Embodied Language in Neuroscience and Psychoanalysis

Jeanine M. Vivona

J Am Psychoanal Assoc 2009; 57; 1327 originally published online Nov 19, 2009;
DOI: 10.1177/0003065109352903

jaPa

Jeanine M. Vivona 57/6

EMBODIED LANGUAGE IN NEUROSCIENCE AND PSYCHOANALYSIS

There have been relatively few discussions of systematic studies of language, including neuroscience studies, in the psychoanalytic literature. To address this dearth, a detailed review of research on embodied language in neuroscience and related disciplines is presented, after which their findings are considered in light of diverse views of language in psychoanalysis, specifically the models of the Boston Change Process Study Group, Wilma Bucci, Fonagy and Target, David Olds, and Hans Loewald. The juxtaposition of psychoanalytic models with the findings of research on embodied language shows that scientific studies can focus psychoanalytic understanding of verbal processes, and that integrations with neuroscience neither inherently threaten the traditional psychoanalytic focus on verbal meanings nor reduce the richness and complexity of psychoanalytic theory.

Among many who study the mind, there is palpable excitement over the possibilities offered by contemporary neuroscience. Some psychoanalysts believe that knowledge of the brain may inspire important revisions to our theories, and that integrations with neuroscience may enhance the scientific status of our discipline (Beutel, Stern, and Silbersweig 2003; Olds 2006; Pulver 2003; Westen and Gabbard 2002a,b). Moreover, findings from neuroscience and related disciplines may be brought to bear on points of disagreement in our field in a way that may illuminate both the disagreement and the potential contributions of neuroscience to psychoanalysis. This paper, which considers diverse psychoanalytic models in light of research on embodied language, is such an effort.

To date, most psychoanalytic discussions of neuroscience have explored the implications of brain studies for conceptualizing nonverbal

Associate Professor of Psychology, The College of New Jersey; adjunct clinical faculty, Department of Psychiatry, Pennsylvania Hospital.

Submitted for publication July 1, 2009.

DOI: 10.1177/0003065109352903

processes. Westen and Gabbard (2002a) have integrated theories of mind from cognitive science and neuroscience with psychoanalytic understanding of memory and other unconscious cognitive processes. Pally (2001) has presented neuroscience studies to support her argument for a "primary role for nonverbal communication in psychoanalysis" (p. 71). The Boston Change Process Study Group (BCPSG 2007) has cited neuroscience evidence for their model of implicit intersubjective processes. Neuroscience findings have also been linked to a variety of specific affective treatment processes (Evans 2008), including those involved in enactments (Ginot 2007), projective identification (Cimino and Correale 2005), and empathy (Aragno 2008). Several authors (reviewed in Vivona 2009) have discussed the role of the mirror neuron system in facilitating automatic experiential understanding of another's internal experience.

Neuroscience studies of verbal processes have received less attention from psychoanalysts. Beutel, Stern, and Silbersweig (2003) have identified some brain imaging studies of verbal processing, noting their obvious relevance to the verbal mode of psychoanalytic treatment. Similarly, Shapiro (2004) has cited a small set of neuroscience studies to demonstrate the influence of words on body and brain. He concludes that "verbal instruction has now been shown to penetrate the mental apparatus to the brain, and to change physiology" (p. 341). Others (e.g., Westen and Gabbard 2002a,b; Fonagy and Target 2007) clearly both value neuroscience and grant a central role to verbal processes in psychoanalysis. Yet we have only begun to explore how neuroscience might expand or focus our understanding of the nature of language and verbal treatment mechanisms.

Moreover, some psychoanalysts have expressed doubt that neuroscience might inform psychoanalytic understandings of verbal processes and meanings. Pulver (2003) asserts that "knowledge of the structure and function of the brain as dealt with in neuroscience tells us little about what the mind is experiencing, and experience is at the core of psychoanalytic technique" (p. 762). A similar belief underlies Blass and Carmeli's rejection of neuroscience as inherently at odds with the focus on meaning at the heart of psychoanalysis (2007); they consider integrations with neuroscience as attempts to supplant personal psychological meanings with biological truths, as though these are incommensurate. Indeed, because nonverbal processes have been the predominant focus of psychoanalytic discussions of neuroscience research, and particularly discussions of its clinical relevance, the current state of the literature could leave one with the false impression that brain studies reveal little about language, and,

consequently, that integrations with neuroscience move psychoanalysis away from its traditional focus on language and verbalization.

An exploration of research on language in neuroscience and related fields reveals a wealth of intriguing findings, with diverse potential implications for psychoanalytic understandings of the nature of language and its uses in treatment. Here I focus on the major theories and findings on *embodied cognition and language,* an emerging viewpoint in neuroscience and cognitive science. Embodied models propose an experiential basis of language comprehension that may inform psychoanalytic theories regarding the ability of language to evoke inner experiences and to communicate those experiences to another person, a crucial therapeutic function about which there is disagreement in our field. After detailed presentation of this research, I consider the findings with respect to the diverse theories of language and therapeutic process presented by the Boston Change Process Study Group, Wilma Bucci, David Olds, Fonagy and Target, and Hans Loewald. This exploration demonstrates, I believe, that neuroscience and psychoanalysis can teach each other about their central shared concerns, and that neuroscience provides a perspective that may help resolve some of our internal disagreements.

THE EMBODIED LANGUAGE PARADIGM

Since the cognitive revolution of the mid-twentieth century, prevailing theories of language in cognitive science, psychology, and linguistics have conceptualized semantics as a complex memory system for categorical knowledge, one that is distinct from the system for autobiographical memory (Fodor 1975). Word meanings are considered to be *amodal,* that is, they are abstract entities, independent of the modal systems of perception, action, and emotion involved in interacting with the world (Gallese and Lakoff 2005). Words are powerful because, as abstract symbols, they transcend personal meanings and thus can function as a medium of interpersonal communication and a means of organizing and reflecting on one's experiences. Abstract symbols such as words enable the detection of relationships within and across categories, facilitating logic and reasoning (Bucci 1997; Smith and Glasser 2005; Olds 2000). Psychoanalysts tend to agree that treatment mobilizes this capacity of language, wherein verbal reflection on experiences facilitates more sophisticated understanding of present and past, and thus more flexible ways of being. In one sense, insight as traditionally conceived in psychoanalysis involves the use

of words to extricate one from the past, a triumph of rationality through verbalization.

Until recently, knowledge of the neural bases of language was derived largely from studies of individuals with brain lesions, including the influential autopsy studies of the nineteenth century that led to identification of Broca's area (in the left frontal operculum) for language production and Wernicke's area (in the left superior temporal gyrus) for language comprehension (Damasio et al. 2004). Contemporary neuroscience has generally confirmed the originally theorized functions of these regions of the left hemisphere (Price 2000). In addition, brain imaging studies over the past two decades have made clear that these traditional language regions also subserve a range of functions not associated with language (Bookheimer 2002); that Broca's and Wernicke's areas comprise various smaller zones with distinct language processing functions (Bookheimer 2002; Damasio et al. 2004); that language mobilizes multiple brain regions in both hemispheres in a highly interactive and distributed process (Damasio et al. 2004; Price 2000); and that language engages brain regions known to be involved in modes of interaction with the world, notably perception and action (Bookheimer 2002).

Research on Embodied Language

Expanding knowledge of the neural basis of language has posed challenges to the amodal view of language. An emerging alternative perspective in neuroscience, and in cognitive science more generally, considers language and cognition to be *embodied* (Barsalou 2008). Embodied cognition comprises a range of viewpoints centered on the belief that cognitive processes are deeply grounded in modes of engagement with and action on the world, including those involving the body (Wilson 2002). Thinking, then, involves not just the rule-based manipulation of abstract symbols, but also the reenactment of perceptual and motor experiences; understanding language involves experiencing, at least to some degree. This perspective is consistent with the influential work of Lakoff and Johnson (1980) on the embodied foundations of language and with theories of language developed before the cognitive revolution, including that of Freud (1891), which conceptualize the close involvement of language and sensorimotor processes (Martin 2007). Drawing on diverse research methodologies, studies of embodied language suggest that activation of processes associated with action and perception accompanies the processing of various types of language.

