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Philosophy of mind: Coming to terms with traumatic brain injury

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Abstract.
INTRODUCTION: Patients and their families struggle with accepting changes in personality after traumatic brain injury (TBI). A neuroanatomic understanding may assist with this process.
OBJECTIVES: We briefly review the history of the Western conceptualization of the Self, and discuss how neuroscience and changes in personality wrought by brain injuries modify and enrich our understanding of our selves and our patients.
CONCLUSION: The sense of self, while conflated with the concept of a "soul" in Western thinking, is more rationally considered a construct derived from neurophysiologic structures. The self or personality therefore often changes when the brain changes. A neuroanatomic perspective can help patients, families, and clinicians accept and cope with the sequellae of TBI.

Keywords: Traumatic brain injury, personality change, philosophy of mind

1. Introduction

Traumatic brain injury (TBI) often results in significant personality changes that are unsettling to patients and to their families. Following injury, those closest to the individual frequently note: "He is not him-*self*", "She's a different *person*". Adapting to the changes wrought by TBI is complicated by tacit assumptions made about the nature of personality, free will, and the relationship between the mind and the brain. We review the development of the Western Dualistic model of mind and body, and challenge this model by reviewing the constructional nature of perception and neurologic bases of affect, morality, empathy, and sense of self. We discuss embodiment theory and briefly describe an *exocentric model* as one possible way to reframe our understanding of "mind" and "body". Rethinking these issues – modifying and expanding one's "philosophy of mind" – can help patients, family members, and clinicians accept and more effectively respond to brain injury.

2. A brief historical review of the early western theory of mind: The struggle toward a physical system

As stated in one text on Philosophy of Mind, this branch of philosophy explores the relationship between mind, brain, and body and between the mental and the physical (Chalmers, 2002, p. xi). Philosophers attempt

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to answer: What is the mind? Is the mind the same as the brain? What is consciousness? Could a purely physical system be conscious? Can we explain subjective experience in objective terms? How does the mind represent the world, if it does so at all?

These queries may appear arcane, but there are at least two reasons humans require a philosophy or theory of mind.

First, human beings develop theories of mind to survive in our social milieu. Social interactions are complex and we navigate these by developing hypotheses about others' motivations, feelings, intentions, and thoughts, and then responding in ways we anticipate will be most useful. Fonagy et al. call this process "mentalization" and assert it "is the process by which we realize that having a mind mediates our experience of the world... and is intrinsically linked to the development of the self, to its gradually elaborated inner organization, and to its participation in human society" (Fonagy et al., 2002, p. 3). Fonagy et al. argue that creation of a theory of mind is crucial for normal psychological development and social adaptation. From our earliest moments we begin assessing and theorizing about the minds others.

This process of mentalization, or coping with social circumstances, requires extensive neuronal processing. The brain:body ratio of mammals directly correlates with social group size, with humans at the top of that ratio, suggesting that processing complex social interactions may select for or necessitate larger cortical capacity (Macphail, 1982). In a layman's computer analogy, social interactions require copious random access memory (RAM), with our theories of mind being the software used to comprehend/cope with others.

A second reason we elaborate theories of mind is the ubiquity of death. Understanding what disappears when someone dies naturally lead to a variety of theories over the course of human history. Anthropologists have found evidence of ritual burial behaviors dating back 50,000 years suggesting belief in an afterlife even among Neanderthals (Klein and Edgar, 2002; Walker et al., 2012).

Written Western theories about death began with the Greeks. The Greek word for soul, Psyche, derives from the verb *psychein,* which means "to breath." Greek philosophers writing about the Psyche were thus writing "on the principle of life" (Goetz and Taliaferro, 2011, p. 7). Plato (428-348 BCE) viewed the soul as synonymous with the mind, and felt that the soul was immortal, separate from the body, and capable of being reincarnated. He thought reason and intellect were the essence of the soul, which moved the body by setting itself in motion (Goetz and Taliaferro, 2011). [*Mind* is a term used by phenomenalists such David Hume, who wanted to avoid the supernatural resonances of the word "soul." On the contrary, philosophers using the word *soul*, – *psychè* in Greek, *anima* in Latin – defend the existence of a supernatural entity different from the perishable body].

