareness all weave together seamlessly. Under stress, the amygdala *inhibits* the hippocampus, or takes it temporarily off-line.

- *The Amygdala*

Louis Cozolino wrote, “The amygdala never forgets”, and that’s an easy way to remember its function. The amygdala is nestled inside the loop of the hippocampus. Actually, there are two twin structures on either side of the limbic system, properly known as the *amygdalae*, but we’ll follow common usage and refer to it here as the singular *amygdala*.

The amygdala sorts and ranks the importance of all sensory information that comes into the body. It quickly assigns broad, simple designations to any sensation: known/unknown, pleasant/unpleasant (Heller, 2002). The most important decision the amygdala makes is whether or not something is a danger. If you have experienced something negative in the past, the amygdala will instantly react; you yank your hand away from a glowing-red burner on the stove if you’ve been burned before. If something is unfamiliar, the amygdala has less information, which is why unfamiliar things make us draw back instinctively; the amygdala is more likely to default the new information as “danger”. In other words, things are unsafe until proven otherwise. If something is categorized “unsafe”, the amygdala sends a signal along the HPA axis. The *Hypothalamus,* just in front of the amygdala, signals the release of Norepinephrine from the *Pituitary* gland (in front of the hypothalamus) and cortisol. This triggers the *Adrenal* glands on top of the kidneys to release adrenaline throughout the body. This chemical cascade sets into motion the famous “flight-or-fight” response.

When the amygdala is calm (current sensations are familiar and at least neutral, if not in fact pleasant), then the hippocampus interacts with it to sort and code our ongoing experiences into the “story” of our daily lives: I’m doing this, now this is happening, etc. At the end of the day, you could tell someone about your day, in the correct order and with a reasonable amount of accurate detail, and describe the emotions that you experienced with each event. As we shall see, when this is disrupted by stress, the amygdala springs into action and shuts everything else down and our brain is thrown out of synch.

The amygdala is always in the present, sorting through and ranking what is happening *now*. It doesn't, however, place things in context. That's the job of the hippocampus interacting with the cortex. A loud fire alarm will make the average person jump and feel slightly stressed as the amygdala says "Loud! Unpleasant! (and, with experience of fire alarms) Fire!" It takes the hippocampus connecting with the cortex to remind you that it's just a drill and that you can and should calm down. If the fear is strong (let's say, for someone who was once trapped in a burning house), the response may well be faster and more intense. Now the amygdala insistently screams "FIREFIREFIREFIREFIRE!" and the hippocampus, usually *activated* by the amygdala, is now overloaded and *shut down* by the amygdala. It might take that person much longer and with more input (someone speaking to them calmly and directly, reminding them of the drill) to start to override the panic message, remember the context (the email that went out yesterday warning of the drill) and then calm down their fight/flight response. Even clients who do not have a particular trauma history may experience problems with this form of neural dis-integration.

The amygdala records and sorts (safe/unsafe, pleasant/unpleasant) sensations before we are born, and it continues forming throughout the first few years of childhood (Schore, 1994). We sometimes refer to the sense-driven records of the amygdala as "emotional" or implicit memories. Once something is sorted and designated by the amygdala, it can trigger powerful emotions throughout our lives. The smell of your (fondly remembered) grandmother's house, the taste of the cotton candy that made you sick, the sound of a tornado siren - these may cause you to react decades after experiencing them only once, even if we were too young to have a conscious memory of the event. We lack conscious, "explicit" memory from that time because the neural fibers connecting the hippocampus to the cortex don't become strong enough to record long-term memories until we are about 3 years old. This is "childhood amnesia". The amygdala, however, records things from the womb (about 8 months' gestation) onward and that coding (for example, intense aversion to the smell of cotton candy) remains in place - which is why Cozolino observed that it "never forgets".

The Cortex

The cortex was the last on the scene, evolutionarily speaking and distinguishes primates from mammals; thus, the "neo-mammalian" brain. This brain once again is more diversified and sophisticated than the older limbic system and brainstem, so it adds and elaborates functions. This larger, more organized brain region also spurred greater differentiation in those already-existing sections, as they connected to the cortex and interacted with it.

For our purposes, we will focus mostly on the pre-frontal and frontal cortex, which is the area above your eyebrows up across your forehead; or, in the example of your closed hand, your fingers up past your second knuckle.