Physical objects. Decades of behavioral research (reviewed in Fischer and Zwaan 2008) and recent brain imaging studies (reviewed in Martin 2007) document that visual and auditory exposure to verbs (e.g., *grasp*), nouns (e.g., *ball*), and adjectives (e.g., *large*) evokes specific relevant motor programs (e.g., an appropriate hand grip), suggesting both that people automatically prepare to interact with verbally depicted objects and situations, and that mental representations of concepts include or evoke a relevant means of interacting with those entities as real objects or situations in the world. For example, Borghi, Glenberg, and Kaschak (2004) have demonstrated that reaction times to process words for object parts (e.g., parts of a car) are influenced by the verbally described physical perspective on the object; for example, times to determine whether a steering wheel is part of a car are faster after hearing a description of driving a car than after hearing one of fueling a car. Similarly, eye movement studies demonstrate that activation of relevant perceptual processes accompanies verbal description of physical objects of perception (Fischer and Zwaan 2008); for instance, participants' eye movements on a blank screen are predominantly vertical when they hear a verbal description of a tall building. Together, such studies suggest that specific perceptual and motor responses are activated by verbal depictions of physical objects.

Action. Many recent studies, particularly in neuroscience, have investigated motoric components to comprehension of language describing bodily action (see reviews in Fischer and Zwaan 2008; Gibbs 2006; Pulvermüller 2005). These studies address the theory that the meaning of action words is represented, in part, in the cortical network involved in the execution of action, particularly the motor and premotor cortexes; thus, neural processing of language comprehension involves both traditional language regions and modal regions. Studies of the mirror neuron system are an important source of evidence for embodied models, as they suggest a neural mechanism for the motor resonance theorized to underlie action language (Gallese and Lakoff 2005; Pulvermüller 2005; Fischer and Zwaan 2008).

Mirror neurons were discovered in the premotor cortex of the macaque monkey in the early 1990s (Gallese et al. 1996). The premotor cortex is involved in planning and coordinating motor behaviors, whereas the primary motor cortex is involved in motor performance. Mirror neurons are a unique type of motor neuron, which discharge both when a monkey engages in an object-oriented action, such as grasping a banana, and when

the monkey observes another individual engaged in a similar action (Rizzolatti and Craighero 2004). Although mirror neurons have not been discovered in the human brain, brain imaging studies support the theory that the human brain has a *mirror neuron system* similar to the operation of actual *mirror neurons* in the macaque. There is evidence, for instance, that observation of another's object-directed actions stimulates associated regions of the premotor cortex of the human brain (Buccino and Riggio 2006). Compared with the specialized activation of mirror neurons in monkeys, the human mirror neuron system appears to be activated by a broader range of stimuli, including language.

Neuroscientists are documenting that the mirror neuron system responds to verbally described actions as it does to observed actions. Using fMRI, researchers have demonstrated that the premotor cortex is activated when participants listen to sentences describing object-directed actions of others (e.g., *He is sweeping with a broom;* Baumgaertner et al. 2007) and self (e.g., *I grasp a knife;* Tettamanti et al. 2005). Consistent with the researchers' hypotheses, mirror neuron system activations are similar to those obtained during action observation (Baumgaertner et al. 2007) and greater than those stimulated by listening to sentences with abstract content (e.g., *I appreciate sincerity;* Tettamanti et al. 2005). Similar results have been obtained from studies of silent reading. Aziz-Zadeh et al. (2006) have reported that reading phrases describing object-directed actions with mouth, foot, or hand (e.g., *grasping the pen*) activated the same regions of the left premotor cortex as did viewing videos of those actions. Similarly, Hauk, Johnsrude, and Pulvermüller (2004) found that reading verbs for hand, foot, and mouth actions (e.g., *pick, kick, lick,* respectively) differentially stimulated regions of the primary motor cortex and the premotor cortex that closely correspond to regions both stimulated by observation of another's hand, foot, or mouth action and involved in execution of such actions; however, in some studies (e.g., Tettamanti et al. 2005) the primary motor cortex was not activated by linguistically described action. Using PET, Vigliocco et al. (2006) found that nouns and verbs indicating motion events (e.g., *the twirl, it gallops*) and sensory events (e.g., *the darkness, it shines*) differentially activated both modality-specific brain regions, with motion words specifically activating the motor cortex but not the premotor cortex, and brain regions known to be involved in semantic processing (e.g., the left inferior frontal gyrus).

Researchers interpret their findings as consistent with the view that sensorimotor activation is an important component of language comprehension. Tettamanti and colleagues (2005) conclude that their findings support embodied rather than amodal theories of action-related language: "In this domain, language does not appear to be detached from the evolutionarily ancient sensorimotor system, but rather strictly linked to it" (p. 278). Aziz-Zadeh and colleagues (2006) also highlight the role of the mirror neuron system in sensorimotor reenactments associated with this type of language: "Congruence between the cortical sectors activated by observing actions and by their verbal descriptions provides evidence for an involvement of premotor areas with mirror neuron properties in re-enactment of sensory-motor representations during conceptual processing of linguistic phrases describing actions" (p. 1821).

Examining a broader array of sensorimotor processes, Kemmerer et al. (2008) used fMRI to measure brain activity associated with five semantic components (action, motion contact, change of state, tool use) of five classes of verbs (running, speaking, hitting, cutting, change of state). Participants were required to make subtle semantic differentiations of verbs within the same class (e.g., to determine whether *tiptoe* is more like *creep* or *trudge*). Consistent with earlier studies, results revealed somatotypic activation of premotor and primary motor cortexes in response to running, hitting, and cutting verbs. In addition, the researchers found that brain activations for the other four semantic components were largely consistent with the hypothesis that language activates relevant modal processes. All verb classes also activated Broca's area (specifically left BA 45), and all but one verb class (change of state) also activated left BA 47. The researchers interpreted their results as consistent with the Two-Level Theory of verb comprehension, in which the abstract template of verb class is processed in traditional language areas (e.g., Broca's) and the unique qualities of individual verbs are processed in relevant modal areas (e.g., premotor and motor cortexes for action verbs).

Implicit motion. Researchers have also documented the presence of embodied processing when language merely implies motion and action. A behavioral investigation of *fictive motion,* a motion verb with no explicit motion, as in "The road runs along the peninsula," indicated that reaction times to process such sentences were influenced by the description of the scene that preceded them. For example, participants took more time to process the sentence above if it followed a description of a road

through rugged terrain with many sharp turns than if it followed one of a straight, smooth path (Matlock 2004).

In a behavioral study of verbs of transfer (e.g., *Sue told you the story, You gave directions to Paul*), which involve *implicit motion,* Glenberg and Kaschak (2002) found that the participants processed the meaning of sentences more rapidly when the action implied by the sentence matched the action required to make the response (i.e., toward self vs. away from self). In a subsequent study, Glenberg et al. (2008) replicated these results and also found that motor system activity, as measured by transcranial magnetic stimulation (TMS) of hand muscles, was similarly modulated when participants read sentences describing transfer (of either concrete objects or abstract information) relative to sentences that did not.

Abstract language and metaphor. Investigating the embodiment of patently abstract sentences, Ghio and Tettamanti (in press) used fMRI to examine patterns of dynamic interaction among brain regions during processing of concrete action sentences (e.g., *Now I press the button*) and abstract sentences with no metaphoric connotation (e.g., *Now I appreciate the loyalty*). Activity in traditional language areas (e.g., Broca's) was more integrated with activity of the left motor and premotor cortexes for concrete action sentences and with activity of the retrosplenial cingulate cortex, involved in processing one's internal state and representations of external context, for abstract sentences. The researchers concluded that findings for both types of sentences "are consistent with top-down mechanisms by which linguistic areas promote a semantic content-specific reactivation of modal simulations" (p. 9).

Yet other studies that compared brain activations during processing of concrete vs. abstract language yielded less convincing evidence of embodiment in abstract language and metaphors. Ruschemeyer, Brass, and Friederici (2007) found that both the premotor cortex and the primary motor and somatosensory cortexes were activated more strongly when participants read simple action verbs (e.g., *grasp*) than simple abstract verbs (e.g., *think*) or complex verbs with an action stem (e.g., *begreifen,* to comprehend, comprising *greifen,* to grasp). Aziz-Zadeh et al. (2006) reported that activity of the premotor cortex during silent reading of verbal metaphors (e.g., *She grasped the idea*) was not organized somatotypically, as it did not match premotor activity during observation of videos depicting object-related actions, although the researchers speculated that the negative findings might be due to lack of concordance between the

observed actions and the metaphorical actions. Together these studies suggest that there may be limits to the embodiment of language. That said, findings of greater activations for literal language than abstract language do not clarify the degree to which abstract language evokes activity in the motor and premotor cortexes; it may be that activation of motor regions was present but not detected (Aziz-Zadeh et al. 2006) or was overshadowed by the literal language condition (Rüschemeyer, Brass, and Friederici 2007). In general, processing of metaphor has been shown to activate areas of semantic processing regions, including the left inferior frontal gyrus, different from those activated by literal language (Stringaris et al. 2007; Rapp et al. 2004).

