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ABSTRACT

While the physiological explanations from neuroscience help explain the mechanisms of learning, they fall short of explaining the sociocultural and phenomenological factors that determine a stressful versus a challenging interpretation of experience. For this reason, neuroscience seems less than useful to classroom teachers. A major obstacle in developing a humanized neuroscience is the gap between empirical interpretations and the spiritual/philosophical interpretations of neuroscience research. It is suggested that metaphors from quantum physics can be useful in overcoming false separations and mistaken dualisms in the interpretation of neuroscience results. The common language of the brain and mind is hampered by Cartesian dualism. Metaphors from quantum physics can help overcome this mind-body dualism. According to quantum theory, we participate in the creation of our realities through our status as quantum participant- observers. The traditional split between subject and object is overcome through the model elaborated by the participant- observer. The metaphors of quantum physics, including Bohr's Complementarity Principle, corroborate a more holistic interpretation of experience that helps make neuroscience research more practical. Findings from a humanized neuroscience will serve to improve classroom practices and enhance learning. (Contains 12 references.) (SLD)

Changing Our Minds: The Struggle to Generate a Humanistic Neuroscience Language through Metaphors from Quantum Physics

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Neuroscience's Potential for Teachers

Last year at AERA, I presented a paper entitled "Brain Compatible Classrooms: Theory to Praxis," demonstrating how recent discoveries from the field of neuroscience should impact on classroom teaching in important ways. (Sylwester, 1995).

For example, through neuroscience, we are beginning to understand why many of our students perform poorly on exams when we are fairly certain that they 'know' the material. Findings from neuroscience indicate that this results from our students 'downshifting' as their brain physiology responds to stress (Caine & Caine, 1991). That is, under the stress of test-taking, their cerebrum, the most advanced part of their brain, is slowed in the formation of neural networks while their less-advanced brainstem becomes dominant. This is a very effective explanation of the physiological dimension of our learners. However, it does not help us understand why some students interpret a test as threatening (and therefore 'downshift'), while others interpret the same testing environment as challenging (and are able to excel). Thus, while physiological explanations from neuroscience help us understand the mechanism, they fall short of explaining the socio-cultural and phenomenological factors which initiate a stressful versus challenging interpretation of experience. Because of this, neuroscience seems less than useful to classroom teachers.

Humanizing Neuroscience by Bridging Empirical and Spiritual Languages

The predominance of empirical analysis makes the translation of neuroscience findings into the human dimensions of teaching and learning very difficult. Neuroscience informed by humanistic concerns could pursue useful explanations of educational experience outside of the laboratory, and lead to more applicable results for classroom teachers. A major obstacle in developing such a humanized neuroscience is the gap between empirical interpretations and spiritual/philosophical interpretations of neuroscience research. The language used to relate neuroscience findings is usually materialistic and reductionistic. That is, most authors in the field attempt to address physiological questions, what Kosslyn and Koenig (1992) refer to as the "easy questions,"

for example: "How does the brain work?", "How are neural networks formed?", or, as in our example, "What happens in a brain under stress?" Meanwhile, these researchers deftly avoid difficult spiritual and philosophical questions such as: "What is the relationship between a neural network and the thought associated with that network?", "What is the relationship between body and mind?", or, as in our example, "Why does one student feel stress while another thrives upon challenge?"

There has been a tendency either to present neuroscience research in the reductionistic terms of the purely physiological and observable (Dennett, 1991; Churchland & Sejnowski, 1992), or to dismiss neuroscience and pursue more humanistic interpretations of educational experience. Thus, a chasm has formed between the laboratory and the classroom. Classroom teachers, who could and should be able to benefit greatly from neuroscience research, are often left with the impression that these discoveries do not have practical implications for their own classroom behaviors and practices. Indeed, most teacher education courses and textbooks make no mention of neuroscience. My research has been, and in many ways continues to be, a struggle to bridge the gap between the language of neuroscience (which tends to be very technical), and the languages of philosophy and human spirituality (which tend to be more open-ended), in order to make neuroscience accessible to the classroom teacher.

