Interpersonal Neurobiology

by

Lloyd W. Davis

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Debra Wilson, Ph.D.

Walden University

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ABSTRACT

Interpersonal neurobiology is an emerging scientific area of interest for researchers, mental health practitioners, and educators. This field relies on recent brain research and emphasizes the brain as a social organ built through experience. Brain structures involved in these findings teach a great deal about human potential through experience-dependent plasticity of neural systems that shape attachment and are shaped by attachment. This paper intends to outline major neural structures involved in social interactions and the paradigm shift employed by interpersonal neurobiology.

OUTLINE

INTRODUCTION

What is Interpersonal Neurobiology?

Interpersonal neurobiology is a developing biopsychological approach to understanding the human condition based on scientific evidence about the mind, brain, and relationships. An important implication from this interconnected system recognizes that change in one evokes change in the others. Cozolino (2006) stated, “Interpersonal neurobiology assumes that the brain is a social organ that is built through experience” (p. 7). Interpersonal neurobiology emphasizes the influence of the social world in the construction of the individual. The role of attachment relationships to primary caregivers early in life carries significant weight in this emerging paradigm. Attachment figures play an important role in the development of the brain throughout life, particularly early in life (Tronick, 2007). However, because of the recognition of neuroplasticity throughout the life span maladaptive brain development, less integrated, can be modified through many avenues. Throughout life individuals encounter psychotherapists, educators, significant others, and new experiences that contributes to the brain using the mind to reshape itself into healthier more integrative states (Siegel, 1999, 2001, 2007).

An Emerging Science

Recognizing the brain as a social organ began in the 1970’s. Researchers studying primate behavior with brain lesions discovered that certain damaged brain areas produced alterations in social behavior. However, researchers discovered that no single isolated brain area accounted for adverse social behavioral interactions, but that the brain employs several neurological structures in social functioning. Damage to these social regulating areas of the brain altered social interactions that interfered with hierarchical status

(Cozolino, 2006). Pinel (2009) reports conspecific stress results from dominant hierarchical structuring, exists throughout the mammalian social world. Enduring experiences of this type during development produces a syndrome that scientists refer to as subordination stress. Subordination stress from conspecifics produces psychological and physical development in mammal populations that make them less fit to reproduce, thus inhibiting their ability to pass on their genes. Subordinate males of rat populations exposed to subordination stress behave as bullies, have smaller testes, do not live as long, and have higher stress hormones in their systems.

Recognizing the importance of a healthy well-integrated brain for social status takes on greater importance as we recognize the evolutionary advantages for safety, survival, and the ability to thrive. Neuroscientists concerned with these developments borrow from many fields of specialized study to gain greater understanding of what a healthy human brain looks like, its antecedent relational influences, and social functioning. Interpersonal neurobiology gleans scientific data from neuroscience, psychoanalysis, ethology, genetics, and evolution to understand the Intersubjectivity of the human mind, brain, relationships, and their influence on one another. Scholar practitioners interested in interpersonal neurobiology at this time are mostly psychotherapists and educators who want to improve their work as social change agents (Badenoch, 2008; Cozolino, 2006; Siegel, 1999).

Primary Contributors

Many scientists have contributed to the emerging field of interpersonal neurobiology. Advances in neuroscience technology over the past two decades have allowed us to see into the neural infrastructure with greater clarity. Badenoch (2008) stated, “We call the warp *interpersonal neurobiology* (a scientifically grounded paradigm of neural integration developed by Daniel J. Siegel [1999]) and the woof, integrating the *inner community* (a story of internal life born of subjective experience in the counseling room)” (p. 4). One aim of this paper seeks to understand from a biopsychological perspective why some researchers, educators, and clinicians find this field so exciting. It has captured my imagination too.