Emotion. Although emotional foundations of semantic development are increasingly theorized (see Shanahan 2008), research on the embodiment of emotional language is particularly sparse, leaving many unanswered questions about the undoubtedly complex relations between emotional experience and language. Based on their review of behavioral investigations of emotional language processing, Niedenthal et al. (2005) concluded that "a sizable literature now demonstrates that when emotional events are simulated using imagery, and in the absence of the initial stimulus, individuals reenact or relive the emotions, or partial feelings of emotion, as indicated by a number of different measures of emotion" (p. 31). Importantly, studies in which participants were not instructed to engage in imagery also support this conclusion. For example, Niedenthal et al. (2009) demonstrated predicted specific embodied responses, assessed with EMG of facial muscle activity, as participants processed the meanings of nouns (e.g., *glee*) and adjectives (e.g., *joyful*) related to the emotion concepts of joy, anger, and disgust, but not when they processed perceptual features of the words. When facial expression was constrained, participants were less accurate in processing emotion words, suggesting a causal role for embodiment in understanding emotion words. The researchers concluded that activation of embodied emotion processes "constitutes an indication that the conceptual content for the emotion concepts involves reenactments of the emotional states themselves" (p. 1133).

A small number of neuroscience studies provide initial evidence that emotional language activates brain regions involved in processing emotion. An early PET study (Isenberg et al. 1999) demonstrated that visual presentation of threatening words (e.g., *persecute*) compared to neutral

words (e.g., *list*) activated both the amygdala and the left premotor cortex, suggesting mobilization of sensorimotor processes involved in evaluating and responding to threat. Amygdala activation by language appears to be constant across personality variables associated with differential cognitive processing of emotion (Rubino et al. 2007), suggesting that individual differences in emotional processing styles may be unrelated to the degree to which language evokes emotional responses in different people. Conversely, studies of effects of verbal processing on emotional experience suggest that amygdalar (Tabibnia, Lieberman, and Craske 2008) and autonomic (Lieberman et al. 2007) activity are reduced when participants apply verbal labels (e.g., *sad*) to facial displays of emotion. Regarding the effects of emotions on linguistic processing, results of a behavioral study (Havas, Glenberg, and Rinck 2007) demonstrated that covertly manipulated facial expressions influenced speed of processing emotion sentences, such that participants processed positive sentences more quickly when smiling than when frowning, and vice versa.

The bidirectional interactions of emotion and language are consistent with a view of emotional language as embodied (see Barrett, Lindquist, and Gendron 2007) and with clinical wisdom that verbalization may have intensifying or moderating effects on the emotional experience of the speaker. However, no study to date has assessed the subjective emotional experience associated with the observed embodied responses to emotionally evocative language.

In sum, there is strong neuroscience and behavioral evidence that sensorimotor processes in the brain and peripheral organs are activated by some types of language, especially language describing objects, events, and bodily actions, and tentative evidence, with room for doubt, for the embodiment of a broad array of language types, including metaphors, abstract language, and descriptions of emotion. Based on the state of current research, some theorists (Willems and Hagoort 2007) envision a circumscribed role for embodiment in cognition and language closely related to action and perception, whereas others (Barsalou 2008; Borghi, Glenberg, and Kaschak 2004; Feldman and Narayanan 2004; Gallese and Lakoff 2005) believe that embodiment plays at least some role, perhaps a major one, in the comprehension of many or all forms of language.

The Role of Embodiment in Language Comprehension

Although evidence for the neurobiology of embodied processes in language and cognition is accumulating, the precise mechanisms and

roles of embodiment await elucidation. Currently there are diverse opinions regarding whether semantic representations are themselves embodied; whether language comprehension evokes processes, such as simulation or imagery, that activate somatosensory brain regions; and whether embodiment plays a causal or a peripheral role in language comprehension.

Embodied semantics models. Some theorists envision semantic representations as multimodal and comprising patterns of sensorimotor activation (Aziz-Zadeh et al. 2006; Barsalou 2008; Hauk et al. 2008). In this *embodied semantics model,* language is closely integrated with the modal systems involved in action, perception, and emotion. Barsaolou (2008) maintains that the embodied semantics model is consistent with the known operation of the brain, in contrast to the amodal view (see also Zwaan and Taylor 2006). Specifically, the principle of Hebbian learning provides a neurological explanation for embodied semantics (Pulvermüller 2005). In Hebbian learning, neurons that repeatedly fire simultaneously tend to do so subsequently, so that verbal and sensorimotor processes become "wired together" because the neurons that subserve these processes "fire together" during language acquisition. For example, the infant's repeated experiences of hearing an adult say "ball" while looking at and playing with a ball link the perceptual, motor, and semantic processes together neurologically (see also Glenberg et al. 2008).

Simulation models. A closely related view is the *simulation model,* in which automatic simulation is emphasized as the mechanism of embodiment; simulation mediates between verbal and sensorimotor processes (Feldman and Narayanan 2004; Gallese and Lakoff 2005; Gibbs 2006; Matlock 2004). For example, listening to a verbal description of bodily actions evokes automatic simulation of those actions, which activates motor processes associated with performing those actions. Baumgaertner and colleagues (2007) interpret the results of their mirror neuron system study as consistent with the simulation model: "the understanding of action-related sentences implies an internal simulation of the actions expressed by the action-related verb, mediated by the same motor representations that are involved in their actual execution" (p. 887). Studies of the mirror neuron system are considered to offer cogent evidence for the mechanism of such automatic simulation. Drawing on the work of Lakoff and Johnson (1980), Gibbs (2006) extends the simulation model to metaphorical language that cannot, strictly speaking, be enacted behaviorally.

The distinction between the embodied semantics model and the simulation model is subtle, and some theorists (e.g., Glenberg et al. 2008) believe that both Hebbian learning and simulation participate in the embodiment of language. Although these models present strong versions of the view that language activates sensorimotor processes, proponents do not suggest that sensorimotor activation is essential for all language comprehension, or that it involves the full and accurate re-creation of relevant experiences. Instead, they believe that language activates "traces of perceptual and motor experiences" (Zwaan and Taylor 2006, p. 9), which may be influenced by other mental processes, such as attention (Taylor and Zwaan 2008) and bias and error (Barsalou 2008), and that this activation enhances language comprehension when it occurs.

Hybrid models. An alternative theory is that cognition is embodied and language is not. In this *hybrid model,* words are considered discrete amodal symbols, which may be linked to multimodal conceptual structures through the process of transduction (Niedenthal et al. 2005). If embodiment is located in thought rather than in language, even language describing perceptual or motor experiences would not invariably evoke corresponding sensorimotor processes. The work of Damasio (1999) epitomizes this perspective. For Damasio, verbalization of the embodied images that constitute core consciousness requires "a *translation* of something else, a *conversion* from nonlinguistic images which stand for entities, events, relationships, and inferences" (p. 107; emphasis added). Damasio's use of the terms *translation* and *conversion* underscores his view that language and embodied concepts are different kinds of entities that do not encompass one another; on the contrary, the conceptual and lexical systems develop and function separately to some degree (Tranel et al. 2003). A goal of Damasio's research is to demonstrate that people can understand concepts even when language is disrupted. Indeed, his lesion and brain imaging studies of action concepts (e.g., Damasio et al. 2004; Tranel et al. 2003) have demonstrated that brain regions active during the processing of concepts are partially distinct from those active during the verbal naming of concepts, yet there is "some overlap in the neural systems that subserve conceptual knowledge for actions, and those that subserve lexical knowledge for actions" (Tranel et al. 2003, p. 425); the overlap includes the prefrontal cortex.

Consequence models. Some theorists doubt that sensorimotor processes make essential contributions to language comprehension. Most of the available data are correlational, demonstrating only that language processing and sensorimotor activation co-occur under some circumstances.

Indeed, there is as yet no evidence that motor resonance is necessary for the comprehension of action language (Willems and Hagoort 2007), and developmental and lesion studies provide evidence to the contrary (Tranel et al. 2003). Some researchers interpret the findings in line with a *consequence model* in which sensorimotor activation follows rather than precedes semantic understanding; thus, embodiment is viewed as a potential consequence of language comprehension rather than as a cause.