Aristotle (384 – 322 BCE) by contrast, opined that everything alive has a soul but that different life forms have different types of souls, and that man's soul has the unique capacity to reason. Unlike Plato, Aristotle suggested in *De anima* that the soul cannot be separated from the body but rather viewed man as a soul-body composite. His theory of movement was that the soul chooses to act, affirming Plato's notion of mental-to-physical causation (Goetz and Taliaferro, 2011).

In the Judeo-Christian tradition, the Old and New Testaments are themselves unclear regarding the relationship of the soul to the body, and overall "affirm a holistic or integrated view of human beings. We are not souls trapped inside our bodies" (Goetz and Taliaferro, 2011, p. 30). The New Testament refers to immortality in multiple contexts, as for instance when Christ stated, "For this is the Will of My Father, that everyone who beholds the Son and believes in Him will have eternal life, and I myself will raise him up on the last day" (*John* 6:40). On the other hand, death is described in terms of "The dust [body] will return to the earth as it was, and the spirit will return to God who gave it" (*Ecclesiastes* 12:6,7). This implies a belief in separation of body and soul. In the first century the Jewish philosopher Philo taught, "The death of a man is the separation of his soul from his body" (Yonge, 1993, p. 37).

St Augustine (354-430 CE) believed, like Plato, but unlike Aristotle, the soul is "a special [and separate] substance, endowed with reason, adapted to rule the body" (Goetz and Taliaferro, 2011, p. 33). St. Thomas Aquinas (1225-1274 CE), however, always the Aristotelian, believed there are different kinds of souls and that, "Body and soul are not two actually existing substances; rather the two of them together constitute one actually existing substance of human being" (Goetz and Taliaferro, 2011, p. 51). According to Aquinas' *Summa Theologica* Thought and Will are functions of the soul, not the body, presuming, like the Greeks, that the Mind is in some ways synonymous with the Soul. However, he also opined, "A well-ordered brain is necessary for ... memory, imagination, cogitative power" (Goetz and Taliaferro, 2011, p. 54).

3. The establishment of dualism

Following Martin Luther's (1483-1546 CE) break from the Catholic Church and the rise of the Reformation, many Christians questioned the absolute authority of the Catholic Church, and the Renaissance in some quarters included a rekindling of interest in the Greek and Roman Skeptics, such as Pyrrho (360-270 BCE) and Sextus Empiricus (160-240 CE) who believed that nothing could be known for certain. Skepticism proved unsettling to many, and prompted Rene Descartes (1596-1650 CE), a rationalist and the founder of analytic geometry, to search for proof of absolute knowledge.

In *Meditations on the First Philosophy*, (Descartes et al., 2006) Descartes proposed a thought experiment to test the existence of absolute knowledge, asking "If Satan were in control of all of my senses and controlled my very perception of the world, how would I know that I existed or that anything was true?" (St. Augustine had formerly posed the same question – and the idea later served as the basis for the film "The Matrix"). Through a series of arguments, not unlike geometry proofs, Descartes ultimately concluded that although we can doubt the validity of our perceptions, at least we know that we exist since we are doubting – and doubting is one of the modes of human thought (*cogito ergo sum*). Descartes formalized a philosophy of Dualism positing that the world is composed of two entirely different kinds or realms or stuff: *res cogitans* or the mental stuff of feelings, hopes, thoughts and consciousness; and *res extensa* or the physical realm of things made of matter and governed by the laws of physics.

Decartes' *Meditations* reified assumptions about a clear separation between the soul and the body that thinkers had been making for centuries, and seminally influenced Western philosophy thereafter. However, problems with this Dualist perspective arose even during Descartes' life, as Dualism begs the question, "if the mind is entirely separate from the body, then how does it make the body move?" Descartes thought that only humans have souls, and presumed that since only humans have pineal glands (not true), perhaps the pineal gland serves as a locus for the soul to control the body.

His arguments on this point were weak, and his own devotees questioned his logic (Yablo, 1992). But the appeal of the Dualistic perspective persisted, no doubt in part because it is intuitively sensible: If we cut off a limb, our core experience of self remains intact, suggesting that the self is separate from the body. However, formulating a plausible mechanism by which the Mind influences the Body has vexed Western thinkers ever since (Yablo, 1992; Kim, 1998).

4. The brain and sensory constructs

Descartes sought neuroanatomic solutions to the Mind:Brain dilemma. We can productively follow his lead. The visual system is an apt starting point given that up to 40% of neurons in the human neocortex process visual information (Vishton, 2011; Gilbert, 2013, p. 562) and up to 80% of all human neurons respond to visual input (Wang, 2010). Vision is the most extensively studied human sensory modality (Albright, 2013; Nolte, 2009, p. 416).