Building this bridge is very difficult, as the response to my presentation last year demonstrated. During my presentation, I deliberately adopted the term "mind-brain" in order to avoid materialistic reductionism on one hand, and immaterial ungroundedness on the other. I was surprised by the reaction I received from my audience. It seemed that the room was divided in half. One group of the listeners took issue with what they perceived as a reductionistic bias, while the other half opposed what they saw as overly philosophical or spiritual. Thus, in mutually contradictory fashion, I was accused of being both too ethereal and too materialistic. It seemed that some reduced the term "mind-brain" to mean only "mind," while others misconstrued the term to mean exclusively "brain." I left the presentation determined to understand this division in the audience. I realize now that my shift in terminology away from the common language, dualistic separation of "brain" and "mind" to the unity of "mind-brain" requires elaboration.

Thus, an objective of this session is to stimulate discussion and dialogue regarding both the physiological aspects of brain, as well as the philosophical/spiritual implications of mind and thereby move toward a humanistic neuroscience of the unified mind-brain. I hope to work toward a language that allows us to avoid the "either-or" separations of common language. I believe that metaphors from quantum physics can help overcome false separations and mistaken dualisms.

Common Language and Cartesian Dualism

Common language requires the creation and maintenance of dichotomous and dualistic interpretations of experience. For example, common language encourages the oppositional presentation of the mind and body/brain. In general use, the "mind" refers to the immaterial and conceptual aspect of thought -- that which defines my self. In contrast, the "brain" refers to the physical organ in my body that carries on the synaptic functions necessary for thought. Laughlin, McManus and d'Aquili in their book Brain Symbol & Experience: Toward a Neurophenomenology of Human Consciousness discuss this Western tendency toward dualism, referring to it as a "natural attitude in Euro-American cultures." They state:

> Members of Western cultures tend to be conditioned to think in terms of mental versus physical events and to experience themselves as being distinct, separated, or even alienated from their bodies. (Laughlin, McManus & d'Aquili, 1990, p. 10)

In this way, common language and thought create clusters of words which fall on one side or the other of an invisible line, corporeal or non-corporeal, brain or mind. This a cultural heritage largely attributable to Descartes.

> Since the seventeenth century the body has been primarily identified with its scientific description, i.e., regarded as a material object whose anatomical and functional properties can be characterized according to general law. As such, the human body, while perhaps unusual in its complexity, is taken as essentially no different from any other physical object. (Leder, 1990, p. 5)

From a traditional Western perspective, then, the body (and therefore, the brain) is taken to be an object in the world which is owned, possessed and inhabited.

Problems of Dualistic Language

Because our language encourages us to think of the body and the brain as if they exist as objects and not as subjects, we mistakenly remain confined to either the physical or the metaphysical dimension of experience. Due to Cartesian dualism, there is insufficient language to express a unity of the physical and the metaphysical. We come to experience our self as separate from our body, our mind apart from our brain.

For example, the locale of thinking is languaged as being nearly irrelevant to the concept of thought itself. I can even speak of my own mental activities as if they are taking place in outer space. I may speak concurrently of the entrainments formed by the neurons in my brain, but this discussion will not reveal the thoughts which these entrainments signify or produce because the explanations generated by entrainments remain focused on the physical dimensions of experience. My language does not facilitate simultaneous exploration of both the metaphysical content (the idea) of a thought and the physical dimensions (neural networks) of the thinking process.