The prefrontal cortex (PFC) is experience-dependent, which means that it changes with your experience. Every time you learn something, for example, your PFC changes in a minute way. That change probably won't be permanent unless the experience is exceptionally powerful, or is repeated many times, but even so, if technology permitted we could see impossibly small changes happening to your brain all the time. Similarly, your hippocampus changes slightly with increased memory retention. In the days before GPS systems, London cabdrivers seeking a license had to learn what was called "The Information" - every street and alley in the city. Autopsies done on their brains showed enlarged hippocampi compared to the average brain. However, most of the rest of the limbic system doesn't change that much over our lifetime. Finally, the brainstem changes very little after we are born. This, as we've said, is a good thing. Unusual cases where experiences have changed (enlarged) the brain stem, often from extreme sexual abuse in early childhood, indicate profound damage and a very basic, pervasive level of dysfunction in the child (Perry 2006; De Bellis, 1996).

The experience-dependent nature of the cortex is at the heart of what we talk about when we talk about changing thoughts and behavior as a way of creating real change in clients' lives. As mentioned in the section about the limbic system, the PFC helps to put sensory input into a larger context. It works with the hippocampus to do this, but it is even slower than the hippocampus, which in turn is slower than the amygdala.
To explain it another way: the cortex makes conscious decisions to attend to or ignore something. Using our fire drill example: the hippocampus pulls the conscious memory of the email explaining the drill from our medium range explicit memory. The cortex examines that memory and analyzes the difference between that information and the screaming, panicking amygdala. It concludes that there is no reason to be afraid, despite what the amygdala is saying, and begins soothing inner talk as we calm ourselves down: "It's ok. It's just a drill. The noise is upsetting but there's no danger. Take a breath and relax". Helping a client learn to reflect on what is happening and observe their own emotions without getting distressed by them is a classic example of the clinical usefulness of mindfulness, and it is central to an I-BMS approach.

Additionally, the cortex organizes information, plans, problem-solves, projects into the future, and generalizes information. To sum it up: This area of the brain does all our "rational" thinking.

As noted earlier, having a complex brain with functions divided between two sides allows for much more sophisticated activity. They inform each other, knit information together and maintain balance (Siegel, 2007).

The Brain: Front and Back

Other areas that we won't be discussing in detail except for what they control and where they're located include:

Frontal cortex: motor behavior, expressive language, executive function, abstract reasoning, directed attention. This includes the orbital-medial prefrontal (OMPFC) and the dorsal lateral prefrontal (DLPFC) cortices. *Located behind the PFC, on the top of the head*

Cingulate cortex: integration of inner and outer experience, linking rest of cortex with somatic, emotional experience. *Located behind the PFC, inside the middle of the brain, touching the front of the limbic system* (Cozolino, 2010)

Parietal lobe: linking senses and motor, proprioception (where one's body is and how it is positioned). *Located at the top of the brain*

Occipital lobe: visual processing. *Located at the back of the brain*

Temporal lobe: auditory processing, receptive language and some memory. *Located at the sides of the brain.*

A quick way to orient yourself to the areas of the brain is to remember that the *front* of the brain largely has to do with *perception of internal states*, and the *back* with *perceiving the external environment.*

The Brain: Left and Right

The left hemisphere governs things like linear thinking, grammar and syntax (the structure of speech), planning, sequencing, and conscious reflection on our thoughts and emotions. The right hemisphere is closely involved with emotion and prosody, the rhythm, expressiveness and "music" of speech. The right hemisphere is more closely linked to the amygdala than is the left; it has more and thicker neural fibers descending into that part of the limbic system. Unsurprisingly, then, when we consider the function of the amygdala, the right hemisphere is linked with associative learning (which things are safe, scary, comforting, etc.), sensations from the body and unconscious beliefs about the world. These deep, forgotten right brain-amygdala connections make up what psychoanalyst Gregory Bateson called "the unthought known".

Cortex Development

The cortex is the last part of the brain to develop, and does not fully finish growing until around age 25 or so (or even 30), which is why adolescents and young adults have trouble with some of the most sophisticated kinds of reasoning (delayed gratification, planning for the future, evaluating consequences, generalizing experience).