"Vision is often incorrectly compared to the operation of a camera" (Gilbert, 2013, p. 556), an erroneous conceptualization that fails to comprehend the complex constructive nature of vision. To briefly outline the visual system, when light falls on the retina several cell types are stimulated (or suppressed) and translate the visual information into electrical signals in a process called "transduction" (Nolte, 2009). These signals travel via the optic nerves in a spatially consistent fashion (retinotopic arrangement) to neurons in the lateral geniculate nucleus (LGN) of the thalamus (Nolte, 2009; Gilbert, 2013). Thus a spatially consistent map of the retina is reproduced at the level of the LGN. Neurons project from the LGN posteriorly to the primary visual occipital cortex, and from there information is projected forward for further processing to association cortex regions of the parietal lobe (the "where" pathway) and the temporal lobe (the "what" pathway) (Nolte, 2009, p. 440). More than 30 cortical areas in the brain separately process size, color, location, contrast, spatial line orientation, depth, motion, and recognition of objects (Gilbert, 2013, p. 564; Kandel, 2012, p. 239). Discrete lesions of different regions result in discrete deficits, such as a failure to recognize faces due to loss of the facial recognition patches in the fusiform face area of the inferior temporal lobe (Kandel, 2012, p. 292).

We don't just "see the world as it is." Rather, as Kandel (2012, p. 284) observed, "we live in two worlds at once, and our ongoing visual experience is a dialogue between the two: the outside world that enters through the fovea and is elaborated in a bottom-up manner, and the internal world of the brain's perceptual, cognitive and emotional models that influences information from the fovea in a top-down manner". Perception is not merely passively responding to an outside stimulating world. In addition to bottom-up and top-down

processing, the brain fills gaps of visual information in a seamless illusion. We all have a blind spot where the optic nerve leaves the retina, for instance, yet we perceive a cohesive visual field. The brain *constructs* a convincing and cohesive map of the world that is a complex electrochemical experience rather than a veridical portrait. Visual illusions demonstrate some quirks of this constructive process (see Michael Bach's website illuminating features of the visual system through such illusions at http://www.michaelbach.de/ot/).

Most visual processing happens unconsciously, as dramatically illustrated by the phenomenon of "cortical blindness" due to damage to Area 17 of the visual cortex. Patients with this condition report that they cannot "see" and yet are able to catch balls or locate objects in space under various testing conditions. "Despite having no sensory-based perception of objects in the blind parts of the visual field, these patients do have unconscious information about the objects and this information is available to guide their behavior" (Frith, 2013, p. 1375). Another illustration is activation of amygdala fear circuitry by visual information from the LGN before the visual cortex has "seen" the object. We sometimes start running reflexively from dangers spotted by the amygdala well before we have consciously identified what we are running from.

We synthesize and then perceive sensory maps of the outside world – not the world itself. Other sensory modalities, such as hearing, function similarly (Vishton, 2011). This provides an answer to at least one Zen Koan: A tree falling in the forest makes no sound unless there is a creature present with sensors capable of transducing the vibrations into electrochemical signals, and equipped with an auditory cortex to *interpret* those signals as "sound".

5. Qualia and binding

Philosophers of mind raise two key issues in the neuroscience of perception: the issue of "Qualia" and the "Binding problem." The term Qualia comes from a Latin word meaning "what sort" or "what kind". Q*ualia* is "an unfamiliar term for something that could not be more familiar to each of us: *the ways things seem to us*" (Dennett, 1988, p. 226). The term highlights the disjunction between the physical process of perception and our subjective experience. We can delineate the physiology of taste, but this scientific understanding cannot explain why pineapple tastes like pineapple. A Materialist perspective, the polar opposite of Descartes' hypothesis, assumes mind arises from and is not separate from brain: all experience results from neurophysiology – no separate Mind or Soul required. As such, the existence of Qualia argues against a purely materialist view of the world given the uniquely and ineffably subjective nature of experience.