Siegel (1999) led the way to a new exploration of the human experience that other scholar-practitioners in mental health and education embrace. There seems to be a great deal of excitement as the mental health field transforms itself with solid neuroscientific evidence and research from diverse fields of attachment theory, affective neuroscience, cognitive science, and mindfulness studies. Wallin (2007) stated, “The most powerful conceptual links between the brain and the mind—and between neuroscience and psychotherapy—have been forged by Allan Schore (1994, 2002, 2003) and Daniel Siegel (1999, 2001, 2006)” (p.69). Most of their work based itself upon attachment relationships and their importance to brain development during critical periods of prenatal and postnatal development. Of particular interest for this conceptual framework concerns the ideas surrounding interpersonal attunement (Cozolino, 2002, 2006; Siegel, 1999, 2007). The type of relationships humans experience during these sensitive periods shape the developing brain and mind. Primary caretakers early interactions with infants set in motion neuronal development that provides the environmental culture that shapes the social neural networks (Siegel, 2001; Tronick, 2007). Interpersonal neurobiology builds upon these themes providing evidence for healthy adult-infant relationships and the significance of the therapeutic relationship too.

INTERPERSONAL NEUROBIOLOGY AS THE SCIENCE OF HUMAN RELATIONSHIPS

Interpersonal neurobiology provides a paradigm for understanding healthy human relationships and the neural structures involved in the social synapse (Cozolino, 2006; Siegel, 1999, 2001, 2007). I chose this paper because of the important implications for human growth and development. These researchers assert boldly, statements concerning the biopsychology of the individual and the interpersonal growth culture involved in different types of social, emotional, and brain development. Comparing the evidence of these researchers, scholar-practitioners, and educators with knowledge from biopsychology evidence and employing critical thinking helps to gain a greater understanding of the evidence. The knowledge gained from taking a deeper look at the brain, its structures, and functions exercises our brain and helps our fitness as a positive social change agents.

Reasons for Writing This Paper

Interpersonal neurobiology captures my imagination because it holds out promise of a story about human existence carved from scientific evidence and interpersonal relatedness that seems to make sense. Philosophically, for a story to be true it must meet three criteria. First, the story must stand the test of logical consistency. Each of the parts must fit together tightly in a logical consistent fashion without contradiction. Second, the story must gel with the scientific facts, as we know them. This means that it must past the test of coherency, to be understandable within our framework of testable evidence. Third, the story must be pragmatic. This assertion states simply that the theory must pass the test of usefulness. Whitehead (1929) stated it this way, “Thus the philosophical scheme should be coherent, logical, and in respect to its interpretation, applicable and adequate" (p.3).

One aim of this paper is to integrate the findings from interpersonal neurobiology within the system of ideas and evidence supported by scientific inquiry on the nature and structure of the human brain from biopsychology. Using as a basis to test the proposed theory of mind, brain, behavior of interpersonal neurobiology evidence relies heavily upon the biopsychology of Pinel, (2009). Pinel, (2009) stated, "Biopsychology is the scientific study of the biology of behavior…. Some refer to this field as *psychobiology, behavioral biology,* or *behavioral neuroscience,* but I prefer the term *biopsychology* because it denotes a biological approach to the study of psychology…" (p. 3-4). This approach is a scientific study of behavior from a biological perspective. It places biological evidence in a foundational role. This includes all activities of the human organism internal and external. Pinel (2009) employed, as relevant evidence and structure of consistency, coherence, and adequate applicability, four major themes: Thinking clearly, clinical implications, the evolutionary perspective, and neuroplasticity.

Siegel (2001) discussed important details of interpersonal neurobiology:

> Recent discoveries from a number of independent fields, including those of developmental psychology and cognitive neuroscience, can be synthesized into an integrated framework for understanding how the brain gives rise to mental processes and is directly shaped by interpersonal experiences. This "interpersonal neurobiology" (Siegel, 1999) presents an integrated view of how human development occurs within a social world in transaction with the functions of the brain that give rise to the mind. (p. 1)

The above statement is loaded with important information regarding interpersonal neurobiology's foundations and approach. Biopsychology as described by Pinel (2009) views human behavior from a slightly different angle and appears to ground its suggestive evidence upon biological processes of the individual. Interpersonal neurobiology seems to take a broader perspective and includes the fundamental assertion that individuals studied and understood outside the larger context of the social world is no longer plausible (Iacoboni, 2008; Insel & Fernald, 2004). One assertion of this paper purports that studying the individual alone; separate from the social world fails to take into account all the facts of existence and merely represents an abstraction. How does this assertion maintain force of thought from a perspective that places the biology of the individual first? This problem resolves easily and the contradictions fall from view when we state that we are constructing an intrapersonal neurobiology.

