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Neuroscience meets dance/movement therapy: Mirror neurons, the therapeutic process and empathy

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Abstract

The recent discovery by neuroscientists of mirror neurons has launched a spate of scientific investigations. A keystone of the therapeutic process of dance/movement therapy (D/MT), the concept of mirroring is now the subject of neuroscience. An interactive phenomenon, studies are revealing that the identical sets of neurons can be activated in an individual who is simply witnessing another person performing a movement as the one actually engaged in the action or the expression of some emotion or behavior. The domains of behavior currently under investigation span motoric, psychosocial and cognitive functions, including specific psychosocial issues related to attunement, attachment theory and empathy. Although D/MT embodies empathic forms, until recently their neurological underpinnings have not been studied. The paper addresses the theoretical constructs of the mirror matching mechanism and empathy, and the implications for D/MT. Beginning with the basic mapping of important central nervous system structures and their behavioral functions, the focus shifts to the mirror neurons with respect to the formative years vis-à-vis the developmental issues of empathy—attachment, attunement, social cognition and morality. The final section offers two exemplars of mirror neurons and empathy as mediated through dance and D/MT.

Keywords: Mirror neurons; Dance/movement therapy; Intersubjectivity; Empathy; Neuroscience; Formative years

In 2002, an unusual brochure arrived in the mail that immediately caught my attention. The first international conference on Neurosciences and the Arts was to be launched by the Minerva Foundation of the University of California, Berkley (UCB) with co-sponsor, the Institute of Neuroesthetics of the University College, London. With curiosity piqued, I registered for this inaugural meeting at UCB. It proved a fascinating day in which a cast of international presenters discussed the relationship of the "Pleasure of the Arts and the Brain." Of even greater relevance to me was the 2005 conference devoted to "Empathy in the Brain and Art." Featured among the speakers were the distinguished Italian neuroscientist Vittorio Gallese (2005a), who discussed his current research on mirror neurons and their association with imitation, empathy and intersubjectivity, and eminent psychologist Paul Ekman (2003), who addressed his research on the universality of the emotions displayed in facial expressions.

Inquiry into the nature of the linkage between art and science has, in the past decade, been spreading rapidly, capturing the interest of many human and behavioral scientists, developmental psychologists and human development theorists as well as those in arts-related disciplines. The psychotherapeutic implications of mirror neurons have enormous clinical relevance for the creative arts therapies, and in particular, dance/movement therapy (D/MT), for whom the notion of "mirroring" should strike a familiar resonance. The growing fascination with the relationship between neuroscience and the arts, although long due, is a particularly welcome and exciting phenomenon.

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In early experiments on the brain of the macaque monkey in the mid 1990s, a group of Italian neuroscientists such as Umilta et al. (2001) and Gallese, Keysers, and Rizzolatti (2002), Gallese (2005a, 2005b), Gallese, Fadiga, Fogassi, and Rizzolatti (1996) reported the discovery of a class of pre-motor neurons (located in the frontal lobes) that were activated not only in brain of the monkey performing the actions of grasping objects with its hand, but in a monkey or human witnessing those actions. Like a mirror image, the same sets of neurons are activated in an observer as in the individuals actually engaged in an action or the expression of some emotion or behavior. Gallese (2005b) emphasizes that these inherent mirroring properties help explain the mechanisms of social, kinesthetic and emotional cognition or understanding. As experience-based reactions, the neuronal discharges are sparked by a "direct simulation of observed events through the mirror mechanism" (p. 1), not intellect or reasoning.

A keystone of the therapeutic process of D/MT, the concept of mirroring is now the subject of neuroscience. The domains of mirror neurons currently under investigation span motoric, psychosocial and cognitive functions, including specific psychosocial issues related to attunement and attachment theory and empathy. Although D/MT embodies empathic forms, their neurological underpinnings have remained virtually unexplored.

This paper examines aspects of the neurobiological mechanisms and evolving theoretical constructs of mirror neurons and then views them through the qualitative lens of the therapeutic process vis-à-vis D/MT and empathy. To establish a framework for conceptualizing the research and its behavioral implications, we begin with a simplified review of the geography of the central nervous system (CNS), that is, the brain and spinal cord. With a focus primarily on the brain, concentration is on its general configuration and functions, specifically, common basic formations and neuronal network systems in addition to some general information concerning neurotransmission.

Brain structure and function

Depictions of the human brain typically reveal multiple structural divisions such as its hemispheres, cortices and lobes. Neural landmarks help differentiate and identify specific regions of the brain, such as ridges (gyri), grooves or depressions between the ridges (sulci) and grooves even deeper than sulci (fissures). Gifted writer Diane Ackerman (2004) portrays the essence of the three-pound walnut-shaped brain with stunning and vivid imagery.

> Imagine the brain, that shiny mound of being, that mouse-gray parliament of cells, calling all the shots, that dream factory, that petit tyrant inside a ball of bone, that huddle of neurons calling all the plays, that little everywhere, that fickle pleasure drome, that wrinkled wardrobe of selves stuffed into the skull like too many clothes into a gym bag. The neocortex has ridges valleys and folds because the brain kept remodeling itself even though space was tight. We take for granted . . . the undeniable fact that each person carries around atop the body a complete universe in which trillions . . . of sensations, thoughts and desires stream. They mix privately, silently, while agitating many levels some of which we're not aware of . . .. Our brain is a crowded chemistry lab, bustling with non stop neuro conversations . . . an impersonal landscape where minute bolts of lightening prowl and strike . . .. Sometimes it's hard to imagine the art and beauty of the brain because it seems too abstract and hidden an empire, a dense jungle of neurons . . . [and] thousands of wires . . . influenced by a caravan of hormones and enzymes (pp. 3, 4, 6).