Two recent TMS studies of the timing of motor cortex activity during semantic processing support this view (Papeo et al. 2009; Tomasino et al. 2008); TMS allows for a finer-grained temporal analysis, compared to fMRI. Both studies assessed the precise timing of primary motor cortex activation as participants silently read action verbs, and compared activation in tasks designed to evoke processing of word meanings vs. nonsemantic aspects of verbs (e.g., number of syllables). The studies yielded two findings that the researchers interpreted as contradicting the view that sensorimotor activation is an essential aspect of language comprehension: (1) the primary motor cortex was activated only in the semantic tasks and not in the context of nonsemantic processing of words; and (2) the primary motor cortex was engaged rapidly only when the semantic task required participants to use mental imagery (Tomasino et al. 2008) and was engaged more slowly, suggesting postconceptual processing, when semantic tasks did not necessarily evoke imagery (Papeo et al. 2009). Both research teams interpreted their findings as consistent with the view that sensorimotor processes are evoked not automatically, but electively in response to task demands. Papeo et al. concluded that activation of the left primary motor cortex "would *result from* understanding action verbs rather than *contributing to* it" (p. 8).

By contrast, two behavioral studies by Boulenger et al. (2006) suggest that sensorimotor activation occurs during early stages of verb processing, prompting the researchers to conclude that "language-related activity in cortical motor regions is part of action word processing and cannot be solely attributed to processes that occur after the word had been identified (i.e., motor imagery)" (p. 1612; see similar conclusions in Pulvermüller 2005). Clearly, the issues remain unsettled.

EMBODIED LANGUAGE RESEARCH AND PSYCHOANALYSIS

The research evidence for embodied language is intriguing, despite the crucial questions that await empirical elucidation. The precise role of

embodied processes in language comprehension is a matter of current debate in neuroscience and experimental psychology; the available data do not clearly favor one model over the others. That said, there is little disagreement among these scholars (but see Fodor 1975) that at least some types of language are associated with activation of sensorimotor processes in previously unappreciated ways. Embodied models, even in their weaker forms, have implications for psychoanalytic understanding of the nature of language and verbal treatment processes, and may inspire new ways of thinking about the potentials of psychoanalytic integrations with neuroscience.

Methodological Caveats

As we consider the implications of this research for psychoanalysis, we must acknowledge three important differences between the research methodology and the psychoanalytic situation. First are differences in the mode of language delivery. Studies of embodied language thus far have assessed activation of sensorimotor processes in the context of written words and audiotapes of spoken language. The latter may be analogous to the processing of the other's spoken language in psychoanalysis using the couch, when analyst and patient hear one another's words but do not see the corresponding facial movements and expressions. However, there are as yet no studies of sensorimotor activations associated with processing the meaning of speech as one person observes another person speaking. There is evidence that the mirror neuron system is activated both by mouth movements and by the content of language, and speculation that the mirror neuron system responds to facial expressions of emotion (but see Vivona 2009). Yet we do not know about the sensorimotor activation that occurs when these sources of information are present simultaneously, as they are when the psychoanalytic participants speak face to face. Nor do we know about the fate of sensorimotor activation when the meaning associated with these sources of information diverges.

Second, there are noteworthy differences in the content and context of language in embodied language studies compared with psychoanalysis. The reported studies, particularly within neuroscience, assess sensorimotor activation as participants are presented with single words or short sentences that presumably have no particular personal meaning; importantly, the words are not produced by the participants. Moreover, semantic processing is superficial; for example, participants may be asked to

determine whether the meaning of two verbs is similar. By contrast, psychoanalytic treatment entails extended, detailed, personally generated, emotionally relevant discourse that emerges in a dialogue with a familiar person. Findings across several studies indicate that sensorimotor activation occurs most reliably when participants focus on the meaning of language and, to some degree, when language is more detailed (i.e., presented as phrases or sentences rather than single words). By extension, the elaborated personal and interpersonal contexts of language processing in psychoanalytic treatment may enhance the sensorimotor and affective experiences evoked by language. If so, the research underestimates the degree to which embodiment participates in the verbal mode of psychoanalytic treatment. Alternatively, it may be that isolated words and phrases provide a pure and thus strong test of embodiment, and that sensorimotor activation in typical language use might be attenuated by greater complexity of both context and semantics.

Third, no study has yet examined whether the presence of sensorimotor activation in language contributes to a sense of involvement in the experience conveyed in words, for either the person who produces the words or the person who receives them. Indeed, the research has yet to identify the relevance of the observed sensorimotor activation; even its role in word comprehension is debated. The power of language for the meaningful communication of inner experience is a basic assumption of the verbal psychoanalytic method; embodied language models propose a mechanism by which language achieves that power. The studies presented here are a first step toward testing the theory that sensorimotor activation in language connotes a meaningful, if attenuated, reenactment of a bodily experience.

Given the crucial differences in the content and context of language in the systematic studies and in psychoanalytic treatment, and the important unresolved questions, we must maintain a speculative stance as we consider the implications of the findings for our understanding of the nature of language, for the therapeutic process, and, ultimately, for integrations between neuroscience and psychoanalysis.

PSYCHOANALYTIC MODELS OF EMBODIMENT IN LANGUAGE

Although the embodiment of cognition was a fundamental assumption of early psychoanalytic models including Freud's (Fonagy and Target 2007),

contemporary psychoanalysis houses diverse theories of the nature of embodiment in language. Here I consider three examples of hybrid models in psychoanalysis, which propose varying degrees of embodiment in language, and two examples of embodied semantics models. Juxtaposition of the psychoanalytic models with the research on embodied language facilitates consideration of the theoretical implications of these diverse models and, conversely, reveals ways in which psychoanalysis may contribute to the theoretical basis of embodied language research.

Hybrid Models

The Boston Change Process Study Group model. The amodal view of language has figured centrally in the theorizing of the BCPSG. Stern (1985), a leading member of the BCPSG, famously depicted language as a "double-edged sword" in that it "drives a wedge between two simultaneous forms of interpersonal experience: as it is lived and as it is verbally represented" (p. 162). The main project of the BCPSG (see, e.g., 2005, 2007) has been to elaborate the vicissitudes of the embodied *implicit procedural domain* of life and treatment and to distinguish it from the *declarative-verbal domain.* "Implicit relational knowing is based in affect and action, rather than in word and symbol. . . . Further, the complexity of the phenomena as enactively stored will never constitute a perfect or perhaps even good fit with its linguistic and narrated version. . . . The implicit domain is exceedingly rich and elaborated, containing greater nuancing than language" (BCPSG 2007, p. 845). The BCPSG present a hybrid model that foregrounds the limitations of abstract, amodal language for capturing and conveying the depth and complexity of lived experience (for a critique of this model, see Vivona 2006).

Notably, the BCPSG (2008) have recently softened their view of the limitations of language, acknowledging the findings of embodied language research, and now see language as having greater potential to access the embodied phenomena of the implicit procedural domain: "In these senses words are not disincarnated symbols but are also pathways into direct embodied experiences that function implicitly, and vice versa. This may help to explain the evocative power of words and stories. We live them virtually" (pp. 133–134). The evolution in the theorizing of the BCPSG is striking, and may attest to the compelling nature of the research on embodied language for prompting reconsideration of long-held beliefs. That is, demonstration of sensorimotor activation by language, even in its weak forms, is inconsistent with the view that language necessarily

dominates and perhaps renders inaccessible the procedural basis of thought; the research suggests that, to some degree, language is not a wedge between forms of experience but a bridge.

Bucci's Multiple Code Theory. Like the BCPSG, Bucci (1997) has noted a disjuncture between amodal language and embodied experience. Her complex hybrid model, Multiple Code Theory, has three distinct systems. Two embodied systems, the *nonverbal symbolic* and the *subsymbolic,* comprise motoric, visceral, and sensory modes of being, as well as the prosodic qualities of language. The nonverbal symbolic system, similar to Damasio's core consciousness (1999), is made up of modal images that may also be manipulated as symbols; it is "transitional" in that it shares features with both the fully modal subsymbolic system and the *symbolic verbal system.* The symbolic verbal system comprises the amodal symbols of language; in this model, words are "the quintessential symbolic forms, . . . arbitrary and abstract in their reference, . . . and not resembling the entities that they represent" (Bucci and Maskit 2007, p. 1361). Bucci (1997) acknowledges the importance of language for logical thought and the transmission of culture, yet notes its limitations for conveying internal experience: "The subsymbolic sensory and somatic representations can be expressed only indirectly by the discrete, abstract symbols of the verbal code" (Bucci 2002, p. 771).