Intrapersonal neurobiology continues to place biology at the apex of our investigation from an individual perspective, but includes importance evidence from studies that converge with the social world on the development of the individual. The works of some researchers interested in a brain-based psychology are reconstructing biopsychological evidence from this perspective (Davidson & Fox, 1989; Davidson, Putnam, & Larson 2000; Iacoboni, 2008; Panksepp, 1998). Pinel (2009) emphasizes clear thinking, evolutionary perspective, neuroplasticity, and clinical implications as four important themes of biopsychology to keep it on scientific ground. Interpersonal neurobiology increases its place as a legitimate science when adhering to this foundational framework.

Gaining a Greater Understanding of the Neural Structures of the Social Brain

Neuroscience advances understanding of human motivational behavior through greater understanding of brain-based emotional substrates of mammalian behavior.

Panksepp (1998) stated, “For the discipline of affective neuroscience, the most important issue in emotion research for the foreseeable future will be the accurate specification of the underlying brain circuits, in anatomical, neurochemical, and neurophysiological terms” (p. 17). Neuroscientists empowered, particularly in the past two decades, by technological advances have gained greater understandings of our basic motivating systems hardwired and shaped by experience. Powerful motivating factors located within the middle regions of the brain and interconnected throughout the brain and nervous systems indicate that basic emotional circuits play a significant role.

Although some debate exists about the exact number and names of primary emotions humans and other mammals experience and display, researchers agree that emotions serve as motivational systems located within the brains’ limbic hypothalamic region. Pinel (2009) asserted research by Paul Ekman on facial expressions showed that there are six primary emotions and that these easily extend to eight: surprise, anger, sadness, disgust, fear, happiness, contempt, and embarrassment. Panksepp (1998) discussed “genetically ingrained emotional operating systems” (p.51) that he labels seeking, panic, fear, rage, lust, care, and play. Social emotions motivate mammals from within to seek caregivers to provide safety, nurturance, bonding, and continuation of the species (Panksepp, 1998; Damasio, 2003). These emotions, thought to be ready for activation at birth, prior to language development, but basic to mammalian survival play important roles in social behavior. Insults to these motivations produce poorly integrated brain systems less prepared to survive and thrive in the social world. Primary emotions produce secondary cognitive emotions developed later in life such as sympathy, shame, guilt, envy, and gratitude (Damasio, 2003). What purpose do these biologically ingrained emotions serve for our understanding interpersonal neurobiology? As we will see, attachment researchers and neuroscientists provide evidence that humans and other mammals seeking systems require attuned recognition for survival and optimal neural integration (Cozolino, 2002, 2007; Insel & Fernald, 2004 Siegel, 1999, 2001, 2007).

The social emotions build upon background emotions and primary emotions. Damasio (2003) states, “The social *emotions* include sympathy, embarrassment, shame, guilt, pride, jealousy, envy, gratitude, admiration, indignation, and contempt. The nesting principle applies to social emotions as well. We can learn a great deal about social emotions when we understand the effects of stress chronic stress upon the immune and endocrine systems (Pinel, 2009). Not long ago behavioral scientists viewed the primary seeking behavior of human infants as based solely upon the provision of food, water, safety, and other survival needs. Stress research suggests that the loss of a loved primary attachment figure can cause the most severe emotional pain (Bowlby, 1973; Lazarus and Folkman, 1984; Panksepp, 1998). Social bonding in the mammalian brain associates with the experience of pain from loneliness caused by separation from loved ones. Researchers provide evidence that social bonds connect with pleasure centers and endogenous chemistries within the human brain. Social connection facilitates activation of chemical neuropeptides oxytocin and prolactin, and endogenous opioids such as endorphins. The endorphins act on the same brain sites and in the same ways as dangerous drugs such as heroin and dangerous drugs of abuse.