As Searle (1997, p. 33) suggested regarding the Binding Problem: "The visual system has cells and regions that are specially responsive to…color, shape, movement, lines, angles etc. But when we see an object we have a unified experience of a single object. How does the brain bind all of these different stimuli into a single, unified experience of an object?" Kandel (2012, p. 283) cited work by Ann Treisman suggesting that the binding of visual experience "does not occur at any single site. Rather, it occurs when the activities of the various regions of these two (the 'what' and the 'where') pathways are coordinated – and this coordination is achieved by attention". But this creates more questions. How does attention play a role in this process? How does it coordinate or bind various activities between other activities in the various pathways? A comprehensive account of how we synthesize all of our discrete visual processing into a cohesive visual experience remains elusive. This as yet unexplained binding of diverse neurological processes into a conscious subjective experience of the world and our selves argues against a purely materialist view.

6. This emotional (and social and moral) life

It may be unsettling to reduce our perceptions of the world to purely electrochemical maps, yet a Dualist might hold out hope that our treasured emotions are beyond the reach of neuroanatomic principles. Ledoux and Damasio define emotions as "automatic, largely unconscious behavioral and cognitive responses triggered when the brain detects a positively or negatively charged significant stimulus. Feelings are the conscious perceptions of emotional responses" (Ledoux & Damasio, 2013, p. 1079). Emotions involve the limbic system ("limbus" means border or margin) which forms a rim of tissue in the medial wall of the hemispheres including part of the medial temporal and frontal lobes, the cingulate and parahippocampal gyri and insula, and subcortical structures including the amygdala, hippocampus, and hypothalamus (Nolte, 2009; Ledoux & Damasio, 2013).

Imaging and lesion studies demonstrate a pivotal role for the amygdala in fear and aversive conditioning, and

activation of several limbic regions in distinctive patterns when subjects report happiness, sadness, pain, and anger (Ledoux and Damasio, 2013). The role of the nucleus accumbens in pleasure and addictive states is well-documented (Berridge & Kringelbach, 2013).

Emotions play a vital role in social interactions, perhaps explaining why regions of the brain mediating social relationships overlap with those processing emotion. Reptiles lack the social organization of mammals and may as a result have primitive limbic systems. In humans, pathways involving the orbitofrontal cortex and deeper limbic structures regulate social judgment and decision-making by adding affective "valence" or information to what might seem to be purely rational decision processes (Damasio, 2005). A dramatic illustration of the dependence of emotional regulation and moral behavior on limbic structures is found in the classic case of Phineas Gage, a railroad worker injured in 1848 when a tamping iron blasted through his cheek and exited his skull, destroying sections of his orbitofrontal cortex. Mr. Gage survived the accident, but as noted by his physician:

> The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities, seems to have been destroyed. He is fitful, irreverent, obstinate . . . capricious and vacillating . . in this regard his mind was radically changed, so decidedly that his friends and acquaintances said that he was 'no longer Gage' (Harlow, 1868 in Nolte, 2009).

Gage demonstrates the neurologic underpinnings of our emotional lives and the central importance of emotional data in ostensibly cognitive processes like financial decision making, risk assessment, and even 'moral' choices (Damasio, 2005).

7. Empathy and mirror neurons

We regard empathy as a commendable personality trait, crucial for good child rearing (Fonagy et al., 2002) and a cornerstone of ethical and moral behavior (Keysers, 2011). As was the case with emotions, the neurological underpinnings of empathy are being clarified. The discovery of mirror neurons in 1990 by Rizzolatti, Fogassi, and Gallese in the frontal motor cortex of macaque monkeys is reshaping our understanding of empathy, language acquisition, and socialization (Iacoboni, 2008; Rizzolatti and Craighero, 2004). Keysers recounted the eminent neuroscientist Vilayanur Ramachandran suggesting, "I predict that mirror neurons will do for psychology what DNA did for biology" (Keyers, 2011, p. 13).

Mirror neurons "are unique in that they respond not only when the monkey performs a particular action, such as grasping a small raisin, but also when the monkey sees someone else perform a similar action" (Keysers, 2011, pp. 13–14).

These neurons respond to sensory perceptions *and* code for motor behavior: "Virtually all mirror neurons show congruence between the visual actions they respond to and the motor responses they code" (Rizzolatti & Craighero, 2004). Auditory input – like hearing someone speak or perform a task – also activates mirror neurons (Keysers, 2011).