The cortex has vertical columns of neural pathways that tend to specialize in functions like vision. Cross–connecting horizontal interneurons let us coordinate activities (for example, see and hear simultaneously) (Siegel, 2007). The hemispheres connect to each other through the corpus callosum, a “fleshy bridge” in the middle of the brain, sheathing a thick bundle of long neural fibers. The corpus callosum is small in childhood, so the connection is weak and the hemispheres don’t interact as much. Also, the left hemisphere develops more slowly than the right. This is why we are dominated by our right brain in childhood. The insula, which helps to create a highway for information from the body up to the brain, creates an emotionally relevant context for sensory experiences, takes this information from the parietal lobe (links senses and movement, gives us a perception of how our body is oriented in space) to the limbic system and back to the body. This is where bias, or schema based on previous experience, comes in; our implicit memory chimes in to interpret what is happening. “This is when we can hold things in check if we are used to slowing things down, identifying them and putting them to one side” …[t]hen the information flows to the medial prefrontal cortex where it is integrated into thought. When this results in empathy we bodily relax. This is a resonance circuit” (Siegel, 2007).

In childhood, our right-hemisphere-dominated brain causes our emotions to outweigh our thinking, and we have poor control over our impulses. Memories from that time, encoded in the right brain, are sensory-based and are usually connected to strong negative emotion; typically, out of our conscious awareness. This is why in adulthood we react instantaneously to a perceived threat before we can “think it through”. It’s also why we usually don’t have access to those memories through the conscious (left-dominated) brain.

The threat may be one that anyone would perceive as dangerous (a coiled snake, a loud noise) or it may be something specially coded in our emotional brain (an angry woman, feeling embarrassed). Much of psychotherapy, in various modalities, aims at making these deep associations, these “unthought knowns”, conscious. Cognitive- based therapies do this in order to eliminate wrong thinking and expand choices. From a brain-body perspective, we will see in the next section that making unconscious, emotionally-laden associations known actually changes the brain and how it functions as an integrated whole.

II. Neuroplasticity: The Brain Model for the 21st Century

Our brain interprets the signals from our body about our environment, and then directs our responses to that environment. These responses range from automatic reflexes controlled by the brainstem to carefully considered behavior in complex situations, dictated by the subtle weaving-together of information between the limbic system and the cerebral cortex.

As neuroscience allows us finer and finer observations of the workings of the brain, we are starting to understand more about how it works, especially about the limbic-cortical complex that is sometimes described as “the social brain” (Tanguey, personal communication, 2013). Neuroscience in the 1800s and 1900s was divided on the question of how exactly the brain worked as a system. Some argued that the brain worked like an assembly line: each part doing its separate function over and over. Others felt it works more holistically, like a symphony: each instrument's part rises and falls, sometimes playing the lead and sometimes more muted, and always responding to one other. For example, if the violin player is getting over a cold and is playing more weakly than she should, the brass section may play more softly than usual to allow her part to be heard properly. The overall effect is of a whole; the audience is unaware of individual musicians and experiences only the uninterrupted music while the separate parts compensate flexibly as needed to maintain function and flow.

This flexibility, or plasticity (plastic is derived from the Greek for "moldable") is the umbrella term for several elements of this holistic view of the brain. The neuroplasticity model is a radical departure for how many Western scientists viewed the brain for the previous 150 years.

In the late 19th and much of the 20th century, the "doctrine of localization" was the dominant theory in neuroscience, although there had been a small cadre of maverick neurologists who continued to think of the brain as a responsive, changing system rather than a series of unalterable mechanical functions. Localization assumes that a) the brain never generates new cells the way the rest of the body does, and b) each area of the brain has a clearly identified function, and those never change either. This localization theory was applied to the neurologist Wilder Penfield's work in the 1930s identifying neural "maps"; distinct areas on the surface of the brain that would become activated when the left hand moved, for example, and a different map of neurons activated when the right hand moved. Most scientists assumed thee maps were permanent. More recent discoveries in the 1980s by Michael Merzenich began to validate the then-unfashionable plasticity model when he demonstrated, surprisingly, that these maps change when input to the brain changes. In one of a famous series of experiments, he surgically fused monkey's fingers together and noted the brain change from disparate finger "maps" to a single, large map (Merzenich, 1988, 1991; in Doidge, 2007).

Meanwhile, medicine has documented innumerable clinical examples of blind people having the visual cortex light up while "clicking" through obstacles, or experiencing activity in the visual cortex while tapping across a room with their cane. In those cases, motor input was "rerouted" to the visual centers and became, effectively, the same kind of input that would have come through the eyes. Clinicians also noted that some people with brain injury or malformations (TBI, stroke, cerebral palsy) seemed to have compensated brain function into undamaged parts of the brain, providing functions that should have been severely limited or entirely absent. This leads to the conclusion that under certain circumstances, the brain is able to shift functions from one area to another. This may involve forming new neuronal networks or actually growing new brain cells.