The neocortex, a feature distinguishing humans from lower forms of animals, endows us with the potential for complex cognitive and oral language function. As the prime center of operation, the CNS processes and controls all human behaviors, and varies little from person to person in terms of form, organization and function (Berrol, 2000). As shown in Fig. 1 (basic structures of the brain), the spherically shaped cerebral hemispheres—joined together by the corpus callosum, a large collection of nerve fibers that maintains neuronal communication between them—constitute the largest portion of the human brain. Although the hemispheres may appear as mirror images, there are many asymmetries, particularly in terms of function.

The outermost layer, the cerebral cortex, is divided into four lobes: frontal, parietal, temporal and occipital (see Fig. 1). Deeply embedded in the cerebrum (i.e., the hemispheres containing the four lobes) are three smaller regions. These comprise the nuclei of the basil ganglia (a subcortical mass of nerve fibers that deals with complex habitual movement), the hippocampus (its name indicating a seahorse-like shape) and the amygdala (meaning almond-shaped). The latter two, which make up part of the limbic system (see Fig. 2: basic formations of the limbic system), are commonly considered the "emotional brain" or the "seat of emotions," regions that will be addressed more fully below (Diamond, Schiebel, & Elson, 1985; Restak, 1984).

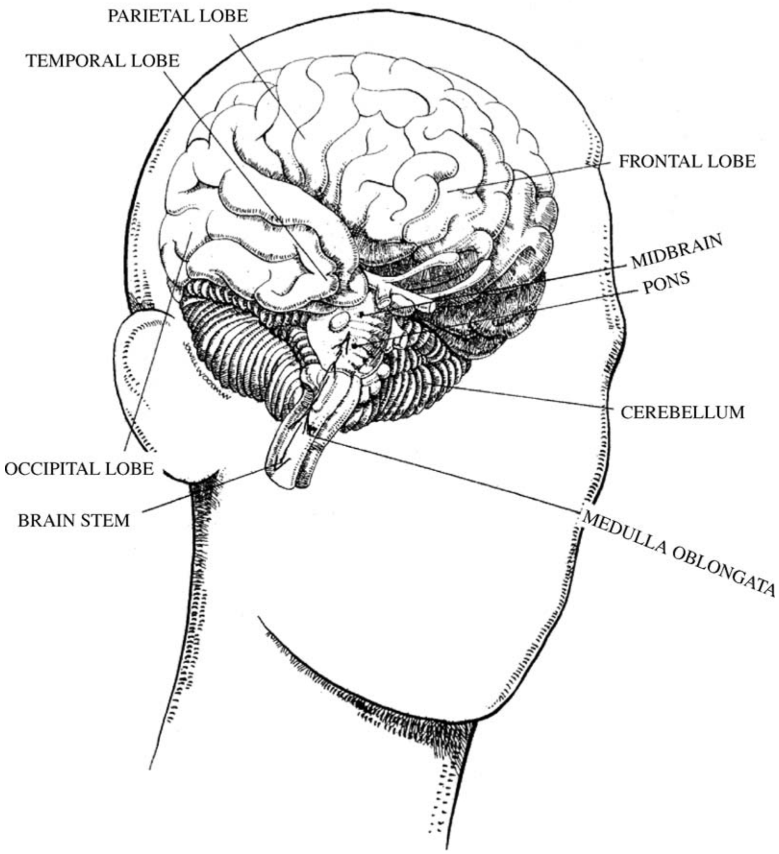

Fig. 1. Basic structures of the brain (from Restak, with modifications, 1984, p. 13).

Beneath, and to the rear of cerebrum lies the somewhat conically shaped brain stem, a tri-part structure of upper, middle and lower sections. The upper brain stem—sometimes referred to as the diencephalon—contains the thalamus, hypothalamus and pineal gland. The middle portion is simply known as the midbrain, while the lower brain stem is composed of two formations, the pons and medulla oblongata. Behind the brain stem and just above the spinal cord, rests the cerebellum, a regulator of posture, balance and motor coordination (Bloom, Lazerson, & Hofstadter, 1985; Diamond et al., 1985; Kolb & Wishaw, 1985; Nolte, 1981; Restak, 1984) (see Fig. 1).

The frontal lobes of the neocortex

As indicated by its name, this formation is located anterior to the other three lobes referred to above. Considered the thinking part of the brain, it is associated with cognition (particularly the most anterior portion, the prefrontal cortex), i.e., judgment, planning, abstract thinking, problem solving and initiative, as well as personality and behavior. The pre-motor and motor cortex, the hind section of the frontal lobes, deal with coordinated motor actions and speech articulation (Diamond et al., 1985; Stuss, 1988). Interestingly, each side of the motor cortex controls muscle movement on the opposite side of the body. As a result, damage to the right hemisphere impairs movement on the left side of the body and vice versa. In terms of speech, damage to the lower left side (Broca's area) causes impaired articulation (expressive aphasia) while damage to the lower right lobe leads to problematic spatial judgment. Here then are discrete exemplars of differences in function between the two sides.

As explicated by Luppino and Rizzolatti (2000) and of particular import to this paper, the prefrontal motor areas of the cerebral cortex are responsible for converting incoming sensory information into motor instructions or actions. Similarly, this area is purported to mediate other complex behaviors, including imitation or awareness of actions