Mirror neurons in prefrontal, parietal, temporal, and insular areas contribute to miming subtle aspects of others' behavior, simulation of their actions, and understanding their experience (Rizzolattie and Craighero, 2004, p. 174). "Premotor areas mirror the *actions* of other people and may enable us to perceive other individuals' goals and motivations from their perspective. The insula, on the other hand, mirrors the *visceral states* of other people and may enable us to share their emotions" (Keysers, 2011, p. 109). Social impairments in autistic individuals are in part mediated by mirror neuron dysfunction documented by at least six different laboratories (Iacoboni, 2008). Empathic capacity, however much valued as a laudable personality feature, has been correlated with mirror neuron function (Keysers, 2011) and thus at least partly devolves from our neurobiology.

8. Our beliefs, convictions, and intentions

Many religious traditions consider faith to be essential in the spiritual journey – for some the key to eternal life. In the secular sphere, one's convictions and opinions on political, aesthetic, and cultural issues have a privileged status in our conscious experience. We value our opinions. But as neurologist Robert Burton demonstrated in *On Being Certain*: "Despite how certainty feels, it is neither a conscious choice nor even a thought process. Certainty and similar states of 'knowing what we know' arise out of involuntary brain mechanisms that, like love or anger, function independently of reason" (Burton, 2008, p. xiii). Burton described the brain's organization into neural networks wherein thousands of neurons synapse on a given neuron, trying to influence it to fire or not fire. These inputs represent a "hidden layer" of information processing of which we are not conscious. Burton discussed the

"committee" of "hidden neurons" that contribute to our decision-making:

> Imagine billions of committee members, each with at least 10,000 hands reaching out to shake hands, prod, poke, seduce, or fend off other members. Miraculously, this orgy of utter chaos is transformed into a seamless and focused stream of consciousness ... the schema of a hidden layer provides a conceptual model of a massive web of neuronal connections microscopically interwoven throughout the brain. ... How consciousness occurs remains an utter mystery, but conceptually, it must arise out of these hidden layers ... (This) helps explain why established habits, beliefs, and judgments are so difficult to change (Burton, 2008, p. 53).

Traumatic brain injuries often produce diffuse axonal injury (DAI) in which many so-called "committee members" perish and other members join to fill in the gaps. TBI may change the "hidden layer" and alter how decisions are made, what opinions are formed, and what attitudes are held. This may help explain why TBI patients often develop a "Personality Change due to TBI", with 31–71% of patients after severe traumatic brain injuries exhibiting irritability 1–15 years post injury (Silver, Yudofsky, & Anderson, 2011), and 13–40% of children and adolescents with TBI exhibiting personality changes 1–2 years post injury (Max et al., 2006). These personality changes are difficult for families. As Marsh et al. (1998) noted,"It is the presence of behavioral problems in the person with the TBI that has the most severe and pervasive impact on all aspects of caregiver functioning."

The biological underpinnings of beliefs and personality are reified by recent twin studies demonstrating genetic contributions to political beliefs (Kandler et al., 2012; Klemmensen et al., 2012) and to borderline personality disorder (Bornovalova et al., 2013), and differences in brain morphology in those who display psychopathy (violent individuals lacking of empathy, remorse, or emotionally responsiveness) (Gregory et al., 2012).

9. Sense of self

William James likened the self to a "cheap and nasty edition of the soul" (Feinberg, 2009, p. 186). A Dualist might yet hope that at least the experience of "self" is beyond the reach of biological reductionism. However, Antonio Damasio's *Self Comes to Mind* made a compelling case for the evolutionary necessity and neurobiological roots of our sense of identity.

Damasio suggested that the experience of "oneself" starts with visceral sensation mapped in the brainstem as a *protoself.* A more complex *core self* develops in higher order neurological structures in the context of relationships between the organism and objects. Our human experience of an *autobiographical self*, constitutes the "social and spiritual me" that emerges from yet a higher level of cortical structures (Damasio, 2010). He suggested we evolved a sense of self because:

> The self focuses the mind process, it imbues the adventure of encountering other objects and events with a motivation, it infuses the exploration of the world outside the brain with a concern for the first and foremost problem facing the organism: the successful regulation of life ... A concern naturally generated by the self process, whose foundation lies in bodily feelings, primodial and modified (Damasio, 2010, p. 283–284).

Damasio proposed that the creation of a conscious autobiographical self occurs in the posteromedial cortices (PMC), the most metabolically active part of the entire cerebral cortex, including the posterior cingulate cortex, retrosplenial cortex, and precuneus. He viewed the "self" as a mental construct formed by the PMC integrating information from multiple neuronal levels.