Within the culturally accepted model of Cartesian dualism, we tend to speak as if our minds think while our bodies vanish. When I think about something, I quickly lose awareness of my own physical being, as if my body disappears while I think. Another way of saying this is that I 'background' physical experience, while 'foregrounding' mental activity. While there are millions of synapses firing in my brain, I am not aware of this activity. Instead, I continue thinking thoughts. My 'mind' or rationality, becomes the focus of my attention, not my brain. Likewise, even as my fingers touch this keyboard, I am not noticing the movement of my fingers, nor the feel of the keys (except of course, as my attention is drawn back to these as I write about it) ... instead, I am engaged with my thoughts. I become unaware of the movement and physicality of my being. I fail to notice that my arms are getting tired, or that my feet have "fallen asleep." I attend only to the thoughts as they occur in my mind.

Drew Leder gives another phenomenological account:

> When engaged in inner monologue, even my hands and mouth, my eyes and ears, drop out of immediate employment. The sensorimotor organs that were used in speaking or reading are now placed in background disappearance with the rest of the body. I can think while sitting perfectly motionless, no corporeal activity whatsoever apparent to myself or to another. *It seems as if the thinker makes no use of a body.* (Leder, 1990, p. 123)

It is for this reason that Leder speaks of the body as the "nullpoint." (Leder, 1990) The body or brain is the place from which we begin, the vantage point from which we each come to experience the objective world. As such, this point itself is not available to be seen "from" while simultaneously being seen "to." For example, our eyes can never directly perceive their own functioning.

> Just as [the quantum physicist] Heisenberg recognized theoretical limitations on knowledge that could not be overcome by technical advance, such is our condition relative to embodiment. We simply cannot see our seeing no matter what reflective means are employed. (Leder, 1990, p. 17)

Equally, the experience I have of my body and brain cannot be directly perceived.

> Ultimately there are elements so proximal within the "from" structure that they are irreversible for the subject, unavailable for being experienced "to." ... The nervous system lies at the very core of the experiencer. As such, it radically resists alienation and objectification. (Leder, 1990, p. 114)

Leder re-iterates, "the surface body tends to disappear from thematic awareness [during thought] precisely because it is that *from* which I exist in the world." (Leder, 1990, p. 53)

This apparent disappearance, which Leder terms *dysappearance*, may have mis-led Descartes to his dualistic conclusions regarding the brain and the mind. For the most part, this line of demarcation between objectivity (physicality) and subjectivity (metaphysicality) is taken for granted in our culture, thanks in large part to Descartes. Nonetheless, he, and by extension our culture, fell victim to the problem of observation. For, when I turn to look specifically at the so-called 'purely physical' dimensions of my experience as they meet the so called 'purely mental' aspects of my experience, the arbitrariness of Cartesian distinctions is revealed.

Metaphors for the Mind-Brain Unity

As the previous discussion demonstrates, the common language of brain and mind is hampered by Cartesian dualism. The separation of mind and body (brain) is foundational to seventeenth-century Cartesian thought. Leder states the case, "Cartesian categories of mind and body merely reify and segregate classes of experience that stand in ceaseless interchange." (Leder, 1990, p. 149) An integrated experience and understanding of mind-brain can generate new interpretations of our worlds which overcome separations of object and subject.

There are postmodern, alternative, non-objectified positions which challenge Cartesian dualism and its mis-understanding of the human body. For example: *biogenetic structuralism*. This view "holds that 'mind' and 'brain' are two views of the same reality -- mind is how brain experiences its own functioning, and brain provides the structure of mind." (Laughlin, McManus & d'Aquili, 1990, p. 13) As I have discussed over the past

two years, this position is significant in the field of neurophilosophy. My use of the term mind-brain, based in biogenetic structuralism, allows me to explore and supersede the culturally-imposed line between objectivity and subjectivity, matter and spirit, physiology and metaphysicality. Thus, biogenetic structuralism provides one possible bridge over Cartesian dualism.

Quantum Participant-Observer

Another possible bridge is found in quantum physics. Traditionally, we adopt metaphors from our most complicated discoveries and inventions to describe the functioning of our mind-brain. In previous centuries, we compared our brains to complicated machinery, such as clocks and automobiles. Presently, we adopt metaphors from computer technology, such as parallel processing and programming.