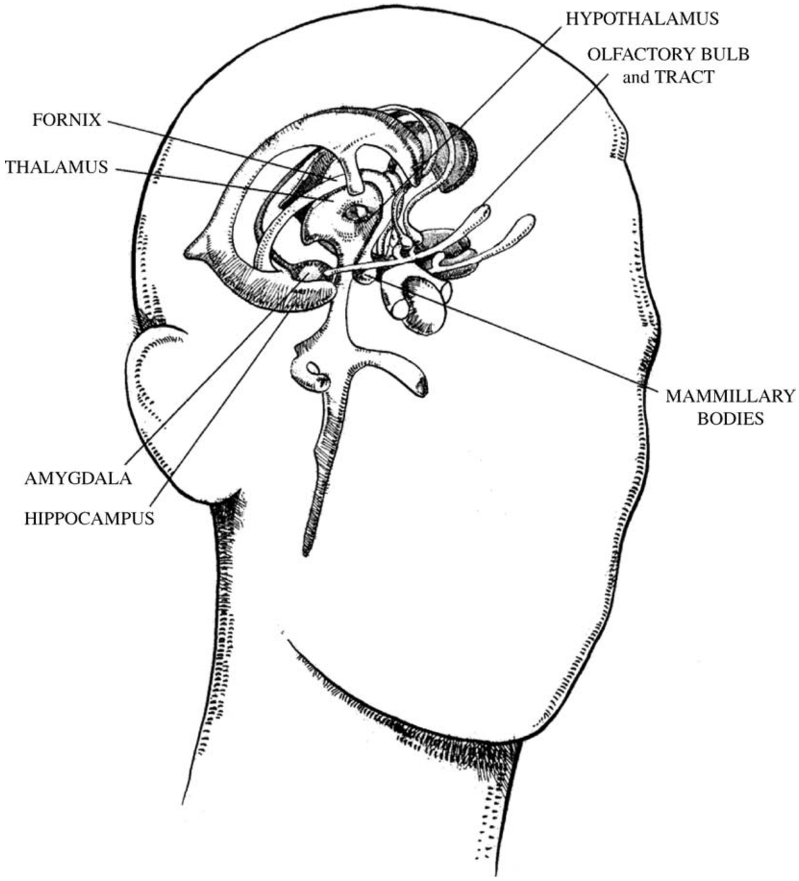

Fig. 2. Basic structures of the limbic system (from Restak, 1984, p. 15).

performed by others, i.e., "associative motor learning." In other words, within the pre-motor cortex is a class of neurons said to be actively engaged in the process of simulation, hence the moniker "mirror neurons" (Bloom et al., 1985; Diamond et al., 1985; Luppino & Rizzolatti, 2000; Restak, 1984).

The parietal lobes

Immediately adjacent to the motor area strip, the parietal lobes extend from a central location toward the posterior part of the cerebrum. The primary sensory and secondary areas of this lobe—those neurons closest to the motor strip and fanning posteriorally—are responsive to body sensations of temperature, touch, pressure and pain. In addition, aspects of body scheme and language are associated with the parietal lobes. In fact, dysfunction in the lower region is affiliated with reading disability (Bloom et al., 1985; Diamond et al., 1985; Luppino & Rizzolatti, 2000; Restak, 1984).

The temporal lobes

In the lower sections of the cerebrum, behind and below the frontal and parietal areas, lie the temporal lobes. While its upper section mediates auditory function, the lower portion deals with memory. Consequently, injury to these areas may cause hearing and/or memory impairments, as will damage to a particular section of the lower left temporal lobe (Wernikes's Area) may result in the inability to comprehend spoken language (i.e., receptive aphasia). The temporal nuclei are, in addition, believed to be involved with multisensory integration of touch, vision and hearing (Bloom et al., 1985; Diamond et al., 1985; Luppino & Rizzolatti, 2000; Restak, 1984).

The occipital lobes

Occupying the hind- and lowermost section of the cortex, the occipital lobes seem to emerge out of the dorsal sides of the parietal and temporal lobes. As the primary visual center, it is directly linked to the eyes via the optic nerves. Damage to these nerves may range from visual impairment to blindness. The more generalized association area of the lobes is devoted to higher-level interpretation or analysis of visual information (Bloom et al., 1985; Diamond et al., 1985; Luppino & Rizzolatti, 2000; Restak, 1984).

The insula

This somewhat triangular structure within the cerebral cortex—occasionally referred to as the central lobe or the Island of Reil—lies hidden within the convolutions of deep neuronal fissures. It extends beneath regions of the frontal, parietal and temporal lobes and behind a section of the hippocampus (Mesulam & Mufson, 1982). The insula is associated with visceral functions and integration of autonomic information (Diamond et al., 1985). A number of articles, especially those contributed to by Gallese and his associates, focus on the presence and role of mirror neurons within the insula (Gallese, 2003, 2005a; Rizzolatti, Fogassi, & Gallese, 2001; Wicker et al., 2003). From a developmental, psychoanalytic or psychodynamic stance, and of particular interest to clinicians, is the association of mirror neurons with social conscience (or the super ego—identified with feelings of disgust, shame guilt, pride and sexual desire). A noteworthy factor here is the region's interneuronal networking with the limbic system. (The linking of mirror neurons with the development of social conscience and empathy is amplified in a subsequent section.)

The limbic system

Deep within the cerebrum, between the neo-cortical lobes and the brain stem sits a neural complex known as the limbic system, the name indicating a C-shaped or rim-like structure (see Fig. 2). This phylogenetically old neuronal formation is common to most animal species and generally identified with emotion and behavior. Importantly, its functions are mediated through complex axonal connections to the neocortex and the brain stem. Likewise it has extensive neural hook-ups with the basil ganglia, a sub-cortical area that, according to Marsden (1986), has some basic ability to "integrate" thought and emotion in motor behavior.

Within the scope of the limbic neural network are the amygdala, hippocampus, hypothalamus, portions of the thalamus, the fornix and mamillary bodies. Although it is beyond the scope of this paper to detail the functions ascribed to each, as a whole they range from regulation of the autonomic nervous and endocrine systems to survival mechanisms of flight-fight–freeze. Importantly, the limbic brain is regarded as the home of primary emotions, such as fear, anger, sadness, joy disgust, as well as aggression. The amygdala, in particular, is associated with fear, pleasure and aggression (Bloom et al., 1985; Diamond et al., 1985; Nolte, 1981; Restak, 1984). A point of emphasis is the role the hippocampus plays in the imprinting of recent memory.[1] Like evanescing footprints in shifting sands, with injury to this structure, the encoding of these time delimited memory traces may be seriously impaired and along with it, the corollary conversion of short-term to long-term memory.