Feinberg articulated a similar neurobiological view of self, arguing that "the achievement of the human self ... is the outcome of an increasingly complex but ontologically necessary hierarchical arrangement of the nervous system" (Feinberg, 2009, p. 185). Thus, both Damasio and Feinberg suggested that self is understood to be a construct.

10. Boxed in

Positing that we create constructs (of self, or of perceptions of the world) has its critics (cf., Wegner, 2002) who believe that invoking "constructs" adds nothing more to understanding behavior than did the ideas of soul or mind.

Some constructs fall into a category of explanations that rely on the notion of *agency*: actions are distinct from natural events. As Baum (1995, p. 94) described: "In Western culture, we find it easy to think that sunrise and sunset just happen, but if Liz walks to town, it seems some additional element enters in: There is an agent, a *doer*. Liz's walk to town doesn't just happen —it differs

from sunrise and sunset—because Liz is there, *doing* it".

Non-agency accounts of human behavior exist in various cultures. Some Eastern traditions like Buddhism have posited for millennia that there is no absolute self or permanent identity. As Thich Nhat Hanh explained, "All phenomena (physical, psychological, and physiological) are devoid of a permanent identity... Existence would be impossible if things were not empty of an absolute self. If they were not impermanent, how could a grain of corn grow into an ear of corn?" (Hahn, 1995, p. 106). Mark Epstein, writing on the relationship between Buddhist psychological formulations and Western psychoanalytic thinking, observed that through meditation, "The 'I' experience is revealed to be a constantly changing impersonal process, increasingly insubstantial the more carefully it is examined. As a result, the self-concept that was once experienced as solid, cohesive and real becomes increasingly differentiated, fragmented, elusive and ultimately transparent" (Epstein, 2007, p. 44). Buddhism sees self as an epiphenomenon arising from body, thought, feelings, perceptions and consciousness (what are referred to as the five aggregates). As Goldstein noted, "with this understanding of the five aggregates. . the Buddha . . deconstructed the concept of self with incisive clarity. We see that 'self' or 'I' is not something we need to get rid of or demolish. Rather, we understand that it was never there in the first place" (2013, p. 200).

Buddhism thus regards the "I" experience as a process or construct. Feinberg came to the same conclusion from a neurobiological perspective:

> Just as life is not localized within any particular cell in the structure of an organism, consciousness is not localized in any particular zone or structure of the nervous system; rather, it is embodied within the physiological functions of the brain... the self is best conceived of as a 'process.' I find this conception of the self the only reasonable explanation for the seeming transparency and apparent immateriality of what we are (Feinberg, 2009, pp. 209–210).

Eastern mysticism views individual existence is an illusion and reality as one indivisible whole (Baum, 1995). The role of *agency* governing behavior diminishes and the concept of *a doer* becomes unnecessary to account for behavior. Baum (1995) noted, "In Taoism and Zen this idea appears as the concept of 'doing without doing' or simply 'non-doing."' Poem 47 in *Tao Te Ching*, by Lao Tsu goes:

> Accordingly, the sage knows without traveling;
> He sees without looking;
> He works without doing.

Whorf (1956) argued that language determines one's perception of the world:

> ...we are compelled in many cases to read into nature fictitious acting-entities simply because our sentence patterns require our verbs, when not imperative, to have substantives before them. We are obliged to say 'it flashed' or 'a light flashed' setting up and actor IT, or A LIGHT, to perform what we call an action, FLASH. But the flashing and the light are the same; there is no thing which does something and no doing (pp. 262–263).

Baum, Whorf, and others (Chiesa, 1994; Hineline, 1980) point out that English is unwieldy for a scientific account of behavior because "the use of an agentic verb sets the occasion for mentalism and dualism" (Baum, 1995, p. 98). Baum concluded there is a natural affinity between the teachings in Eastern mysticism and the tenets that define Radical Behaviorism, stating that behavior is comprised of natural events, and rejecting the notion of agency or self in behavior (Skinner, 1945, 1969, 1974, 1989).

11. Resolving the conflict: Dialectics

Compelling evidence that perceptions, emotions, personality, morality, empathy, convictions, and sense of self are all connected to our material neurobiological existence undermines the Dualist perspective. However, the Materialist also faces explanatory challenges. In addition to needing to account for Qualia and the Binding Problem, the Materialist view eliminates "free will" since it assumes that sequences of neurochemical events, not a separate immaterial Soul, result in our choices and behavior. If free will is a fiction, how do we as a society ethically address crime, socioeconomic inequality, and myriad other issues where assessments of motivation, personal choices, and accountability shape public policy?