Evidence suggests that grieving mammals stop their crying and other characteristics common in mourning when administered opiate substances. Evidence suggests that pleasurable social interactions such as grooming of children by parents, rough and tumble play, sexual behavior, and falling in love create positive neurochemical changes in the brain of humans (Panksepp, 1998). Tronick (2007) provided evidence for basic emotions guiding infant behavior and labeld them, “The 10 discrete emotions are interest, joy, surprise, sadness, anger, contempt, fear, shame/shyness/guilt, distress, and disgust” (p.235). These emotions are higher cognitive higher emotions and develop early in life depending upon quality of attachment, but their neural substrates are present at birth. Tronick (2007) asserted that the interactions between caregiver and infant create states of consciousness crucial to the dyadic regulatory system making meaning of the world between individuals.

When the failure to connect is chronic, “…infants and children become distressed, depressed, listless, and fail to develop. In less extreme situations, where caregivers are withdrawn and emotionally unavailable, infants go into sad withdrawn mood states” (p. 477). However, at the opposite end of the dyadic regulation system are the exuberant smiles and joyful giggles of infants and children when they connect with others and are emotionally attuned to from a primary caregiver. Feelings of connection produce happy well-adjusted states that are measurable within social circuits of the brain and open to observation for anyone paying attention. Feelings of isolation produce sad withdrawn states and failure to thrive in the world that are measurable within social brain circuits and open to observation of behavioral abnormalities and psychological distress.

The human brain develops more slowly than other species, not maturing until late adolescence. The period from birth to young adulthood, neurons in the human brain quadruple in density, but the brain does not increase its size. The hippocampus and the olfactory bulb create new neurons throughout most of the life span. However, by the seventh month of prenatal development the brain has all the neurons that it will have throughout life. Postnatal neuronal growth consists of three distinct types. The first kind of growth consists of synaptogenesis, which is the formation of connections between neurons after birth. The second growth consists of myelination. Myelination occurs when fatty cells wrap around the neuronal axons to facilitate the speed of energy and information transfer and axonal protection. The third type of postnatal neuronal growth consists of dendritic branching. This process follows the original neuron migration paths extending from deeper brain layers to surface layers of the brain (Pinel, 2009).

Synaptogenesis begins prenatally and increases in the cerebral cortex shortly after birth. Between the fourth and the eighth postnatal months, the auditory and visual cortices reach maximum density. Synaptogenesis of the prefrontal cortex begins after birth and grows at a steady state, reaching maximum density during the second year (Pinel, 2009). This data is important to those interested in interpersonal neurobiology development because the prefrontal cortex's role in attachment strategies.

Myelination of brain sensory areas happens in the first few months postnatal and for motor areas not long after. The myelination of the prefrontal cortex begins shortly after birth and matures during adolescence (Pinel, 2009). Once again, for interpersonal neurobiology this biopsychological process takes on importance.

Implicating neural structures involved in the social world requires a great deal of work and scientists have begun the focusing their attention on this tasks through merging many fields of research. Neurons are the basic building blocks of the brain. These brain cells specialize in the reception, conduction, and transmission of electrochemical signals for diverse activities and functions (Pinel, 2009). Neurons have long extensions that stretch from the cell membrane to the synapses of other neurons. The brain regions discussed in the aforementioned discussion connect to each other through these extensions called axons. The parts of the neurons that receive the electrochemical signals are dendrites. Dendrites are short extensions that branch out to help form the synapses designed to process the signals from one neuron to another. The brain has about 100 billion neurons each with about 10,000 connections to other neurons in a vast web of possible arrangements. This complex structure functions to produce consciousness and connections with other brains through perceptions from our five senses.

Interpersonal neurobiology, as noted throughout this paper, holds that this the human brain functioning at its best produces social connections with others that through healthy integration across synapses and structures within individual brains. Siegel (1999, 2001, 2007, 2008) asserted that the mind emanates from the processes of the brain. Neuroscientists do not know exactly how the brain and the mind function to create the mental images, but through body maps from sensory organs through the brain and its interconnected neurons. The entity scientists call the mind consists of patterns of energy and information flowing through the brain using neurons forming and acting upon one another. Energy and information can flow in one brain through perceptions from the environment through sensory organs. Siegel (2001) stated, “The mind is created from the whole brain. ‘Integration’—the ways in which functionally distinct components come to be clustered into a functional whole—may be a fundamental way in which the nervous system functions” (p.70).