The brain stem

This lower-level portion of the brain receives incoming stimuli from sensory receptors located in the various sense organs of the body creating a chain reaction. Various electro-chemical discharges are transmitted along the sensory spinal tracts to the brain stem, the conduit to higher centers. At this point, the brain stem serves as a filtering station, determining whether incoming impulses will be inhibited or potentiated for further neural networking. The transmission cycle is completed when these electro-chemical discharges exit the CNS via the effector (motor) tracts of the spinal

[1] Memory of different types is stored in various parts of the brain; the hippocampus being one associated with short-term memory. For conversion to long-term information storage (in other areas of the brain), it must first be imprinted and readied for more permanent storage and subsequent retrieval. Thus, cerebral damage to the hippocampus will interfere with this process, impairing capability for new learning (Long, 2006 retrieved 1/17/06).

cord where they activate targeted muscle groups in the form of an action, thought or behavior (Bloom et al., 1985; Diamond et al., 1985; Nolte, 1981; Restak, 1984).

Equally significant, the brain stem plays a crucial role in basic survival functions, controlling or mediating vegetative operations such as swallowing, respiration, heart rate and blood pressure, and aspects of consciousness and arousal states (Bloom et al., 1985; Diamond et al., 1985; Nolte, 1981; Restak, 1984).

The process of neural transmission

Innervation of the CNS is generated by electro-chemical impulses. A nervous system lacking such enabling transmission within the complex of neural networks would be tantamount to a car without a battery and fuel. A dual pronged operation, the process begins with an electrical discharge from the cell body of a neuron that travels down its axon (i.e., branch-like extension) to its juncture point (terminus), potentiating the release of a neurochemical substance—a neurotransmitter, a chemical messenger required to transmit the neuronal impulse across a synapse. This tiny bridge-like gap between neurons is, in essence, a conduit of symbiotic connectivity (Moore, 1969). The chemical transmitters, in turn, serve to trigger other cells carrying affiliated compounds.[2] In effect, an intricate relay is established throughout the brain for the transmission of sensory inputs and their consequent motor (efferent) outputs (Kolb & Wishaw, 1985).

The whole brain

While this simplified portrait of the brain cannot capture the profundity of its intricate architecture, organizational circuitry and system of processing, it is intended to help provide a foundation for grasping the neurobiological basis of mirror neurons and their functional implications. Importantly, although the brain can be discussed and explicated according to the individual formations and structures of its two hemispheres, clearly implicit is that in such a highly complex system, the whole is much greater than its parts. Restak (1984) explains that an action as basic as picking up a pencil requires the orchestration of millions of nerve cells radiating throughout both hemispheres, as well as the active participation of brain regions that, until recently, had not been recognized as related to this function.

Unlike the story of the blind men who inaccurately perceived the elephant based on the particular part each touched, the brain cannot be conceived as a collection of parts independently driven. From highly specialized zones to diffuse cortical association areas, the brain operates as a collective, its global mission, the outward manifestation of meaningful actions and behaviors rather than isolated muscle movements (Berrol, 1992).

Theoretical constructs related to mirror neurons and empathy

With basic explications of the CNS as a backdrop, we turn to the evolving research on mirror neurons. Early mirror neuron research with the macaque monkey (Gallese, Fadiga, Fogassi, & Rizzolatti, 1996) helped spawn widespread interest in the nature and significance of mirror neurons. The underlying principle of the mirror matching mechanism is that humans and their subspecies are biologically wired with these types of brain cells. Researchers inform that while some of these neurons may discharge involuntarily (i.e., automatic reactions to certain stimuli), others are experience-dependent for activation, requiring social and physical recognition and cognitive understanding. Thus, mirror neurons are currently being linked to psycho-affective, social and cognitive development, attachment, attunement, empathy, social cognition and morality (Gallese, 2005a, 2005b; Gallese & Goldman, 1998; Goldman, 2005; Schore, 1994; Stern, 1985/2000).

A fundamental concept is that the mirror matching mechanism is activated in relation to a stimulus or stimuli outside the self, that is, in relationship to another. The catalyst might be visual observation of motor actions, or of facial expressions such as disgust, joy, fear, et cetera (Gallese, 2003, 2004, 2005a; Gallese & Goldman, 1998; Meltzoff & Prinz, 2002; Rizzolatti & Arbib, 1998). In effect, this specialized class of brain cells is believed to be located in parts of the brain that respond to sensorimotor stimuli (visual, auditory, olfactory, tactile, et cetera).

[2] In terms of affinities, a specific group of neurotransmitters, biogenic amines—such as dopamine, norepinepherine and serotonin, manufactured in the body by particular amino acids—have been hypothesized as major contributors to various affective states (Kolb & Wishaw, 1985; Restak, 1984; Thompson, 1975).

Using functional magnetic resonance imaging (FMRI)[3] to study the influence of various odorants on the brain, a team of researchers (Wicker et al., 2003) exposed one individual to three types of olfactory stimuli—malodorous, pleasant or neutral—to elicit either an emotion of disgust, pleasure, or a non-specific reaction. Simultaneously, an FMRI was performed on a second person who simply witnessed the facial reactions of the one exposed to the stimuli. In the conditions of both "disgusting" and pleasing scents—but not the neutral stimuli—the researchers report that both the amygdala (associated with emotions) and the insula (a structure possessing extensive connections to the amygdala as well as other somatosensory areas) of the observer were activated. The outcome lends support to the role of mirror neurons in human interactions.