Neuroplasticity is involved in both adaptive and maladaptive changes. Neuroplasticity may allow a stroke victim to recover dexterity with much practice, but neuroplasticity can also account for negative changes, such as “phantom limb pain” after an amputation, which is caused by neurons “remapping” to create input from a limb that is no longer there (Cramer et al, 2011). Neuroplasticity is being investigated in many disciplines for many dysfunctions and injuries. A by no means exhaustive list includes: CNS (central nervous system) injury, traumatic brain injury, stroke, psychiatric disorders, pediatric and developmental disorders, neuro-degeneration and aging. (Cramer et al, 2011). Brain injuries and disorders are easier to study than mental illness, but disorders such as schizophrenia and addiction are also being examined for having a neuroplastic element (Cramer et al, 2011)

Brain plasticity, healing and learning are also closely related to brain development, specifically specialization. Specialization allows for faster and more sophisticated processes. Just as the human brain underwent gross changes through evolution, our brain continues to grow and alter itself over our lifetime. How the brain changes usually involves the connections between cells: a neuron links to other neurons, creating a faster, stronger pathway, or the connections deteriorate (Cozolino, 2010; Doidge, 2007; Siegel, 2007). This process happens more easily in some areas of the brain than others. The brainstem, as we discussed earlier, changes very little after birth. Other areas like the hippocampus, which helps to code and retrieve memories, changes (in a microfine way) every time we learn something new. Barring illness or injury, what changes our brains is *experience*. This is a good thing in many ways. We learn and remember new information, and practice skills until we grow proficient. We mature and slow our reactions and cope with unpredictable, frustrating others in socially acceptable ways. However, this also is bad news when it comes to things like trauma or abuse, which negatively change the brain; or early neglect, which starves the brain of experience. The most powerful experiences for a human brain come from interactions with other humans (Perry, 2006).

Understanding that the brain can change, and that experience is one of those levers, means that it is imperative that clinicians are well-versed in how the brain forms, what changes it and how to use the plastic nature of the brain to help our clients. This is a neurologically based mirror of much of Eastern thought, which posits that how we perceive the world *creates* our experience of it, and how we perceive can change.

An emerging focus for neuroscientists is how smoothly the various areas of the brain work together, which is “neural integration” (Bradenoch, 2008; Siegel 2007). Here’s how it works: Louis Cozolino refers to the “binary” quality of the brain. A cell is “on” (chemically activated) or it’s off, much like the way a light bulb is lit up or dark. A neuroelectrical impulse is stimulated by the receptors on the dendrites sparking a reaction along the body (axon) of a cell, or it isn’t. When an activating chemical is released by a cell into the space between it and the next cell (the synapse), it’s followed by an antagonist; a chemical that breaks the first chemical down and clears it away: an on-mechanism, then an off-mechanism. When it is set off, it may set off neighboring cells. If this happens frequently enough the cells become sensitized to that neurochemical reaction, and they “turn on” more easily - long term potentiation, or LTP (Cozolino 2010). This new sequence of easily-lit cells creates a neural “pathway”, where signals travel even faster than normal. If the reaction fails to be set off, then over time the cells will lose their sensitivity (long term depression, or LTD) and the “pathway” vanishes.

The brain extends that on-off quality to how each region of the brain functions, like a system of governmental checks and balances. When one part of the brain is too active, say the more emotionally linked right hemisphere, the left hemisphere kicks in and inhibits, or slows down, the right side. The obvious analogy that many science authors use is a car: you speed up with the gas and slow down or stop with the brakes. Naturally, you wouldn’t want to drive a car with weak, ineffective brakes, or one with too much or too little gas. You need both, in the right proportions, working quickly and in synch with each other, for the car to drive smoothly and reliably. This balance of complementary opposites is mirrored nicely in the Yin-Yang theory. Each function exists only in relation to the other, and in constant motion: turning on and turning off, strengthening and weakening, waxing and waning (Lee et al, 2009). There is a similar reciprocity in how the brain gives rise to, and in turn is affected by, experience, over and over, in an endless rotation.