Pinel (2009) stated, “Postnatal human brain development is not a one-way street; there are regressive changes as well as growth (Huttenlocher, 1994). For example, once maximum synaptic density has been achieved, there are periods of synaptic loss" (p.223-224). Loss occurs in different brain regions during different times. The decline in synaptic density of the visual area of the brain reaches adult levels by age three. Prefrontal cortex synaptic density peaks during the second year and declines reaches adult levels during late adolescence. This is part of the higher neuroplasticity of the young brain and its relative importance to interpersonal neurobiology.

Interpersonal neurobiology developed from interactions of many fields of science concerned with human behavior and the brain. Central claims from researchers concerned with this developing paradigm place emphasis upon therapeutic change possibilities and the importance of early attachment schemas. On the one hand, heavy emphasis places memory and early attachment imprints as extremely important for neural structure and development. On the other hand, practitioners and adherents place a lot of weight on neuroplasticity entwined with the ability to change brain structure throughout life (Badenoch, 2008; Cozolino, 2002, 2006). Insel and Fernald (2004) stated, "There is now evidence that in real time behavior causes changes in the brain of an adult animal. …Understanding the mechanisms responsible for such dynamic changes in the nervous system of adult animals is a major challenge" (p.712).

Evidence provided by researchers indicate that the reproductive status of certain fish populations changes the brains, reproductive organ size, physical presentation, and behaviors depending upon the social interactions. Social interactions regulate neuron size, reproductive status, and growth in this animal population with the influence of sex hormones on the brains. Apparently, neuroplasticity affects memory regions of neural structure as well.

What does this research about the social brain of fish populations say about the social brains of humans? First, looking at neurological changes in primate brains related to social structures provides evidence. Recognition of familiar individuals in primates largely relates to visual face perception. Functional magnetic resonance imaging (fMRI) studies contributes much of what we understand about human social neuroscience. The fusiform area of the occipital-temporal junction corresponds to face recognition as well as other visual stimuli such as birds and houses. Lesions within these areas produce deficits in face recognition and the lack of cortical volume of these regions associates with schizophrenia (Insel & Fernald, 2004).

fMRI studies of human subject usually focus upon brain regions activated during face recognition and object recognition. However, recent studies researched brain regions activated while subjects viewed social interactions. Brain regions implicated in these studies noted activation the social neuron circuits associated in the lateral fusiform gyrus, superior temporal sulcus, the amygdala, and the ventromedial prefrontal cortex. These studies included non-human primates and humans. The amygdala traditionally has been associated with social the emotions guilt and arrogance, as well as the primary emotion of fear (Damasio, 2003; Panksepp, 1998; Pinel, 2009). The ventromedial prefrontal cortex connects to the amygdala through axonal and dendritic branching (Siegel, 1999, 2001, 2008) and implicates social processing of pleasure and vocalization in non-human primates. The fusiform gyrus does not activate in people diagnosed with autism on facial recognition studies. This neurodevelopmental disorder bears symptoms of lack of social motivation, language difficulties, and abnormal attachment skills.

fMRI studies implicate the striatum, the medial insula cortex, and the anterior cingulate cortex in romantic love and loss. These areas of the brain also associate with the ventral prefrontal cortex in social isolation (Insel & Fernald, 2004). These regions of the human and non-human primate brains are implicated in social loss, neurodevelopmental disorders (autism and schizophrenia), and may be linked to early attachment disorders related to growing up in impoverished social environments. These studies can help researchers better understand individuals who grow up in socially enriched environments, but fail to develop normal social functioning implicating problems in the brain regions listed above. Researchers can build upon this evidence to discover the cellular and molecular building blocks of these neural mechanisms (Insel and Fernald, 2004).

Pinel (2009) outlined four major functions of the prefrontal cortex and individuals with damage to this area of the brain can experience social isolation. This area of the brain plays a role in working memory important for focusing on relevant information for short time periods. The prefrontal cortex is also important to planning and understanding sequences of action that are relevant and meaningful. Understanding appropriate behavior and putting the brakes on inappropriate behavior.