The mind:body split may be an epiphenomenon of the human brain's preference for reducing complex issues to simplistic dualities: good/evil; love/hate; generous/selfish; team player/lone wolf; rational/emotional; liberal/conservative.

Dialectical philosophy suggests one possible solution. Ancient Greeks used the term, *dialektike* meaning

"art of debate or dialogue", to refer to a method of reasoning and discussion to discover the truth. The German philosopher, Hegel, applied the term to a process of thought wherein apparent contradictions, termed thesis and antithesis, are seen to be part of a higher truth or 'synthesis'. Although we may prefer reductionist either-or explanations, a dialectical understanding where *both* contradictory postulates may be true, is often more accurate. As one example, it is important to be self-reliant and independent, but it is also important to depend upon others. As applied to the mind:body dilemma, a dialectical understanding would suggest that the "mind" and "brain" are complementary, but incomplete concepts to understand ourselves. In other words, the split is artificial and fails to capture the fact that some elements of both Materialism and Dualism are true. This type of analysis has been employed by some critiques of the recent rise in neuroscientific explanations of behavior:

> The neurobiological domain is one of brains and physical causes. The psychological domain, the domain of the mind, is one of people and their motives. Both are essential to a full understanding of why we act as we do . . . The brain and the mind are different frameworks for explaining experience (Satel and Lilienfeld, 2013, p. xxiii).

Although logically correct, this dialectical solution fails to satisfactorily resolve the mind body dilemma.

12. Resolving the conflict: Embodiment theory and an exocentric model

Embodiment theory offers a compelling answer. Drawing on pragmatist philosophers-psychologists John Dewey and William James, Johnson noted:

> The denial of mind/body dualism is still a highly provocative claim that most people find objectionable and even threatening. Coming to grips with your embodiment is one of the most profound philosophical tasks you will ever face. Acknowledging that every aspect of human being is grounded in specific forms of bodily engagement with an environment requires far-reaching rethinking of who and what we are, in a way that is largely at odds with many of our inherited Western philosophical and religious traditions (Johnson, 2007, p. 1).

According to Johnson, "Meaning and thought emerge from our capacities for perception, object manipulation, and bodily movement" (Johnson, 2007, p.113) which are the three major tasks that babies must learn to function successfully in their physical and social environments. We create metaphors that describe one domain of experience in terms of another (Lakoff & Johnson, 2003, p. 117), from these early experiences. We utter one metaphor for every ten to twenty-five words, or about six metaphors per minute of conversation (Geary, 2012). Lakoff and Johnson (2003) provided many examples:

Orientation metaphors: Happy is up; sad is down: "I'm feeling *up.* That *boosted* my spirits. I'm feeling *down*. I *fell* into a depression." Conscious is up; unconscious is down: "Get *up*. Wake *up*, He *fell* asleep. He *dropped* off to sleep. He *sank* into a coma."

Conduit metaphors: "I *gave* you that idea. Your reasons *came through* to us. Try to *pack* more thought *into* fewer words. Your words seem *hollow*. The idea is *buried* in terribly dense paragraphs. His words *carry* little meaning" (Lakoff and Johnson, 2003, p. 11).

We generalize and integrate principles learned from corporeal interactions with the world into schemas and concepts. "From the very beginning of life, the problem of knowledge is *not* how so-called internal ideas can re-present external realities, because the *mind was never separate from its environment in the first place*" (italics added) (Johnson, 2007, pp. 121–122). This principle is exemplified in neural map formation. "We live in a world significantly (but not totally) defined by our maps. Topologically speaking, our bodies are in our minds. Our 'minds' arise through our ongoing coupling with our environment. Mind is in and of this embodied experiential process, not above it all" (Johnson, 2007, p. 130). Since Qualia and Binding are inherent properties of our unified physical experience, an embodied understanding reconciles these conceptual byproducts of the Materialist view.

Similarly, Damasio suggested in his discussion of Qualia: "Neurons in charge of conveying to the brain signals about the body's interior would have such an intimate association with interior structures that the signals conveyed would not be merely about the state of the flesh but literally extensions of the flesh . . . in the complex interconnectivity of the brain-stem nuclei, one would find the beginning of an explanation for why feelings . . . feel like something" (Damasio, 2010, p. 273).