II. Function, Movement and Modulation In The Brain: Neural Integration and Self-Regulation

Neural Integration

In action, the brain moves endlessly in all the directions we mentioned above: up and down, front and back, and left and right. How all the areas of the brain work in concert together, moving in all these directions at once, is referred to as *neural integration.*

Let’s review the issue of speed one more time as we enter a deeper discussion of neural integration. The amygdala in the limbic system takes the “low road” of perceiving and evaluating stimuli; it’s fast, but crude. The frontal cortex takes “high road”; a slower, more sophisticated path, attuned to the environment (van der Kolk, 2015). Both have advantages and disadvantages, and when they are working in synch, the amygdala evaluates quickly (but crudely) and then the cortex gives a slower, more “attuned” interpretation of the situation. In other words, the amygdala makes you jump back from the snake; the cortex takes a second look and realizes that it’s a garden hose, and maybe sends reassuring self-talk to calm the system back down.

In terms of the entire nervous system running through the body, these activities energize or slow the autonomic nervous system (ANS), composed of the sympathetic nervous system (SNS) and the parasympathetic system (PNS).

Van der Kolk suggests a good way to remember which system does what: sympathetic means “with emotion”. This system “goes with”, or in the direction of, the emotion and the amygdala. Parasympathetic means “against emotion”. In this case, the PNS is trying to inhibit the emotions and the amygdala.

When someone responds accurately and proportionately to their environment, they don’t over respond or under-respond. They also can be (mostly) in charge of their own mood - they can elevate a low mood or calm an escalated mood. This requires some psychological strategies, such as calming self-talk and reality testing, but all of *that* depends on being able to:

Notice that you are feeling something
Understand what you feel
Feel capable of at least modifying that feeling
Have enough emotional flexibility to change

For example, let’s take the first item on the list: *noticing that you are feeling something*. This requires that internal signals travel slowly and predictably enough that you can perceive them. Recognizing that you are angry, thinking about the consequences of lashing out violently and then telling yourself to calm down, all take time. If the emotional part of the brain moves too fast and the analyzing, self-control parts of the brain move too slowly, you may have hit someone long before you even fully realized how angry you were. Neural integration means that the parts of the brain move at the correct speed, and synch with one other, like a car in which all the moving parts are going at the correct strength, and they connect to one another to move the car forward. Too fast or too slow, too weak or too strong, and the parts of the car will not be in synch and the car will race dangerously or lurch awkwardly (Bradenoch, 2007).

Poor neural integration is often linked with body awareness issues. The brain, particularly the right hemisphere, takes in sensations from the limbic system and interprets them: “I feel tension in my stomach - I think I’m afraid”, for example. “You can’t do what you want until you know what you’re doing” (van der Kolk, 2015).

However, in order to express that feeling of fear, you have to be able to use words like “afraid”. That requires the right and left brain to work together. Inability to put words to an emotional experience – alexithymia – is often a problem for clients seeking relief from emotional distress or repetitive tangles in their lives. People suffering from PTSD are particularly vulnerable to experiencing this. You can’t express feelings if you don’t have words for it, and you can’t have words for your feelings if you can’t feel your body.

Some predict that the future of diagnosing mental illness will rest on distinguishing between organic brain dysfunction, which we will be able to test for, and emotional or spiritual unease. (Thomas Insel, head of NIMH, in Greenberg, 2013). Much of those diagnoses may be based on neural integration. Activating and inhibiting various areas of the brain through psychotherapy and psychopharmacology (and psychosurgery in some cases) will probably be the blueprint for treating brain functioning problems. Psychotherapy will also have a part to play, as it activates the left brain by asking people to reflect on thoughts, feelings and sensations, and can be effective in helping people thinking about the reality of things rather than assigning an overly gloomy interpretation to events. We can use therapeutic approaches to improve self-awareness, self-regulation, decision-making, and ability to connect to other human beings.

Nine Things Neural Integration Makes Easier (Bradenoch, 2007)

1. *Regulation of the body*

As we've established, the sympathetic branch is the accelerator of the nervous system, the parasympathetic is the brakes. Integration of the pre-frontal cortex's left and right hemispheres slows responses, which allows for time for a person to evaluate and use familiar techniques to regain calm.

2. *Attuned communication*

Neural integration also involves the mirror neurons (in the lower front portion of the parietal lobe). These neurons affect empathy, synchrony, imitation, and language.