Mirror neurons and empathy

The dictionary defines empathy as "emotional and/or intellectual identification with another; vicarious experiencing of the feeling or ideas of another" (Guralnik, 1992). Empathy extends beyond simply understanding the other's emotional state to embodying the experience of that state (Dolan, 2005; Gallese, 2003, 2005a, 2005b). The capacity for vicarious, transitory identification with the other is implicit here (Stern, 1985/2000). Likewise, Stern considers empathy an embodied affective resonance that involves some level of cognitive processing. In that cognition and emotion are integral to the evolvement of empathy, the presumption is that neuronal connectivity between the prefrontal cortex (the thinking brain) and the limbic system serve as vital conduits.

Intersubjectivity and empathy

Given that the activation of mirror neurons is dependent upon the empathic identification with another, Gallese (2003, 2005b) proceeds to amplify this construct further, distinguishing between two types of identity, the i-identity (individual) and the s-identity (social). The s-identity, he postulates, is a neurobiologically based capacity for empathy and understanding of another, evolving from very early self-other interactions. Stern (1985/2000), contends that the development of intersubjectivity is cultivated by a "shared framework of meaning and means of communication such as gesture, posture or facial expression.. . . [T]he interpersonal behavior has moved . . . from overt actions and responses to the internal subjective states that lie behind the overt behaviors" (p. 125). Thus, intersubjectivity, as described here, is the embodiment of empathic processing between self and other when witnessing an action or an expression of feeling of another. Moreover, Stern perceives this transfer of meaning to another (that is, ascribing to that person feelings, sensations, emotions and thoughts) a form of "empathic projection"—a concept significant to D/MT clinicians.

The notion of an innate relationship between intersubjectivity and the emergence of empathy is a common theme in literature devoted to early development. Schore (1994, 2005) espouses comparable theoretical constructs in his publications on self-regulation and affect in infants. Highlighting the significance of the early reciprocal dyadic mirroring gaze between caregiver and infant (elaborated upon below), he labels this form of visuo-affective interaction "primary intersubjectivity."

Precursors of empathy: imprinting, attachment and attunement

The genesis of the dyadic interplay between infant and primary caregiver involves, according to Schore (1994), a neurobiological process common to most species, that of imprinting. "Independent of previous learning" (p. 82), it is an "intrinsically motivated, unconditioned response . . . and innately reinforcing via intracranial stimulation" (p. 82). A biologically wired behavioral template, imprinting creates an automatic receptivity to certain stimuli, the face in particular, in human babies. This neural mechanism promotes visual recognition and bonding to members of one's own species. In humans, it is considered the basis of emotional and social attachment of the neonate to its caregiver. On a neuroanatomical level, Schore informs, visual and affective stimuli are being transmitted via cerebral connections in the right hemisphere, between the anterior temporal lobe and the orbital frontal cortex (located, topographically, behind the eye socket), a region affiliated with central visual processing.

[3] FMRI is an image scanning technique that maps the brain during different types of somatosensory activity. Increased blood flow in activated areas of the brain are revealed on the FMRI scans (Smith, Retrieved March 2006).

Schore (1994) asserts that visual stimulation from the dyadic interaction via sustained mutual eye contact —i.e., the mirroring—imprints specific areas of the baby's brain, promoting neurobiological maturation by facilitating an increase of dendritic connections among areas that shape patterns of behavior. Dopamine has been identified as the primary neurotransmitter activating this neuronal interface (Schore, 1994; Stern, 1985/2000). Schore (1994) contends that the mother or caregiver's facial expressions act as "a highly arousing unconditioned stimulus" (p. 83), and that the "mirroring self-object experience induces states of positive arousal and pleasure" (p. 86). Active engagement in mirroring is thus considered essential to the formation of normal attachment schema—i.e., behavioral patterning.

Stern (1985/2000) refers to the preverbal communication between mother and infant (about 7 to 9 months of age) by way of "gesture, posture and facial expressions" as a "shared framework of meaning " (p. 125). The infant's internalization of these overt forms of mutuality— i.e., attunement—sparks subjective affects, creating "a new domain of intersubjective relatedness" (p. 125) that nurtures the evolving empathic process. Attunement, Stern informs, although often beneath conscious awareness, begins with imprinting and is dependent on familiarity, recognition and cognition, albeit a rudimentary preverbal "prototype" of communication. Thus, attunement establishes the underpinnings of intersubjectivity and social cognition (Schore, 1994).

Intersubjectivity and mirroring in D/MT

Interestingly, Stern's explication of the process of affect attunement parallels that of the therapeutic relationship in D/MT. It embodies the "quality of feeling of a shared affect state, not necessarily imitating the exact behavioral expression of the [other's] inner state" (1985/2000, p. 142). While not an identical replication or echoing, a qualitative mutuality is reflected. Comparable to Laban's system of Effort/Shape, matching of the other's behavior may be represented by qualitative elements of intensity, duration, spatial shape, tempo and/or rhythmic pattern. As in D/MT, mirroring can be overtly manifested in one or a combination of forms—a single effort or a mix of efforts exerted by way of movement, facial expression and/or voice (Stern, 1985/2000). Underlying these dynamical interactions, the neurons of the mirror matching networks within the CNS are actively discharging. Theoretically then, comparable sets of CNS neurons are potentiated in the therapist when moving in synchrony with the client or when a therapist simply witnesses a moving client. In this latter instance, the network of actively matching mirror neurons is, in effect, generating interneuronal connectivity between the two individuals.

Self-other identity enables an intersubjective or subpersonal transfer of meaning. An example of a purely kinesthetic level of embodiment of another was heard in an interview with internationally renowned choreographer Paul Taylor. When queried during a radio talk show about how, as company director and prolific dance maker, he deals with no longer being on stage performing the movement, he quite simply replied: "I can feel steps that someone else is doing in my own body" (Ludden, 2004).