Feinberg concluded his argument similarly:

> How close are we today to that point of resolution in the neuroscience of self? I propose that we are

> there now . . . consciousness is based upon a particular hierarchical system of organization that makes the creation of mind and self possible. And it is the nature of this system itself that can explain the remaining most perplexing issue in consciousness – ontological subjectivity. . which (is) the outcome of the brain's known organization and processes" (Feinberg, 2009, pp. 211–212).

Johnson emphasized: "The mind *emerges*, and is enacted through, social cognition . . . In order to have human meaning, you need a human brain, operating in a living human body, continually interacting with a human environment that is at once physical, social, and cultural" (Johnson, 2007, p. 151 and p. 155).

Putting together Damasio's model and the Eastern notion of the self arising from a combination of our thoughts, feelings, perceptions, body, and consciousness (the "five aggregates" – remove any one of these and a sense of self is not possible) we can envision the posteromedial cortex integrating these five aspects of self into an autobiographical experience of self each moment we are conscious. Recent imaging studies of the "default network" provide intriguing evidence of a neuroanatomic locus for such integration of experience into our ongoing experience of "me" (Fair et al., 2008; Gusnard et al., 2001).

A further model, the *exocentric* paradigm, suggests that cognition happens in the whole body and in the environment, as well as the brain, thus expanding the scope from the centralized location (neocortex) to the entire nervous system (Killeen & Glenberg, 2010). Inclusion of interactions between organism and environment into behavior shifts an important portion of behavioral events once attributed to agency to an account based on "renewal and empowerment of both cognitive and behavioral science." (Killeen & Glenberg, 2010, p. 780).

Embodied and exocentric notions of self assert each individual's behavior is the expression of multiple physical and environmental events and not solely as the Will of a disembodied Mind making choices for its Body. As such, these models erode our treasured concept of "free will", seeing choices as evolving from biochemical, neurophysiologic, and environmental factors that interact to ultimately give rise to action. In sacrificing some of our "free will" however, we gain a richer more comprehensive and holistic account of behavior and a deeper sense of our profound interconnection to one another. We have found that educating patients and families about the inevitable links of behavior to neuroanatomy helps them to make sense of their experience following traumatic brain injuries that often turn their lives and senses of self inside out.

13. Caveats and conclusions

We are biologically endowed with and invested in our Selves. Assumptions about a separation of the Mind-Soul-Personality from the Body, buoyed for millennia by cultural tradition and conditioning, make it difficult to accept the personality and behavior changes that often follow brain injury. However, science is finding biological origins for virtually all facets of behavior: perceptions, emotions, morality, empathy, decisions, opinions, and sense of self.

Critics of the quality of research and the reach of conclusions drawn by some contemporary neuroscientists (Satel & Lilienfeld, 2013) appropriately caution against assuming that all of the answers are in. Neuroscience can devolve into reductive materialist conclusions prematurely and mistakenly applied in legal and social policy settings (Marcus, 2013).

More presciently, assuming that science can fully answer the mind:body debate is likely flawed from the start:

> Materialism is held to be the more respectable scientific view. . What such philosophers too often fail seriously to consider is the possibility that empirical science is simply not the only form of rational inquiry. . In the final analysis, the debate between materialists and dualists, like the debate between atheists and theists, isn't a scientific debate, but a philosophical one (Feser, 2005, pp. 234–237).

Thus, for instance, it is quite possible that a life force or soul of some kind may exist and leave the body to experience realms that our physical bodies cannot, as described by neurosurgeon Eben Alexander (2012). The scientific work cited here cannot rule this out. What it does demonstrate is that many facets of personality and self are inextricably tied to our neurobiology and therefore subject to marked change when our biology is altered by injury or disease. For our purposes, it may be enough to appreciate that neuroscience can create a less punitive and more forgiving perspective of aberrant behavior than a dualistic assumption that a transgressor's "bad" behavior is due to his sinful soul.

It can also promote humility regarding our patients, their motivations, and our confidence in our opinions, as our very feeling of certainty is likely due to activation of

neurological structures. As Burton (2009, p. 218) noted, "The message. . is that *feelings of knowing, correctness, conviction, and certainty* aren't deliberate conclusions and conscious choices. They are mental sensations that *happen* to us."

Finally, neuroscience and an embodied view of mind make clear that the pharmacologic agents we use to treat the "brain" ultimately also change the "mind." Taking this into account when assessing side effects and the patient's experience of treatment can deepen our understanding of and alliance with our patients.

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