When we are attuned to someone, we can sense their emotional states accurately, by reading the fine movements in their face and subtle changes in voice and posture. This input may activate our mirror neurons, which help us to understand intention, by letting us experience the same intention and emotional state in ourselves. We then demonstrate that we understand them by using non-verbal cues, such as tensing the eyebrows to frown in shared disapproval as they tell how someone wronged them, or smiling appreciatively as they describe a funny incident. This attuning with occurs in microseconds, below conscious awareness. We need to modulate our amygdala to see others somewhat objectively and mirror their emotions correctly. Otherwise, we are in threat mode; perhaps experiencing the hyper-arousal of fight-or fight, perhaps collapsing in hypo-arousal.

3. *Regulation of emotion*

The HPA axis creates a self-reinforcing loop, with internal and external triggers. As integration increases, pathways lengthen and the process slows enough to let us make conscious decisions about how to respond to the trigger, which itself becomes a feedback loop to increase integration, and so on.

4. *Response flexibility*

One of the most common problems our clients report, especially young adults, is reacting impulsively to a trigger. For example, when this author worked with teens, it was a constant challenge to help them to evaluate a situation before lashing out at someone or storming out of a class, even when they hadn't been threatened or insulted. They could see later that their response had been incorrect or out of proportion to the event, but by then of course it was always too late. These teens needed a few extra milliseconds to consider what was happening before responding. Pausing before taking action required longer neural pathways than they had. A longer pathway provides those all-important fractions of a second, and responses can be more closely aligned with the reality of a situation, because there are more response that can be considered and rejected. The wider the choices, the more likely you are to choose the right one.

5. *Empathy*

Resonance circuits, made up of mirror neurons, create an internal representation of the intention and feelings of the other. Empathy involves

- ***interoception***: an inner awareness of body states, interpretation and understanding of what *we* are feeling
- ***attribution*:** awareness that it may also be happening in the *other person*

These awarenesses are the building blocks of attuned communication.

6. *Insight* (self-knowing awareness, autobiographical narrative)

Insight can be defined in many ways, but for our purposes, it is the ability to shape and tell our own story in a way that is coherent and retains emotional contact with its meaning; neither overwhelming nor disconnected, fostering a sense of our pathway through life (Bradenoch, 2008). We need integration of the limbic system with the pre-frontal cortex to create this; especially, the hippocampus needs to stay online to keep knitting together the discrete “snapshots” of sensory input into a flowing, uninterrupted story (van der Kolk, 2012).

7. *Fear extinction*

The PFC-amygdala link contains axonal fibers that carry GABA (a calming inhibitory neurotransmitter) from the PFC to the amygdala, where the fear-encoding neurons are (remember, the amygdala’s job is to record and remind us of dangerous or unpleasant events). Unless physically destroyed, these neurons will carry GABA to help modulate fear even though implicit-based fears remain, significantly changing the subjective experience of the trigger for the fear. This is an example of neuroplasticity through synaptogenesis; creating sensitive cells in a “path” that will fire over and over again. When we face a fear and decide it’s not so bad, or when we soothe ourselves, the path for GABA is stronger and fear is more manageable.

8. *Intuition*

This may come up from the body to the right hemisphere. The author once experienced near-panic one morning when crossing between buildings in a walkway several stories above the street, even though she had crossed it many times in the past without any fear. There didn’t seem to be any obvious reason for the panic. Later that day, she learned that the entire city block was closed off because high winds were shaking the walkway and tearing metal plates off the bottom, sending them crashing to the ground.

The author hypothesized that the wind had already been picking up several hours before when she had crossed it in the morning, and that she had sensed a subtle increase in movement (perhaps through the inner ear) without being consciously aware of it. What could be labeled “intuition” was actually a message relayed from the inner ear through the amygdala and up to the right hemisphere, but without external context clues (such as if the bridge had been visibly moving) to engage the left hemisphere. The result was fear without a rational explanation, that later seemed to have “predicted” the subsequent event.

9. *Morality*

Moral action arises from empathy for others. As we a) read the emotions of others, b) relate them to sensations that signal those same emotions in ourselves, c) recall how those emotions feel when we experience them ourselves and then d) conclude it must feel the same for the other person, we can then treat them as we would want to be treated – the heart of moral codes and religious systems around the world.