Although these metaphors have been useful, they perpetuate the false separations of brain and mind. Metaphors from quantum physics can help us overcome this Cartesian dualism. Twentieth-century quantum physics has changed and enriched the metaphors for human existence. Furthermore, quantum physics has shown that the metaphors we employ to explain and understand our mind-brain are especially important to the creation of our worlds. According to quantum theory, we participate in the creation of our realities through our status as quantum participant-observers. Thus, a look at the metaphors we use to describe our selves is significant. As Chopra notes:

> No matter where you look, the visible universe is fundamentally a set of signals. Yet these signals all hold together, turning totally meaningless vibrations into full-blown experiences that have human meaning. (Chopra, 1989, p. 130)

The human act of attributing significance and value to these "meaningless vibrations" generates the world as we know it. This means that the use of metaphors and models creates our reality. In this way, the traditional understanding that we create models to explain what we observe in the world gives way to a quantum mechanical understanding that we create models as part of our participation in the creation and explanation of our worlds.

The model of quantum physics informs us that the choice to measure certain properties actualizes those properties. All possibilities exist until we choose to measure or actualize one of the possibilities.(Wolf, 1988) The models and metaphors which our understanding of the subatomic level generates allows the creation of new metaphors to

explain and create new ways of being. This metaphor of the participant-observer can allow us to envision a bridge between matter and spirit facilitating a more integrated understanding of our worlds. Our current metaphors regarding the human body for example, can be revised based upon these new metaphors and understandings generated through quantum physics. Rather than continuing to use out-moded Cartesian metaphors, we can metaphorize our worlds and bodies in quantum terms. Thus, the term mind-brain can take on a more significant and integrated meaning.

The shift from traditional classical mechanical metaphors of experience to quantum mechanical metaphors results in understanding the mind-brain as a participant-observer. Through this metaphor, the body and brain are no longer a separate entity which is *owned* as an extension of the Self. Instead, the mind and brain are understood as mind-brain, with integrated physical and metaphysical dimensions.

The traditional split between subject and object is overcome through the model elaborated by the participant-observer. This metaphor allows the body to be experienced as presence. The mind-brain serves to present the world in a similar fashion as Heidegger's language makes present the object or event encountered. (Heidegger, 1971) No longer a thing to be owned or observed, the body is understood as a complex part of the participant-observer unity which serves to actualize the world. The breaking down of boundaries encourages a view of the world in which discrete objects no longer exist. Instead, the emphasis shifts from the borders to a recognition of the constant exchange taking place everywhere and all of the time. Thus, the mind-body, through its functioning; for example, the intake of food becoming thought, exhibits physicality transforming into metaphysicality. Again, the term mind-brain demonstrates the intimate connection of what is commonly referred to separately as mind and brain.

Quantum Fuzziness and Constant Exchange

The shift to quantum explanations produces changes regarding the ways in which we relate to the constant exchange of molecules and matter in and through the mind-brain. An emphasis on the changing conditions of the body and the brain, as well as the continual exchange between body and world, makes ownership of an exclusive body, or an exclusive brain impossible. If one were to "own one's body" within quantum metaphors, "one's body" or one's brain would have to include everything (including nothingness). Chopra describes the body and brain using the metaphor of a quantum experience and process:

> If you could see your body as it really is, you would never see it the same way twice. Ninety-eight percent of the atoms in your body were not there

> a year ago. The skeleton that seems so solid was not there three months ago...The skin is new every month. You have a new stomach lining every four days, with the actual surface cells that contact food being renewed every five minutes...It is as if you lived in a building whose bricks were systematically taken out and replaced every year. If you keep the same blueprint, the it will still look like the same building. But it won't be the same in actuality. The human body also stands there looking much the same from day to day, but through the processes of digestion, elimination, and so forth, it is constantly and ever in exchange with the rest of the world. (Chopra, 1989, p. 48-49)