Moreover, various researchers posit that because of the trans-modal nature of the mirror neuron system, not only can the actions of others be understood and embodied, but likewise their intentions. (Gallese, 2003, 2005b; Gallese & Goldman, 1998; Goldman, 2005; Hurley, 2005; Rizzolatti & Arbib, 1998). Ekman (2003) points out that all humans share common emotional feelings and empathize with those with whom they feel a strong identity. A striking representation of these assertions is contained in pioneer D/M therapist Trudi Schoop's poignant autobiography (1974). In describing her early studies and experiments with movement, she wrote, "On the streets [of Zurich] I followed strangers, imitating their gait and posture, and imagined, by taking in their manner of movement, that I was able to feel their state of mind" (p. 7). When working in hospitals in psychiatric wards, Schoop mirrored her patients' movements. This process, she believed, enabled her to embody their feelings, to enter into their world in a state of intersubjective communication.

"Empathic reflection," a term familiar to D/M therapists, is associated with venerated D/MT pioneer Marian Chace. When this former dancer/teacher first began to work with unmedicated WW II veterans in the psychiatric wards of St. Elizabeth's hospital (Washington, DC) in 1942, she intuitively understood that establishing an empathic relationship was a primary vehicle for communication with these profoundly emotionally traumatized men (Shelly, 1993). By reflecting their moods, movements and sounds she was able to create an intersubjective union with the patients; that is, mirroring—"picking-up" (p. 100)—not simply "what" they did, but the qualitative dynamics of their movements (Sandel, 1993). Sandel points-out that Chace used the process of empathic reflection to "gather information about the clients" during a group session; "engage them in contact first with the therapist and then with one another and develop a sense of mutuality which facilitates the communication and sharing of feelings" (pp. 102–103). Two basic elements identified with Chace's sessions were the circle, a basic formation to organize the group to engender a sense of relatedness and community; and music to stimulate rhythmic group activity (Chaiklin & Schmais, 1993). Mirroring each other as they danced in rhythmic synchrony afforded the men an outlet for personal expression and likewise opened a channel for reconnecting with a world from which they had withdrawn.

Affect regulation, moral development and empathy

The period from 7 to 15 months is considered optimal for receiving particular affective stimuli in the portions of the brain undergoing rapid development. It is a time when axonal myelinization,[4] dendritic proliferation and connectivity are facilitating the maturation of limbic and cortical association areas, a time when attachment patterns are forming. Worth noting, although an infant's development may appear to be linear, it is in fact, a multidimensional dynamical process; while one constellation of behavioral functions may be germinating at a neurobiological level, another may be manifesting outwardly.

The right cortical hemisphere, Schore contends (1994, 2005), is particularly involved with the limbic system in addition to the subcortical areas that mediate the expression and regulation of emotional information.[5] It is during this peak window of opportunity that the reciprocal dyadic experience between caregiver and baby most strongly impacts affect regulation (Schore, 1994; Stern, 1985/2000). Lewis, Amini, and Lannon submit that, "[o]ften the only emotional learning one sees after childhood is the reinforcement of existing fundamentals" (2000, p. 163). Neuropsychologists and developmental psychologists agree that with the passing of the formative years, as brain plasticity diminishes, the shaping of affect patterns, or schema, slows significantly.

Viewing these early years through the lens of developmental, psychodynamic and social psychology, an emergent super ego, which begins to evolve toward the end of the first year, lays the groundwork for moral development, a vital constituent of empathy (Piaget & Inhelder, 1969; Schore, 1994; Stewart, 2001). Similarly, budding social cognition, an important precursor to moral development, primes the awareness and understanding of "what is" and "what is not" considered acceptable behavior. Piaget's model of cognitive development charts the parallel progression of morality, social cognition and intellectual maturation (1969). By the end of the toddler period, about 36 months, if environmental and innate factors of development have advanced within expected norms, the template for empathy should be solidly established and readily observable.

During the period of parallel play (2 to 4 years), children are becoming socially and emotionally aware of the "dos" and "don'ts" of being with others—e.g., sharing, turn taking, no shoving, no hitting, et cetera. They understand that if the rules are not followed, they will receive some form of external admonition. It is the environmental reinforcers—critical factors in the internalization of moral cognition and behavior—that shape the evolving super ego.

Based on the theoretical constructs referenced above, moral and emotional development are integrally related to social cognition. Moreover, humans are characterized as innately programmed to develop a shared perception of the world, allowing them to infer or implicitly understand the experience of the other.

On a neurobiological level, the prefrontal cortex and its limbic connections form the underpinnings of empathy. Stern (1985/2000) and Schore (1994, 2005) emphasize that early right hemispheric prefrontal damage impairs the neural substrates of empathy—moral behavior and social cognition. Further, Stern (1985/2000) reports that some self-psychology theorists suggest that borderline personality disorders may be a consequence of the failure of early attachment and attunement, the facilitators of empathy.

Recently, FMRI research in conjunction with clinically based evidence, were analyzed by a team of researchers to examine neuronal activity relative to various issues of morality (Moll, Zahn, Oliveira-Souza, Kreuger, & Grafman, 2005). Their findings indicated that a number of cortical and subcortical regions of the brain are implicated in moral cognition as well as moral deviation. These included portions of the prefrontal cortex, the temporal lobes and areas of the limbic and para limbic systems (in addition to other neuronal sites).

Congruently several case studies reveal the connection between early prefrontal lobe damage and moral deviance. Grattan and Eslinger (1992) report on the status of a 26-year-old woman exhibiting antisocial behaviors who had

[4] A normal aspect of brain maturation, myelinization is an insulating fatty sheath that wraps around the length of an axon, speeding electrical transmission of an activated neuron. Most portions of the brain are myelinated during the formative years, some even later (Wittrock et al., 1977). If myelinization fails to occur, the child will not survive—as witnessed in the genetically inherited Tay-Sachs disease.