Self-Regulation

So far, we have examined how neural integration allows us to understand others and respond more intentionally to them. However, that’s only one half of the equation. After we choose the “correct” response to a situation, we then have to follow through on that choice. This may mean inhibiting other impulses. For example, after having decided that we need to keep our job for the time being, we have to tell ourselves to nod politely and listen to our angry boss yell at us, instead of stomping off angrily and quitting. In order to carry out the choice we have made, we have to regulate the competing urge to act on our angry feelings. This means that self-regulation is the second half of the equation.

Every closed system has some way to keep itself within workable parameters. You set the thermostat at your house, and when the temperature gets too hot or too cold, the heating system automatically turns on the heat or the air conditioning to keep the temperature within the range you chose. As described above, neural integration allows you (the house) to know what you’re feeling (a thermometer, measuring the temperature). That’s the first half. How you get back into range – in this case mood and affect rather than temperature – depends on self-regulation and modulation. How effective are you at raising or lowering your mood as needed? Can you soothe yourself when you’re worried, or calm yourself down when you’re giddy or enraged? Many of our clients are bad at this, and stay too elevated or too depressed, with little ability to change their feelings. Often, they turn to maladaptive efforts to artificially change their mood, using damaging substances, self-destructive behavior or unhealthy, dangerous interactions with others. People who are diagnosed with what is now called “borderline personality disorder” often experience extreme emotional dysregulation – their thermostats are badly broken.

A quick regulating trick to calm anxiety: 4-5-6 breathing

Tell your client to count to four in their head on their inhale breath, then pause (not hold) their breath, then exhale to the same count. ***Four counts in, pause, four counts out****. After a few rounds of breaths to get into that rhythm, tell them to add one count to the* ***outbreath only****. This changes the rhythm to* ***four in, pause, five out****. After a few repetitions to get used to that, add one more count to the outbreath, for a total of* ***four in, pause, six out****. After breathing in that rhythm for a moment or two, stop and ask them to observe how they feel. They will be very likely to say they feel calmer and more relaxed. Some people will notice their thoughts slowing down. This happens because a longer, slower exhale engages the parasympathetic nervous system and slows the heart. A slower heartbeat indicates calm, so the brain automatically interprets things as safe, and feelings of anxiety subside. In other words, in this method the body is telling the brain to calm down rather than the other way around, which is a more traditionally Western, cognitive-based way to interrupt anxiety.*

A common I-BMS technique is to recognize these kinds of patterns in clients and either strengthen them or encourage a client to switch what they are emphasizing. A very cerebral, “thinking” type of person may be asked to pay attention to movement and physical sensation. This kind of intervention can quickly change patterns in a client who is very intellectual and disconnected from their body and emotions (Lee et al, 2009).

IV. Trauma: an example of the reciprocal relationship between brain, emotions, thoughts and actions.

To understand better how the brain-body connection works, let’s look briefly at the effects of trauma, a challenge many of our clients face. There is a vast catalog of scholarly material written about the neurological and psychological aftermath of trauma, so we will use just a few concepts to illustrate the brain body connection in a therapeutic context.

Traumatic events change the brain and body in a myriad of ways. The calibration of the alarm system (the amygdala and the HPA axis) is thrown off, so traumatized individuals over- or under-respond to stimuli. Trauma – and the reliving of it with chronic traumatic stress – increases stress hormones, especially cortisols (for which there are more receptors than any other neurotransmitter in the body). This increase in stress lasts sometimes for decades. The limbic system that filters relevant from irrelevant information becomes programmed for stress. This “programming” can cause chronic over-focusing and hypervigilance, or a feeling of numbness and detachment from life. Some people alternate between these two states, never resting in calm alertness.

A prominent theory of how our alarm system works is Steven Porges’ polyvagal theory (in van der Kolk, 2015). This states that the ANS regulates us to function on 3 levels, depending on the safety of our environment:

- Social engagement (minor threat or first inkling danger)

We engage with the issue and try to resolve it. This could include approaching someone we know and saying “Why are you angry?”

- Fight or flight (higher threat)

At the next level of danger, our brain signals the release of cortisol and adrenaline. We feel our heart rate speed up, and perhaps feel shaky as our body prepares to run or to fight the threat.

- Freeze/collapse (prolonged threat; inability to challenge or escape).