Bucci's model is unique in theorizing a mechanism to connect the distinct systems. The *referential function* uses the embodied image of the symbolic nonverbal system as the link between the subsymbolic system and the symbolic verbal system in a two-phase translation. Specifically, common sensorimotor processes enable connections between the subsymbolic and the symbolic nonverbal systems, whereas common discrete symbols enable connections between the symbolic nonverbal and verbal systems. When the referential function is operating, language is specific, concrete, and imagistic; for Bucci, metaphor is paradigmatic referential activity. Bucci envisions use of the referential function as a stable personality trait, influenced by genetics and environment, thereby explaining individual differences in the ability both to mobilize and to experience the subsymbolic underpinnings of language. Elucidating the operation of the referential function as manifested in the language produced during psychoanalytic treatment is a primary goal of Bucci's research (see Bucci and Maskit 2007).

At a general level, Bucci's vision of the referential function is consistent with the most robust findings of research on embodied language,

in which concrete language is reliably associated with the sensorimotor processing of Bucci's subsymbolic system. Yet the specific words that form the basis of Bucci's linguistic measure of referential function (i.e., pronouns, prepositions, auxiliary and function words) have not been evaluated for sensorimotor activation in neuroscience or behavioral studies. Moreover, support for Bucci's understanding of the referential function of metaphor has been mixed, although the bodily-action metaphors assessed in embodied language studies (e.g., *She grasped the pen*) certainly do not convey the powerful connecting images Bucci identifies as referential. It may turn out that Bucci's model expands the types of language that are associated with sensorimotor activation, and thus extends the scope of embodiment in language. Yet such an expansion might pose a challenge to her view that connections between language and the subsymbolic system "operate to only a limited degree" (Bucci and Maskit 2007, p. 1362). Bucci has attributed the referential capacity to special types of language, in line with weak embodied models; by contrast, the strongest embodied models would envision all language as having a referential function, at least potentially.

Fonagy and Target's attachment-based cognition. In their strongly embodied hybrid model, Fonagy and Target (2007) elaborate the attachment-related foundations of cognition, including its phylogenetic and ontogenetic origins in gestural communication. Fonagy and Target envision cognition as specifically memorializing physical experiences of the preverbal attachment relationship: "We suggest that the way we experience cognitions . . . is linked with the physical aspects of early infantile experience. Perhaps more profoundly, since the mind never, properly speaking, separates from the body, the very nature of thought, the very nature of adult symbolic processes, will be influenced by characteristics of the primary object relation" (p. 432). In this model, then, a circumscribed range of experiences—interactions with attachment figures during infancy—provides an embodied basis of cognition across the life span.

Fonagy and Target propose a two-level theory of word meanings in which the symbolic semantic *meaning* of a word is distinguished from its embodied *sense;* the latter "represents the accumulation of physical (emotional, bodily) experiences in association with a specific idea or word" (p. 433). "It is sense, as opposed to meaning, that is embodied and encoded through experiences of the physical body" (p. 433). Language is embodied when the sense of a word is activated. In this regard, their

model is similar to Bucci's, with embodiment associated with nonsemantic aspects of language, including procedural aspects that are linked metaphorically to experiences of earliest life. Yet Fonagy and Target do not identify the limitations of language for expressing embodied experiences; instead they presume frequent lively connections between symbolic language and embodied experiences. They believe that the unconscious embodied foundation of cognition can be brought to conscious awareness and verbalized; thus, the potential of language to reawaken experiences originating in the preverbal attachment relationship may often be realized.

Although Fonagy and Target envision cognition as vigorously embodied, their model does not correspond closely to research on embodied cognition. On the one hand, they emphasize a specific foundation of embodied cognition that has not been explicitly investigated; neither has there been an attempt to study the embodiment of the personal sense of a word or concept as distinct from its consensual meaning. If Fonagy and Target are correct that a powerful basis of embodied cognition is attachment-related and highly personal, then studies of abstract constructs and consensual meanings are likely to underestimate it. On the other hand, the research demonstrates sensorimotor activation in contexts that bear no obvious relationship to early attachment experiences. For instance, Fonagy and Target's model does not explain the observed activation of perceptual processes in adult learning, such as driving a car (Borghi, Glenberg, and Kaschak 2004), unless the adult experiences can be understood as grounded in infant attachment, or unless an expanded scope of the embodied basis of cognition is considered in the model.

Embodied Semantics Models

Olds's semiotic model. In his application of semiotics to the "mind-body problem," Olds (2000) presents a theory of mind that is consistent with the embodied semantics model, in which language itself is embodied. Semiotics differentiates three types of sign: the icon, which signifies through resemblance; the index, which signifies through location; and the symbol, which signifies through convention. Eschewing the equation of word and symbol characteristic of hybrid models, Olds believes that words may function as any type of sign and that words function, perhaps frequently, as both icons and symbols. Not only are some words iconic (as in onomatopoeia), but the iconic vestiges of development may remain connected to a word along with its consensual symbolic meaning. Olds remarks that, during language acquisition, "it is likely that the iconic and

the indexical feed the symbolic in crucial and profound ways as yet not fully understood" (p. 523).

Olds's conceptualization of language is consistent with research findings that language processing may involve both sensorimotor (iconic) and semantic (symbolic) systems. Although he does not cite this research, he does mention more generally that neuroscience suggests that the processing of different types of representations engages both distinct and overlapping brain regions. Further, Olds's description of language development is consistent with the principle of Hebbian learning considered by some neuroscientists to be the neurobiological mechanism of embodied semantics.

Olds underscores that the iconic and symbolic representations of a word may diverge. For instance, *mother* comprises both a common symbolic prototype and personal iconic memories, which imbue the word with individual tenor. This is similar to the divergence of meaning and sense identified by Fonagy and Target, although in their model only the former is semantic, whereas both are components of semantics in Olds's model. Olds believes that "noncongruence of these two kinds of signs—icon and symbol—is the bread and butter of psychoanalysis" (p. 516), and that verbalization participates in the reconciliation of icon and symbol because language both evokes experience and enables reflection on it. Although psychoanalysts often confront such incongruence between icon and symbol, neuroscientists have not yet investigated the vagaries of personal iconic aspects of semantics.

Loewald's developmental embodied semantics. In the prescient work of Hans Loewald (1978) we find a psychoanalytic theory of language that coheres most explicitly with the embodied semantics model. Rejecting the notion that words as pure symbolic entities become connected to experience during language acquisition, Loewald viewed language, particularly in the form of mother's speech, as present from the beginning of life as part of the infant's global experience in the world. Over time, the infant becomes able to appreciate semantic meanings of the words others speak and to differentiate those meanings from other aspects of lived experience. But language, for Loewald, is always experientially evocative, at least potentially, because words are always, at least potentially, linked to the sensorimotor experiences they also signify. When those links become attenuated, as they sometimes do, "verbal thought then may have a lifeless nimbleness all its own" (p. 190). But such disembodiment

reflects for Loewald a particular defensive use of language, not the essential nature of language itself.

Loewald's description of the nature of language presaged the conclusions of contemporary researchers of embodied semantics: "Words in their original or recovered power do not function then as signs or symbols for (as referring to) something other than themselves, but as being of the same substance, the same actual efficacy as that which they name; they embody it in a specific sensory-motor medium. The sensory-motor elements of speech remain bodily ingredients of language. . . . This aspect continues to dwell in language, although unattended to, even in its most abstract use, and in written and read language, and in 'inner speech' as well" (Loewald 1978, p. 203).

For Loewald, the embodiment of language is broad and deep. Unlike Bucci, Loewald conceptualized the potential embodiment of a wide array of words, consistent with the suggestive findings of studies of abstract language, rather than a special type of language. Unlike Fonagy and Target, Loewald emphasized the evolving nature of semantics; he did not consider the sensorimotor qualities of language as necessarily evocative of childhood or attachment experiences: "Words have a potential for development and change of meaning while remaining the same words" (Loewald 1978, p. 194). And even more than Olds, Loewald envisioned a close confluence of language and sensorimotor experience, with the former embedded in the latter rather than referring to it in the indirect manner of a sign. The word, for Loewald, is not a symbol but the tip of an experiential iceberg.

THE NATURE OF EMBODIMENT IN THE PSYCHOANALYTIC MODELS

These five psychoanalytic models conceptualize different types of links between language and experiencing. All acknowledge that we do sometimes experience language as highly evocative, certainly during memorable moments of the psychoanalytic hour. Hybrid models must explain how inherently amodal language sometimes evokes experience so vividly. For Bucci, the concrete, imagistic language of the referential function constitutes the mechanism of embodiment, which is shaped by development and sensitive to context. For Fonagy and Target, embodied experiences accompany language because the activity of using and receiving language is rooted in early bodily experiences, which imbue language structure, as

well as the personal sense of words, if not semantics itself. Because the use of language is already potentially embodied in their model, Fonagy and Target attribute greater evocative power to language than Bucci does. Yet neither Bucci nor Fonagy and Target explicitly explain the embodiment of abstract language that has been demonstrated by some studies.