OMPFC. The orbital medial prefrontal cortex (OMPFC) situates at the anterior frontal lobes just behind the forehead above the eyes. It has direct connections with the limbic hypothalamic regions of the brain and the temporal portions of the brain respectively and responsible for emotional control (Kondo, Saleem, and Price, 2005). The OMPFC has long neuron fibers extending to the amygdala that coat it with chemical inhibitors (GABA) during times of stress. Damage to this region of the brain interferes with emotional and social control. The OMPFC and its important neural connections to the emotional centers of the brain make it a key player for interpersonal neurobiology (Cozolino, 2006; Siegel, 2008).

The somatosensory cortex is located anterior to the parietal region of the brain. It process information about the body regarding touch, temperature, pain, control of movements in our environments, and bodily memories. This area of the brain is important to interpersonal neurobiology because of its involvement during early development with caregivers. Damasio (2003) reported that patients with damage to parts of the somatosensory cortex, particularly the left side, experienced difficulty with language and speech, body mapping, and feeling bodily states. Research provides evidence that physical and mental development is experience-dependent. The vagus nerve that connects the brain to the viscera that bypasses the central nervous system runs through this region of the brain. Individual’s perceptions from the body, like when we have gut feelings, to the brain pass along this route. This region connects us to our sense of self, our sense of who we are in the world physically (Damasio, 2003; Panksepp 1998).

Cingulate cortex is a primitive area of the brain that also connects with the viscera, motor, autonomic, and emotional processing. Interestingly, reptiles do not have this part of the cortex and therefore do not have emotions. Evolutionary strategies suggest that this area of the brain evolved to when animals began displaying maternal behavior, sounds that later became language, and mate selection. Destruction of this neural region results in the loss of language, absence of maternal care, and autonomic activity. Phan and Posner (2003) reported that the cingulate cortex connects with the brainstem, parietal, and lateral frontal regions of the brain that making it important for emotional and physical regulation. Damage to this area of the brain could interfere with maternal care that and total destruction of the cingulate cortex would cause maternal feelings to disappear. It is not too difficult to understand the importance for this region of the neural structure for positive social functioning, making it important for interpersonal neurobiology.

The insula cortex is sits on top of the brainstem and the medulla above the hippocampus and below the hypothalamus buried beneath the lateral areas of the frontal lobes. It is an internal structure concerned with internal experience. It connects heavily to the limbic structures of the brain and receives signals from the prefrontal cortex helping it regulate the amygdala and hypothalamus. It serves an administrative role in the service of the executive function prefrontal cortex. It also has neuronal connections that feed forward to the executive prefrontal regions, thus making it a mediator of the bodily and medial emotional areas of the brain (Cozolino, 2006; Damasio, 2003). Remedios, Logothetis, and Kayser (2009) reported imaging studies of the insula cortex reveal data suggesting conspecific voice sound recognition and preference over a wide array of other vocalizations. This evidence suggests that this region of auditory cortex plays a role in emotional regulation by primary caregivers. Voice recognition of primary caretaker vocalizations is important for safety and survival. This also helps us understand the social significance of this region for interpersonal neurobiology.

The amygdala plays a crucial role in emotional processing, attention, and learning. It specializes in recognition of danger and fear responses. It has neural fibers that connect it to the hippocampus and the prefrontal cortex. The central and basal regions of the amygdala respond to immediate danger signals and activate the autononomic nervous system fight, flight, or freeze responses to stimuli. The amygdala matures by the eighth month prenatally allowing it to respond to fear prior to birth. The early maturation of this brain region implicates it in many biopsychological processes. Phelps (2004) stated regarding memory and the amygdala, "…the amygdala is more or less specialized for the processing of emotion. The hallmark of the memory system is that is crucial for the acquisition and expression of fear conditioning, in which neutral stimulus acquires aversive properties by virtue of being paired with an aversive event" (p.198).