At this level, the threat is so great that we can only freeze in terror, perhaps as a survival tactic to avoid being noticed until the threat passes. Bessel van der Kolk notes that we go into a “collapsed” state if we are physically unable to escape the danger (for example, trapped in a crushed car after an accident) or if previous attempts to escape the danger have failed. This goes toward explaining “learned helplessness”, the state in which a creature has tried repeatedly to avoid the painful or fearful stimulus and cannot, and so makes no attempt at all any more. A collapsed state can refer not only to physical immobility but also a state of relative neurological inactivity (van der Kolk, 2015).

Traumatized people can’t integrate new experience because triggers keep shutting down the hippocampus and its connection to the “meaning-making” cortex, and so they get “stuck” neurologically and psychologically as well. Every new event is tainted by the ongoing past, so they cannot learn from experience, which is why efforts to make change often fail. Some “resistant” clients in treatment actually may be suffering from undiagnosed trauma, which impedes their efforts to make the changes that others expect from them. Suppressing an event in one’s consciousness and denying the emotions that stemmed from it takes up energy, leaving none available for spontaneous life (one client described this as “constantly holding the closet door shut”). This resonates with the yin-yang theory of blocked energy discussed elsewhere in this course. People with this dynamic will appear to be hypo yang in a spiritual or integrated assessment.

Chronic stress creates lots of physical conditions as well, affecting physical health. Addressing physical health, movement, diet and self-care in an integrated approach may be especially important with traumatized clients.

Addressing this issue in a holistic fashion incorporates Eastern philosophical approaches and lines up with emerging brain-body science at the same time; East and West mirror and repeat the same ideas, with different perspectives. From the brain-body perspective of I-BMS, we have 3 ways to help clients heal (in this example, from trauma):

1) top-down (talking, connecting, insight)

2) meds
3) bottom-up (“allowing corrective *physical* experience”)

Talk therapy is a good road into this work. Language gives us the power to change ourselves and others by communicating our experiences, helping us to define what we know, and finding a common sense of meaning. It helps us to articulate the “unthought known” (Bateson, in Cozolino, 2010) – the psychological frameworks and schema, *arising from experience and the structure and function of our brains*, that guide our perceptions, our sense of self, and our interactions in the world. At other times, when trauma has been too early in life, too chronic or too severe, body work such as yoga, qi gong or other movement-based practices may help the brain to heal from the ‘bottom up’.

Summary

An integrated assessment and treatment plan should address the whole individual, and interventions must involve the body, the mind, experiences and emotions. This approach, as we’ve seen, is congruent with current neurosciences *and* with social work’s well-established bio-psycho-social model. Understanding the basic structures and function of the brain is a cornerstone of this approach. The limbic system and the cortex, making up the experience-dependent “social brain”, also rule our ability to respond, to think, and to choose, all of which are crucial to proper bio-psycho-social functioning.

Neuroplasticity accounts for how the brain can change, which may be a source of healing in the case of injury, or suffering in the case of traumatic stress. We’ve examined neural integration and its role in much of emotional and social life. The ebb and flow of the impulses of the brain can be likened to the rhythmic movement of the Yin and Yang principle. Finally, trauma is an example of how brain change can be harnessed in therapy and movement to help clients move on from destructive experiences.

Life disturbances bring our clients in to work with us, suffering from the impact of these experiences and imbalances on the mind, the brain and the body. The effects of experience are holistic, and therefore so must be our treatment. We have the ability to regulate our own physiology, including some of the so-called involuntary functions of the body and brain, through such basic activities as breathing, moving, and touching (van der Kolk, 2015). Rhythmic attunement is an example of a common objective in this kind of brain-body work (Perry, 2006). Mindfulness has been studied in a wide variety of settings and continues to be of interest to brain scientists and psychotherapists alike (Slagter et al., 2007; Holzel et al., 2008; Lazar et al., 2005) in Garland, 2009). These are all examples of energy (thought) interacting with and affecting matter (brain) to create a new experience.

The core of I-BMS suggests that we affect our material world or "reality" as we experience it. Our attachment, expectations and interpretations help to create our experience, and then our experiences reinforce our expectations. Subjective and objective realities reflect, reciprocate and flow into each other endlessly. Neuroscience agrees; it says that this interdependent, cyclical relationship between body (brain) mind (thoughts), and internal states of awareness ("spirit") is not just poetic or metaphysical thinking. Brain science says we affect our brains as much as our brains affect us. Our body, mind and spirit are intimately connected and embracing them in practice fits the way social work professionals work in helping humanity.

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