[5] Further delineation of the various neuronal regions identified in the research literature re: the development, of empathy, morality and social cognition are beyond the scope of this paper.

sustained frontal lobe damage at age seven. The outcome of a battery of standardized measures of empathy, psychosocial development and personality revealed deficits in moral reasoning, judgment and empathy. The researchers concluded that early acquired brain injury had a profound effect on her psychosocial development.

Parallel findings are reported by Anderson, Bechara, Damascio, Tranel, and Damascio (1999), researchers who investigated the consequences of early prefrontal lobe damage on two young adults. The female, 20 years of age, sustained brain insult as a 15-month-old toddler in a pedestrian vehicular accident; the male, 23 years of age, was 3 months old when a right frontal lobe tumor was removed. Within several months post-injury, each appeared to be developing normally with respect to physical and cognitive milestones. Although both were raised in stable middle class environments psycho-social problems began to manifest during their prepubescent years. Each displayed severe antisocial behaviors, such as physical aggression toward others, inability to establish friendships with peers, stealing, lying and an inability to hold jobs. Both had encountered problems with the law and neither exhibited remorse for their deviant conduct. While neuroimaging studies displayed localized damage to the prefrontal lobes of the female and the right prefrontal lobe of the male, other brain regions appeared normal. Moreover, despite average intelligence recorded on cognitive measurements, standardized tests related to social and moral behaviors indicated serious deficits in moral judgment and related problem-solving issues that the researchers associated with early prefrontal lobe damage. Comparable adult acquired neuropathology does not, the researchers point out, result in social or moral deficits. The distinction between the psychosocial outcomes of early and late neurotrauma onset is, they submit, that neural schema rooted in “emotionally related knowledge” (p. 1035) and behaviors are patterned and integrated during the formative years of development.

It remains for future research to determine the extent to which early emotional deprivation or severe problems with attachment—in contrast to acquired brain damage—impede normal maturation of the amygdala and its cortical networks, and precisely how, on a functional level, moral development and empathy may be impacted.

Mirror neurons and empathy crystallized through dance and D/Mt

Transitioning from mirror neurons vis-à-vis the neurobiological genesis of empathy, the final section of this paper explores the implications of mirror neurons and empathy as mediated through dance and D/MT. Two exemplars are offered: the first a dance project undertaken by choreographer Bill T. Jones; the second a D/MT artistic inquiry research study conducted by a graduate student to examine *What Are Muslim Women’s Experience in Their Bodies in Dance/Movement Therapy*.

Bill T. Jones and the genesis of Still Here

In 1994 Bill T. Jones, internationally recognized choreographer created a performance piece inspired by his deceased lover and co-founder of the Bill T. Jones/Arnie Zane Dance Company. In the years following Zane’s death in 1988 (due to complications of AIDS), the sorely bereaved Jones set out to craft a personal, emotionally charged work dealing with mortality and belonging. He wanted to explore universal issues with which all human beings identify (Hervey, 2000; Jones, 1997; Kasrel, 1996; Marian Chace Annual Lecture, 1997). Adopting a unique choreographic process, Jones’ dance evolved through workshops with individuals who had confronted or were in the throes of life-threatening illnesses—primarily cancer and AIDS. Fourteen “Survivor Workshops, Moving and Talking About Life and Death” were conducted in 11 cities. The choreographer’s end goal was to create a work of art—a multimedia dance performance piece for his company—molded from the raw material of gestures, movements and spoken words that he believed would evolve from the workshop participants.

His introduction to each group would begin with a brief biographic profile and a statement about his primary movement objectives. Not unlike most dance improvisation and D/MT groups, each workshop started with a basic warm-up and some simple exercises to kindle trust. Jones would then perform his dance “solo 21,” a personal piece composed of particular gestures and their respective “spoken captions” (Jones, 1997; Marian Chace Annual Lecture, 1997, p. 9). With this as a working model for how the workshop material would evolve, the participants were encouraged to develop their own stories using simple gestures along with related words. From this rudimentary beginning, a deeper sharing of each individual’s life emerged—communicated through movement, drawings and verbal expression. Culminating the experience, videos were viewed, the “video-portraits of each participant reading from a short list ... of what each one loved and feared” (Jones, 1997; Marian Chace Annual Lecture, 1997, p. 10).

At the onset, Jones, clearly stated that he was not a therapist but rather a choreographer who wanted to create a complex work dealing with deep emotional issues. While not intended as therapy, the net effect was obviously a therapeutic experience for the participants—strangers, drawn together for a common purpose, and somewhat transformed by the transpersonal revelations that bound them.

Still/Here was composed through a process of variation, expansion and amplification of selected simple gestures, which, Jones informs, were

> like no movements I've ever made . . . imbued with their genesis. They're coming from their source, so specific, so charged . . . the notion of mortality. Because that's something we all share as human beings . . .. My experience. Your experience. When do I become the other? When do you become the other? When do we feel comfortable to say 'us', 'you', 'me,' 'we? (Kasrel, 1996)

As I muse now on my experience of the live performance I attended of *Still/Here* (Jones, 1996), I believe Jones' reflections about the universal essence of his piece seem to represent the quintessential nature of mirror neurons. My recollection of *Still/Here* is as a finished choreographic work, a dance viewed as a totality, not the process that created it. I observed the performers, listened to the accompanying music and verse, and viewed the video displaying the emotion filled faces of the workshop participants. Dream-like now, what remains are memory traces of the kinesthetic and affective sensations evoked in me, and the richness of the visual and auditory sensations that stirred me. As an outwardly silent, non-moving witness, I can only imagine the array of busily discharging mirror neurons circulating through the different regions of my brain, driven by an ongoing charge of multisensory stimuli.