Each system of the human body, especially the brain, functions both separately and in union with the whole. Similarly, each of these particles and molecules, although involved in continual exchange, is also part of a synchronous and unified universe. The "fuzzy" boundaries and continual exchange recognized by and through quantum physics is also coupled with a connectedness between particles through which, "particles seem to know instantaneously what decisions are made elsewhere." (Zukav, 1979, p. 72)

The universe has been described as a series of interactions. Borrowing the metaphors of classical physics, we have traditionally thought in terms of discrete and concrete entities and objects responding to one another through linear-type relationships of cause and effect. Now, however, we can borrow the metaphors of quantum physics and begin to think in terms of possibilities and exchanges which are constantly taking place. These exchanges are noted instantly throughout the universe as each interaction is inter-connected. We can begin to respond to the world as simultaneous responses to each change of state generating the world as we experience it. These metaphors can free us from the constraints of linear, cause and effect thinking. We can begin to recognize the continual, multiplicity of reactions, possibilities and relationships that are formed and re-formed through simultaneous exchange.

An example of this constant exchange experienced in the world takes place in the breath. The body, if it is full of life, is always in motion -- if only the motion of breathing. We are involved in a constant exchange of material and information between ourselves, our bodies and our environments. Thus, in fact, the demarcation that we usually take for granted as separating the body from the environment is arbitrary.

The breath provides a relatively easy place from which to begin to integrate a quantum physical understanding into our way of thinking, and thereby broadening the metaphors within which we create and interpret our worlds. The activity of breathing

creates a bridge transcending the physical and metaphysical. Where indeed do I begin and end in this process? What marks the boundaries of my world? What is it that gives and sustains my life? How does the breath, a physical transfer of molecules, accomplish the sustenance of life? These questions raise a dilemma for those caught within the Cartesian paradigm, and sustain the impulse to move beyond this limiting interpretation of the world.

Classical physical metaphors of breathing generate a visualization of breathing in which air is taken in to the body and released. The processes of transformation are obscured in this account. A quantum mechanical explanation, however, draws our attention to the simultaneous responses of molecule to molecule. When metaphorized through quantum physics, the focus is drawn to the constant exchange of matter and information. The process of transformation from in-coming to out-going air becomes the center of attention. The life-giving integration and transfer of information takes greater importance.

Considering the breath in quantum physical terms generates an enhanced understanding of the tension which exists between the physical and the metaphysical. While the physical dimensions of the process of breathing are understood in detail by practitioners of modern medicine, the metaphysical dimension remains elusive. The metaphors and models of quantum physics makes possible a new understanding of the transforming nature of breathing in a living body. One of the reasons that we have particular difficulty distinguishing mind and brain lies in this fact of exchange. As noted earlier, this constant exchange between self and environment proceeds largely unnoticed, yet it occurs at a remarkable rate. The metaphors generated through quantum physics makes it easier for us to imagine this constant exchange and overcome the Cartesian categorical divide.

Thus, understanding in great detail the physiology of brain function will not reveal the secrets of the mind. Instead, we must elaborate quantum metaphors of mind-brain in which mind must not be reduced to the material functioning of what is commonly referred to as our brain. Neither can brain be properly studied alone. We must accept that the physiology we study is intimately related to -- indeed inseparable from mind. The terms mind and brain are misleading and encourage the perpetuation of out-moded Cartesian dualism. The single term mind-brain will help us comprehend the inter-relationship of mind-brain.

Light as Quantum Wave-Particle

Recent findings in quantum physics also substantiate this position. The firm lines of demarcation between "here" and "there," "me" and "not me" have not been

substantiated in the subatomic realm. Neils Bohr's principle of complementarity provides a pertinent example. The principle of complementarity postulates that, "what we experience is not external reality, but our interaction with it". (Zukav, 1979, p. 116) Bohr hypothesizes multiple "pictures" whose views are complementary and contradictory. In order to make sense of our observations, Bohr maintains that we need to consider pairs of pictures or metaphors, neither of which is complete on its own.