In contrast to hybrid models, embodied semantics models must explain the conditions under which inherently embodied language functions abstractly. Loewald conceptualized the suppression of embodiment in language as both a defensive maneuver and a necessary accommodation for mature intellectual functioning. That is, Loewald considered the ability to manage the nascent embodiment of language to be an important adult achievement and, conversely, that too little or too much embodiment in language might disrupt its communicative potential.

Many aspects of Loewald's complex conceptualization of the embodiment of language have not been investigated systematically. Yet the research calls into question any simple equation of verbal and conscious processes and any strict distinction between verbal and experiential processes. Moreover, Loewald's fundamental ideas, that words reach into sensorimotor experiencing and that semantics are complexly constituted with both conscious and unconscious processes, are consistent with the strong embodied language models of contemporary neuroscientists like Barsalou (2008) and Pulvermüller (2005). Eventually, neuroscience may reveal the specific relationships among semantic, sensorimotor, and conceptual processes that Loewald theorized from the psychoanalytic situation, wherein these processes are entwined.

THE CONTRIBUTIONS OF PSYCHOANALYSIS TO EMBODIED LANGUAGE RESEARCH: PERSONAL SEMANTICS?

Whether embodiment is located in language or in thought, whether it occurs before or after language comprehension, all embodied models propose that the sensorimotor qualities associated with language derive from personal memories. In this way, embodied models in both psychoanalysis and neuroscience foreground individualized foundations of embodiment. Yet, not surprisingly, these highly personal processes are most explicit and elaborated in the psychoanalytic models. Generally, psychoanalysis envisions complex interactions among layers of experiential, cognitive, and verbal meanings that are infused with personal development and, potentially,

with conflict. By contrast, most research on embodied language investigates nomothetic sensorimotor activations associated with conventional meanings of words.

Psychoanalytic contributions to the theories that inspire studies of embodied language might be in the form of more complex understandings of the influences of personal development on semantics and consequent individual differences in the experience, comprehension, and use of language. Specifically, both Olds and Fonagy and Target note that psychological development can lead to divergence of symbolic and embodied representations in or evoked by semantics. The research literature has not yet differentiated the many threads that might be woven into the embodiment of particular words, nor their divergence from either subjective experience of language or conventional semantics. Regarding the relation between abstract and sensorimotor aspects of language, Loewald theorized that either of these qualities may be overemphasized in language, such that embodiment may impede semantic comprehension as well as enhance it, and that the optimal level of each depends to some degree on the specific task with which language is charged in the given moment. By contrast, research models of embodied language have assumed a positive linear association between sensorimotor activation and language comprehension; this may turn out to be an oversimplified view.

Moreover, from the perspective of embodied semantics, psychoanalytic theory offers diverse proposals regarding the processes (e.g., defense, developmental deficit, trauma) that work to segregate aspects of mental experience that might otherwise be integrated. Alternatively, from the standpoint of hybrid theories, Bucci's notion of the referential function proposes a process that may connect aspects that might otherwise remain separate. These mediating processes can be investigated systematically with neuroscientific or behavioral methods in ways not possible in the clinical situation (see Westen and Gabbard 2002a).

For both Loewald and Fonagy and Target, qualities of early interpersonal relationships are carried forward in language; embodiment is the legacy of those early relationships. In the words of Loewald (1978), "The emotional relationship to the person from whom the word is learned plays a significant, in fact crucial, part in how alive the link between thing and word turns out to be" (p. 197). If this is true, then the degree to which sensorimotor resonance both accompanies language and contributes to language comprehension may depend on qualities of that early relationship, including ways in which one's mother brought feelings and experiences into speech. These individual differences, not yet investigated, may

help explain why sensorimotor activations do not invariably assist one in grasping the meaning of others' words.

If semantics are indeed personal, then the communicative potential of language would depend to some degree on the interpersonal similarity of life experiences, wherein the embodied power of language lies. This implication, potentially profound, has not yet been worked out in either psychoanalysis or neuroscience. Fonagy, Gergely, and Target (2007) have rejected the embodied semantics model because they believe it implies identical sensorimotor activations across individuals; the influence of personal development argues against such an assumption. Moreover, we know from our clinical work that similarity of life experience in analyst and patient has diverse effects, sometimes deepening the analyst's understanding of the patient's experience and sometimes hindering it. And we know that the work of understanding the other's experience involves, among other things, conversation about the meanings of the words used to describe it; those meanings are not necessarily automatic or obvious. Thus, it seems, psychoanalytic theory conceptualizes many interesting intersections of personal and consensual semantics that warrant attention in studies of embodied language.

THE MIRROR NEURON SYSTEM AND THERAPEUTIC PROCESS

In the literature on embodied cognition and language, the mirror neuron system is frequently cited as a plausible neurobiological mechanism for embodiment. Mirror neuron studies of language have received little attention in the psychoanalytic literature heretofore, and some authors have doubted their relevance to psychoanalysis (Stern 2004; Fonagy, Gergely, and Target 2007). By contrast, mirror neuron studies of action observation have catalyzed psychoanalytic theorizing about the nonverbal means by which analyst and patient might understand each other's internal intentions and experiences. Elsewhere (Vivona 2009), I have offered a detailed critique of this theorizing, revealing gaps and discrepancies with respect to the actual findings of mirror neuron studies. After a brief introduction to the nonverbal model here, I will contrast the clinical implications of the verbal and nonverbal models of the mirror neuron system.

Psychoanalytic understanding of the mirror neuron system has been channeled by Gallese's *embodied simulation model* (2001). According to

Gallese, as one person observes another, the observer's mirror neuron system matches the sensorimotor activations of the other's brain, enabling the observer to share in the internal experience of the other. Embodied simulation provides "an automatic, unconscious, and noninferential understanding of another's actions, intentions, emotions, sensations, and perhaps linguistic expressions. According to our hypothesis, such body-related experiential knowledge enables a direct grasping of the sense of the actions performed by others, and of the emotions and sensations they experience" (Gallese, Eagle, and Migone 2007, p. 144). The embodied simulation model proposes that the other's internal experiences can be understood directly and in their own experiential modes, rather than only indirectly through cognitive processes such as inference, which yields cognitive rather than experiential knowledge of another's internal experience.

Applied to the psychoanalytic situation, the embodied simulation model proposes that the analyst's countertransference contains a replica of the patient's internal experience due to the operation of the mirror neuron system. Embodied simulation is thought to enable the analyst to resonate accurately with the experience of the patient, to know that experience directly via the somatic resonance of embodied simulation, and to influence that experience through the modulating effects of his or her own brain. Prominent theorists including Olds (2006), Stern (2004), and Siegel (2006) have invoked the embodied simulation model to suggest the relevance of the mirror neuron system to psychoanalysis.

Although both are theorized to involve the mirror neuron system, the models of embodied simulation and embodied language emphasize distinct mechanisms for understanding the internal experience of another. Notably, the embodied simulation model explicitly separates verbal and cognitive understanding from sensorimotor experiencing, whereas the embodied language model explicitly integrates them; the embodied simulation mechanism foregrounds sensorimotor experience without thought and language, whereas embodied language foregrounds sensorimotor experience in language. Moreover, embodied simulation proposes an automatic simulation of the *other's* sensorimotor activity, whereas embodied language proposes activation of one's *own* sensorimotor experiences. The models are not mutually exclusive, however. It is possible that both mechanisms are subserved by the mirror neuron system and that both operate during psychoanalytic treatment (though I question the available evidence in favor of embodied simulation).

The embodied simulation model, if pushed to its theoretical limits, proposes a clinical process with problematic implications. It envisions the possibility of a direct experiential connection to the other that is free of the vagaries of thought and language. Indeed, this direct path might suggest a new royal road to the mind of the other. But unlike its predecessors (e.g., the dream, the transference, the countertransference), this royal road does not require verbalization to realize its therapeutic utility and offers only limited opportunities for the analyst's psychology and subjectivity to enter. More than an interpersonal process, embodied simulation is an interbiological process, not a meeting of minds but a meeting of brains.