Sensory information enters the brain through the auditory or the visual systems and registers on the amygdala that signals the other areas of the brain and this becomes the experience of emotion, mostly fear and anger (Damasio, 2003). Damage to the amygdala through lesions inhibits the fear response and this can be associated with stress prenatally and throughout life. This is important to interpersonal neurobiology because of early stress from abusive or neglectful caregiver's influence how the prefrontal cortex helps develop survival strategies based on experience-dependent encoding.

The hippocampus is located on each side of the brain, sits between the cortex and the limbic region, and plays an important role in memory formation and functioning. It also plays a role in our sense of special relations. Discussion memory structures in the brain none are more important than the amygdala and the hippocampus system. Phelps (2004) discussing this system says regarding the hippocampus, "This memory system can be thought of as a primary memory system in humans, in that it governs the functions most often referred to as 'memory', that is, the recollection of events at will' (p.198). Siegel (1999, 2007, 2008) refers to this aspect of the hippocampus system as important for declarative or autobiographical memory. The hippocampus develops later in life than the amygdala and this provides evidence for why we do not have conscious recall from early childhood. The hippocampus interacts with the amygdala and other prefrontal regions of the brain and important for interpersonal neurobiology.

The hypothalamus and some of its functions have interwoven throughout this paper. This small structure is located at the center of the brain's neural systems. The nerve fibers of this structure extend too many parts of the nervous system and are important as a social regulator of conscious experience and emotional regulation. Other parts of the brain's hormonal regulatory system developed from the hypothalamus. Important in this regard is the posterior pituitary gland that helps regulate hormone levels in males and females (Pinel, 2009). Sexual behavior and aggression involves the hypothalamus as well as hunger and sleep cycles. Reproductive behaviors, nursing, and attachment involve regulation of the nervous system employing hypothalamus.

The above seven brain structures and regions function together and interconnect as in important ways for cognitive, emotional, and social functioning. The medial prefrontal cortex (MPFC) fibers connect to the other structures that pass through the entire brain for regulation of eight processes (Siegel, 2008). The MPFC is involved in bodily regulation, attunement with self and others, emotional balance, response flexibility, insight into who we are and our relationship to others, empathy, fear modulation, intuition through bodily senses connected to the viscera, and morality that allows us to understand and act for the larger social good. These qualities represent individuals with well-integrated social brain structures. The MPFC helps us grow with more complexity to satisfy an evolutionary demand through secure attachment and mindfulness states. Attunement proprieties, with others, and us provide the secure environment that stimulates this growth through neural integration.

CONCLUSION

In conclusion, we have looked at the new perspective developing within neuroscience and psychology that places heavy emphasis upon the social networks of the mammalian brain. We owe a much gratitude to pioneers struggling with these difficult and complicated issues. Neuroscience and psychology traditionally views the brain from a memory and behavioral perspective with aims other than social competence within the intersubjective world. Many of the same brain regions of more traditional emphasis attend to memory and task performance competence concerned with functioning in the objective world. Interpersonal neurobiology's emphasis upon the intersubjective interpersonal experiences and social competence within social structures leads the way with its emphasis upon brain regions designed evolutionarily for attunement in the primary attachment world as basic and foundational to object competence (Tronick, 2007)

In our search for the social brain and the central neural mechanisms, the medial frontal cortex takes center stage. Ridderinkhof, Nieuwenhuis, and Braver (2007) assert that this paradigmatic shift of emphasis by researchers has opened up new avenues of research possibilities and has somewhat fractured the neuroscientific community. It has been exciting to look at the brain from various perspectives because it opens up a whole new world of research regarding the social brain from a solid neuroscientific grounded perspective. Most of the problems facing the world have their origins in failed human relationships. Interpersonal neurobiology and its emphasis upon cognitive social and emotional competence within the interpersonal milieu come into focus at the right time in human history. Understanding mindsight and its neural correlates becomes important for human relations between individuals in and out of the clinical setting. The prefrontal cortex works in conjunction to perform some of these functions and attachment schemas are important in nurturing this developmental social skill (Bos, McClure, Harris, Fisk, & Cohen, (2007).

I have only scratched the surface about these exciting research possibilities and their implications for biopsychology. Interpersonal neuropsychology has provided direction for further research into the ever-evolving brain and its implications for social change.

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