Discoveries related to light epitomize the complementary relationship Bohr was exploring. In 1803 Thomas Young, using the phenomenon of interference, 'proved' that light is wavelike. Just over one hundred years later, in 1905, Albert Einstein, using the photoelectric effect, 'proved' that light is particle-like. (Zukav, 1979; Gibbins, 1987) Thus, scientific evidence supported two contradictory conclusions regarding the nature of light.

Bohr's complementarity principle is an attempt to reconcile these two "truths." By postulating that we understand light in terms of "pictures" or metaphors, Bohr was able to reconcile these two positions into a mutually supporting paradigm. Bohr maintained that in order to understand the nature of light, one must utilize the findings related to both observations. Otherwise the account would be incomplete. Instead of insisting that light be understood in terms of either waves or particles, this principle of complementarity recognized that light is neither wave nor particle, but *both* wave *and* particle (wave-particle). The "pictures" of waves and particles help us metaphorize and therefore better understand the behavior of the "more complex" entity, light, in terms of "less complex" observables, waves and particles.

As this example makes clear, light which must be accepted, studied and metaphorized as wave-particle. Seemingly contradictory explanations and metaphors must be held simultaneously. Quantum physics shows the either/or position of classical Cartesian explanations are invalid.

The same is true of our mind-brain. Neuroscientists and educators alike continue to seek explanations of brain functioning without taking into account the seemingly contradictory information regarding mind. To continue to study the brain alone would be as mis-guided as treating light as either wave or particle. Just as light must be studied and metaphorized in complementary terms so that it may be understood. Thus, the inseparable concept of mind-brain must be accepted in order to avoid mis-guided theories and partial understandings of our selves.

The ability of electrons to be both "here" and "there," coupled with the nature of light to be both wave and particle, have cleared the path for new interpretations of our worlds in which paradox and self-contradictory unity play major parts. The mind-brain is a central paradox which requires complementarity to be understood.

Conclusion

I have brought these quantum perspectives from quantum physics to your attention in order to develop parallels between the metaphors of quantum physics and those of neurophilosophy. The convergence between these areas of inquiry supports an emerging alternative to dualistic interpretations. The separations between matter and spirit, which were taken for granted by Descartes, and many others following him, have come under serious attack in our century.

Quantum physics, the science of explaining the universe at its smallest, substantiates the elimination of dualistic interpretations of experience. The metaphors of quantum physics, including Bohr's Complementarity Principle, corroborate a more holistic interpretation of experience. The traditional dichotomies of objective and subjective, material and spiritual are challenged through these recent observations and discoveries.

The conclusions I have reached indicate that in order to generate a coherent analysis, which takes into account the wholeness of our human being, we must overcome the tendency to break down our communication. We must address our physiology as well as our human spirit/mind. The different languages of materialism and spirituality unnaturally divide us into different camps where one group focuses strictly on understanding physiology, while the other focuses exclusively on understanding our "selves" apart from the physiological basis. Splitting ourselves into these disciplines enables only partial interpretations and analyses of the data available to us.

As a neurophilosopher, I maintain it is imperative that we bring a philosophical and spiritual analysis to neuroscience research in order to restore a more human dimension and move beyond the strictly utilitarian level. Thus, the educational importance of this study lies in the potential of neuroscience research to enhance our understanding of ourselves. Taken out of the anti-humanistic setting, neuroscience research will become even more practical. I assert that the findings from a humanized neuroscience will serve to improve classroom practices and enhance learning.

For this reason, and those cited above, I maintain that the materialistic language of neuroscience research needs the interpretive lens offered by philosophical and spiritual languages. We must all learn to broaden our focus so that we may integrate these languages and thereby generate more holistic and better grounded interpretations of our experiences.

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