In terms of technique, the embodied simulation model might encourage a laissez-faire attitude, as though the mirror neuron system would be an unerring guide to the patient's inner world if analysts would only refrain from interfering with its automatic operation,. This way of thinking might be appealing, as it mitigates the uncomfortable uncertainty of relying on a therapeutic method we have understood to be grounded in ambiguous and fallible subjective experience and its dubious verbal expression. It might bolster an analyst's denial of personal contributions to countertransference experiences by shifting causality to the mirror neuron system. It might move psychoanalysis away from considerations of the inner dynamics of patients and analysts by highlighting automatic processes rather than motivated ones, consequently restricting therapeutic consideration of unconscious conflict and conscious verbal insight.

Do we not risk the same perils with embodied language models, especially if we theorize that language initiates a simulation process akin to that initiated by observation in embodied simulation? No, we do not. Embodied language models consider experiential processes to reside in thought, language, or both; experiential aspects of interpersonal understanding are not segregated from the thinking mind. When we locate the mechanism of interpersonal understanding squarely within the mind, we sacrifice the direct experiential mechanism of embodied simulation and evade its problematic clinical implications. That is, embodied language models leave us with the burden of responsibility for using our knowledge to help another person, with the struggle to disentangle the many influences on the countertransference to arrive at an understanding of the other, and with the uncertainty of words, which can conceal as well as capture lived experience.

It is possible that these verbal and nonverbal mechanisms work together when both words and body convey inner experience, as they often do. Language may provide a context from which to interpret potentially ambiguous embodied simulations, as it does for facial expressions of emotion (Barrett, Lindquist, and Gendron 2007). Yet, given the importance of verbalization in psychoanalysis, the embodied simulation model is an incomplete account of the potentials of the human mirror neuron system in psychoanalytic treatment. Of course, the embodied simulation model need not account for all available data. But because language is always involved to some degree in the clinical situation, and often to a significant degree, the findings of mirror neuron studies regarding language should be considered when the mirror neuron system is invoked to explain psychoanalytic processes. Conversely, embodied language models demonstrate that it is possible for psychoanalysis to learn from studies of the mirror neuron system without accepting the assumptions and implications of the embodied simulation model.

CONCLUSION: NEW INTEGRATIONS OF PSYCHOANALYSIS AND NEUROSCIENCE

Because psychoanalysis and neuroscience share an interest in language yet study it using different methods, there is much our fields can learn from each other. On the one hand, the research on embodied language both validates and extends psychoanalytic understandings of the evocative potential of language, an issue of theoretical and clinical importance. We learn from this research about a particular type of embodiment associated with language, and that semantics can be complexly constituted, with conscious symbolic and unconscious sensorimotor components. Because questions remain about the breadth, depth, and function of embodiment in language, our diverse psychoanalytic models appear similarly valid in light of the current research; eventually, however, studies of embodied language may move us toward consensus regarding the potential of language to connect with lived experience.

More generally, if neuroscience lends a sense of validity and currency to our theories and therapeutic endeavors, the research on embodied language extends these benefits to the verbal realm by demonstrating that language has measurable brain correlates and somatic involvements. Identifying links between language and multiple brain systems validates

verbal processes in the same sense or to the same extent that overt nonverbal phenomena have been validated by neuroscience. In other words, neuroscience demonstrates that, at least to some degree, both language and overt behavior are rooted in biology in the same two ways.

On the other hand, psychoanalytic theories of language are complex and nuanced, derived from a clinical situation that allows us to witness the tremendous scope and power of verbal capacities. In particular, psychoanalysis offers neuroscience a sophisticated understanding of the developmental vestiges that may underlie semantics, as well as the processes that may enhance or impede the embodiment in language. In the study of language, psychoanalysis and neuroscience are equal partners with different contributions; we can participate in this collaboration without losing our identity or complexity.

As we consider the wealth of ideas in a field like neuroscience, it is important to recognize that connections between the scientific data and psychoanalysis are *constructed* by psychoanalysts, not *demonstrated* by researchers. As evidenced in the research on embodied language considered here, research findings are often ambiguous, incomplete, or contested, reflecting the state of a dynamic, expanding field; they rarely offer empirical evidence that bears directly or unequivocally on the constructs of psychoanalysis. Once we acknowledge the gaps between neuroscience data and psychoanalytic processes, we can begin to examine the kinds of theoretical bridges that have been built to span them.

With few bridges connecting neuroscience to the verbal processes of psychoanalysis, the overall tenor of current psychoanalytic discussions of neuroscience may leave some with the false impression that only nonverbal processes can be linked with the cache of recent scientific research and, correspondingly, that integrations with neuroscience necessarily move psychoanalysis away from theories and techniques that grant verbalization a central role. Such false impressions may fuel existing prejudices against neuroscience, intensify disciplinary battles within psychoanalysis, and impede our efforts to learn from studies of the brain. For example, the vigorous protest of Blass and Carmeli (2007) is based on a view of neuroscience as unequivocally on the side of "biology" as opposed to "meaning." Yet this opposition of biology and meaning is not a feature of neuroscience. On the contrary, as I have demonstrated, scientific studies of embodied language have the potential to illuminate psychoanalytic endeavors related to the verbal articulation of meaning and lived experience. Consideration of the research on embodied language suggests support,

albeit tentative, for the fundamental psychoanalytic belief in an experiential basis of language, elaborated most eloquently by Loewald.

REFERENCES

ARAGNO, A. (2008). The language of empathy: An analysis of its constitution, development, and role in psychoanalytic listening. *Journal of the American Psychoanalytic Association* 56:713–740.

AZIZ-ZADEH, L., WILSON, S.M., RIZZOLATTI, G., & IACOBONI, M. (2006). Congruent embodied representations for visually presented actions and linguistic phrases describing actions. *Current Biology* 16:1818–1823.

BARRETT, L.F., LINDQUIST, K.A., & GENDRON, M. (2007). Language as context for the perception of emotion. *Trends in Cognitive Sciences* 11:327–332.

BARSALOU, L.A. (2008). Grounded cognition. *Annual Review of Psychology* 59:617–645.

BAUMGAERTNER, A., BUCCIONI, G., LANGE, R., MCNAMARA, A., & BINKOFSKI, F. (2007). Polymodal conceptual processing of human biological actions in the left inferior frontal lobe. *European Journal of Neuroscience* 25: 881–889.

BEUTEL, M.E., STERN, E., & SILBERSWEIG, D.A. (2003). The emerging dialogue between psychoanalysis and neuroscience: Neuroimaging perspectives. *Journal of the American Psychoanalytic Association* 51:773–801.

BLASS, R.B., & CARMELI, Z. (2007). The case against neuropsychoanalysis: On fallacies underlying psychoanalysis' latest scientific trend and its negative impact on psychoanalytic discourse. *International Journal of Psychoanalysis* 88:19–40.

BOOKHEIMER, S. (2002). Functional MRI of language: New approaches to understanding the cortical organization of semantic processing. *Annual Review of Neuroscience* 25:151–188.

BORGHI, A.M., GLENBERG, A.M., & KASCHAK, M.P. (2004). Putting words in perspective. *Memory & Cognition* 32:863–873.

BOSTON CHANGE PROCESS STUDY GROUP (2005). The "something more than interpretation" revisited: Sloppiness and co-creativity in the psychoanalytic encounter. *Journal of the American Psychoanalytic Association* 53:693–729.

BOSTON CHANGE PROCESS STUDY GROUP (2007). The foundational level of psychodynamic meaning: Implicit process in relation to conflict, defense and the dynamic unconscious. *International Journal of Psychoanalysis* 88:843–860.

BOSTON CHANGE PROCESS STUDY GROUP (2008). Forms of relational meaning: Issues in the relations between the implicit and reflective-verbal domains. *Psychoanalytic Dialogues* 18:125–148.

Boulenger, V., Roy, A.C., Paulignan, Y., Deprez, V., Jeannerod, M., & Nazir, T.A. (2006). Cross-talk between language processes and overt motor behavior in the first 200 msec of processing. *Journal of Cognitive Neuroscience* 18:1607–1615.

Bucci, W. (1997). *Psychoanalysis and Cognitive Science: A Multiple Code Theory.* New York: Guilford Press.

Bucci, W. (2002). The referential process, consciousness, and the sense of self. *Psychoanalytic Inquiry* 22:766–793.

Bucci, W., & Maskit, B. (2007). Beneath the surface of the interaction: The psychoanalytic method in modern dress. *Journal of the American Psychoanalytic Association* 55:1356–1397.

Buccino, G., & Riggio, L. (2006). The role of the mirror neuron system in motor learning. *Kinesiology* 38:5–15.

Cimino, C., & Correale, A. (2005). Projective identification and consciousness alteration: A bridge between psychoanalysis and neuroscience? *International Journal of Psychoanalysis* 86:51–60.

Damasio, A. (1999). *The Feeling of What Happens*. New York: Houghton Mifflin Harcourt.