What are Muslim women's experience in their bodies in dance/movement therapy D/MT[6]

Nancy Toncy's culminating research project in D/MT at Columbia College, Chicago was grounded in artistic inquiry methodology (Hervey, 2000; Hervey & Toncy, 2004). Toncy, a young graduate student with a strong background in dance, journeyed from Egypt to the United States for D/MT training. Her research query centered on whether a small group of Muslim women living in Egypt would be receptive to dance as a form of therapy, and importantly, whether D/MT practice in her country was a realistic long-term goal. Thus, the core of her inquiry, the experiential portion, was conducted in Cairo with five Muslim women with some previous movement experience, mostly dance and fitness. Although the sessions were not identified as therapy, Toncy employed common group D/MT techniques. They began with warm-ups of individual body parts, building to more expansive ranges of motion and use of space. Movement exploration was encouraged through imagery, self-reflection, verbal sharing and questioning (Hervey & Toncy, 2004).

A key challenge was the documentation of the movement pieces created by the women and the conversion of these compositions into an artistic product that remained faithful to their work. Although the women understood that these movement explorations were assisting Toncy in her graduate research study, videotaping was not an option to which they would consent. However, the participants eagerly accepted the inventive idea of videoing Toncy as she mirrored each of their creations. This approach actually provided an opportune means of garnering validity for the accuracy of her movement representations. In effect, Toncy's role was two-fold, the first as a witness, the second as a mover reflecting back her perceptions. The women would then provide feedback in terms of how well Toncy replicated their dances and how well she captured their qualitative intentions. The ultimate demand was to weave the separate pieces into a structured choreographic entity. Returning to the US, Toncy resculpted the movement data into a solo dance that she performed in partial fulfillment of her artistic inquiry research project.

Comparing the two projects

Jones' overarching goal was the creation of a work of art contoured out of the theme of death and dying. The original mirrored gestures of the workshop participants served as stepping-stones that underwent major amplifications and changes. Deeply submerged, the movement roots were transformed into an abstract dance/theatre performance

[6] The information in this section is drawn from several sources: Hervey's Chapter on Artistic Inquiry (in Cruz & Berrol, 2004); Hervey and Toncy's presentation at the ADTA Conference (2004); American Dance Therapy Association Proceedings (2004); personal email communication and video of completed dance received from Toncy (2005).

piece. Toncy's goal was to conduct her research through dance, initially as a therapeutic modality and ultimately as an art form. Rather than a transformation of the original movements, her objective was to maintain the integrity of each woman's creation, orchestrating the parts into a unified whole. In effect, Toncy's research was spawned and crystallized through the process and parameters of her inquiry.

Regardless of their differences, each of the two projects chronicled here was predicated and dependent upon interactional phenomena and inextricably linked to mirror neuron constructs—dependent upon intersubjectivity, attunement and empathic relating. Jones shared deep feelings with workshop members based on the emotionally charged issues of loss and mortality. Toncy, as an Egyptian Muslim female, identified strongly with the women in her group, particularly on the basis of their common socio-cultural and religious heritage.

Summary and some closing thoughts

The relatively recent research linking the neurosciences to the arts inspired a deeper exploration of the subject and the writing of this paper. Particularly appealing to this writer were concepts concerning the functional and clinical implications of a highly specialized constellation of nerve cells in diverse regions of the brain, identified as mirror neurons. Within this context, one component of the paper addressed the mechanisms and evolving theoretical constructs of the mirror neuron matching mechanism with respect to the formative years of human development vis-à-vis the emergence of empathy. Beginning with the basic mapping of important CNS structures and their behavioral manifestations, the focus then shifted to theoretical constructs of empathy in relation to the seminal issues of attachment, attunement, social cognition and morality. Relevant examples and research studies embedded in the various sections were used to illuminate and document the neurological information and theoretical paradigms. The final section provided two exemplars of mirror neurons and empathy as mediated through dance and D/MT. The first described the genesis of a choreographic project by Bill T. Jones that evolved from workshop participants who had sustained profound medical illnesses. The second depicted the culminating research project of graduate student Nancy Toncy, who conducted her research in Egypt with a small group of Muslim women. The underlying method of each involved physical mirroring undergirded by the capacity of each for empathic interrelatedness, i.e., emotional, social, cognitive and kinesthetic.

Ekman (2003), as noted earlier, informs that humans exhibit common emotional responses with those with whom they share a strong identity. Concordantly, Csibra (2005), Rizzolatti and Arbib (1998) emphasize that "in all communication, sender and receiver must be bound by a common understanding . . . else communication does not occur. . . . [T]he process of production and perception must somehow be linked; their representation must, at some point, be the same" (p. 188). Of particular note here, these neuroscientists submit that the development of human speech was spawned by neural precursors in regions of the brain commonly identified with receptive and expressive language—Broca's area and Wernicke's area, respectively. They contend that before spoken language evolved, these neuronal sites possessed a "mechanism of recognizing actions made by others" (p. 190). For the action as well as the intention of the other to be understood, there must first be common grounding. Based on the literature presented in this paper, humans are neurologically endowed with the capacity for mutual knowing, understanding and feeling.

The capacity for and range of empathic responses are molded by the experiences that influence the crystallization of personal and social identity in conjunction with ones world view. With respect to the psychotherapeutic realm in general and D/MT in particular, empathic reflection is considered integral to the therapeutic process. Thus, intersubjective identification can be perceived as what Stern (1985/2000) labels "empathic projection," a phenomenon of particular psychotherapeutic significance with respect to the transference and countertransference issues that guide the therapist–client relationship.

The neuroscientific probing into the intricate inner workings of mind/body operations is still in a nascent stage of unfolding. Yet, through the current revelations of mirror neuron research, a transparent, holistic portrait of mind/body interaction has begun to emerge, unveiling the previously unseen, unrecognized neurobiological mechanisms that underlie human behavior and function.

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