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The Arts in Psychotherapy 33 (2006) 302–315

THE ARTS IN PSYCHOTHERAPY

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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doi:10.1016/j.aip.2006.04.001

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).