Damasio, H., Tranel, D., Grabowski, T., Adolphs, R., & Damasio, A. (2004). Neural systems behind word and concept retrieval. *Cognition* 92:179–229.

Evans, H.M. (2008). The action in therapeutic action: Nonverbal interventions. *Journal of the American Psychoanalytic Association* 56:565–572.

Feldman, J., & Narayanan, S. (2004). Embodied meaning in a neural theory of language. *Brain & Language* 89:385–392.

Fischer, M.H., & Zwaan, R.A. (2008). Embodied language: A review of the role of the motor system in language comprehension. *Quarterly Journal of Experimental Psychology* 61:825–850.

Fodor, J. (1975). *The Language of Thought.* Cambridge: Harvard University Press.

Fonagy, P., Gergeley, G., & Target, M. (2007). The parent-infant dyad and the construction of the subjective self. *Journal of Child Psychology & Psychiatry* 48:288–328.

Fonagy, P., & Target, M. (2007). The rooting of the mind in the body: New links between attachment theory and psychoanalytic thought. *Journal of the American Psychoanalytic Association* 55:411–456.

Freud, S. (1891). *On Aphasia. A Critical Study*. New York: International Universities Press, 1953.

Gallese, V. (2001). The "shared manifold" hypothesis: From mirror neurons to empathy. *Journal of Consciousness Studies* 8:33–50.

Gallese, V., Eagle, M.N., & Migone, P. (2007). Intentional attunement: Mirror neurons and the neural underpinnings of interpersonal relations. *Journal of the American Psychoanalytic Association* 55:131–176.

GALLESE, V., FADIGA, L., FOGASSI, L., & RIZZOLATTI, G. (1996). Action recognition in the premotor cortex. *Brain* 119:593–609.

GALLESE, V., & LAKOFF, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive Neuropsychology* 22: 455–479.

GHIO, M., & TETTAMANTI, M. (in press). Semantic domain-specific functional integration for action-related vs. abstract concepts. *Brain & Language*.

GIBBS, R.W. (2006). Metaphor interpretation as embodied simulation. *Mind & Language* 21:434–458.

GINOT, E. (2007). Intersubjectivity and neuroscience: Understanding enactments and their therapeutic significance within emerging paradigms. *Psychoanalytic Psychology* 24:317–332.

GLENBERG, A.M., & KASCHAK, M.P. (2002). Grounding language in action. *Psychonomic Bulletin & Review* 9:558–565.

GLENBERG, A.M., SATO, M., CATTANEO, L., RIGGIO, L., PALUMBO, D., & BUCCINO, G. (2008). Processing abstract language modulates motor system activity. *Quarterly Journal of Experimental Psychology* 61:905–919.

HAUK, O., DAVIS, M.H., KHERIF, F., & PULVERMÜLLER, F. (2008). Imagery or meaning? Evidence for a semantic origin of category-specific brain activity in metabolic imaging. *European Journal of Neuroscience* 27: 1856–1866.

HAUK, O., JOHNSRUDE, I., & PULVERMÜLLER, F. (2004). Somatotopic representation of action words in human motor and premotor cortex. *Neuron* 41:301–307.

HAVAS, D.A., GLENBERG, A.M., & RINCK, M. (2007). Emotion simulation during language comprehension. *Psychonomic Bulletin & Review* 14:436–441.

ISENBERG, N., SILBERSWEIG, D., ENGELIEN, A., EMMERICH, S., MALAVADE, K., BEATTIE, B., LEON, A.C., & STERN, E. (1999). Linguistic threat activates the human amygdala. *Proceedings of the National Academy of Sciences* 96:10456–10459.

KEMMERER, D., CASTILLO, J.G., TALAVAGE, T., PATTERSON, S., & WILEY, C. (2008). Neuroanatomical distribution of five semantic components of verbs: Evidence from fMRI. *Brain & Language* 107:16–43.

LAKOFF, G., & JOHNSON, M. (1980). *Metaphors We Live By.* Chicago: University of Chicago Press.

LIEBERMAN, M.D., EISENBERGER, N.I., CROCKETT, M.J., TOM, S.M., PFEIFER, J.H., & WAY, B.M. (2007). Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli. *Psychological Science* 18:421–428.

LOEWALD, H.W. (1978). Primary process, secondary process, and language. In *Papers on Psychoanalysis.* New Haven: Yale University Press, 1980, pp. 178–206.

Martin, A. (2007). The representation of object concepts in the brain. *Annual Review of Psychology* 58:25–45.

Matlock, T. (2004). Fictive motion as cognitive simulation. *Memory & Cognition* 32:1389–1400.

Niedenthal, P.M., Barsalou, L.W., Ric, F., & Krauth-Gruber, S. (2005). Embodiment in the acquisition and use of emotion knowledge. In *Emotion and Consciousness,* ed. L.F. Barrett, P.M. Niedenthal, & P. Winkielman. New York: Guilford Press, pp. 21–50.

Niedenthal, P.M., Winkielman, P., Mondillon, L., & Vermeulen, N. (2009). Embodiment of emotion concepts. *Journal of Personality & Social Psychology* 96:1120–1136.

Olds, D.D. (2000). A semiotic model of mind. *Journal of the American Psychoanalytic Association* 48:497–529.

Olds, D.D. (2006). Interdisciplinary studies and our practice. *Journal of the American Psychoanalytic Association* 54:857–876.

Pally, R. (2001). A primary role for nonverbal communication in psychoanalysis. *Psychoanalytic Inquiry* 21:71–93.

Papeo, L., Vallesi, A., Isaja, A., & Rumiati, R.I. (2009). Effects of TMS on different stages of motor and non-motor verb processing in the primary motor cortex. *PLoS ONE* 4(2):1–11.

Price, C.J. (2000). The anatomy of language: contributions from functional neuroimaging. *Journal of Anatomy* 197:335–359.

Pulver, S. (2003). The astonishing clinical irrelevance of neuroscience. *Journal of the American Psychoanalytic Association* 51:755–772.

Pulvermüller, F. (2005). Brain mechanisms linking language and action. *Nature Reviews of Neuroscience* 6:576–582.

Rapp, A.M., Leube, D.T., Erb, M., Grodd, W., & Kircher, T.T. (2004). Neural correlates of metaphor processing. *Cognitive Brain Research* 20:395–402.

Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience* 27:169–192.

Rubino, V., Blasi, G., Latorre, V., Fazio, L., d'Errico, I., Mazzola, V., et al. (2007). Activity in medial prefrontal cortex during cognitive evaluation of threatening stimuli as a function of personality style. *Brain Research Bulletin* 74:250–257.

Rüschemeyer, S.A., Brass, M., & Friederici, A.D. (2007). Comprehending prehending: Neural correlates of processing verbs with motor stems. *Journal of Cognitive Neuroscience* 19:855–865.

Shapiro, T. (2004). Use your words! *Journal of the American Psychoanalytic Association* 52:331–353.

Siegel, D.J. (2006). An interpersonal neurobiology approach to psychotherapy: Awareness, mirror neurons, and neural plasticity in the development of well-being. *Psychiatric Annals* 36:248–256.

SMITH, L., & GLASSER, M. (2005). The development of embodied cognition: Six lessons from babies. *Artificial Life* 11:13–29.

STERN, D.N. (1985). *The Interpersonal World of the Infant: A View from Psychoanalysis and Developmental Psychology.* New York: Basic Books.

STERN, D.N. (2004). *The Present Moment in Psychotherapy and Everyday Life.* New York: Norton.

STRINGARIS, A.K., MEDFORD, N.C., GIAMPIETRO, V., BRAMMER, M.J., & DAVID, A.S. (2007). Deriving meaning: Distinct neural mechanisms for metaphoric, literal, and non-meaningful sentences. *Brain & Language* 100:150–162.

TABIBNIA, G., LIEBERMAN, M.D., & CRASKE, M.G. (2008).The lasting effect of words on feelings: Words may facilitate exposure effects to threatening images. *Emotion* 8:307–317.

TAYLOR, L.J., & ZWAAN, R.A. (2008). Motor resonance and linguistic focus. *Quarterly Journal of Experimental Psychology* 61:896–904.

TETTAMANTI, M., BUCCINO, G., SACCUMAN, M.C., GALLESE, V., DANNA, M., SCIFO, P., ET AL. (2005). Listening to action-related sentences activates fronto-parietal motor circuits. *Journal of Cognitive Neuroscience* 17: 273–281.

TOMASINO, B., FINK, G.R., SPARING, R., DAFOTAKIS, M., & WEISS, P.H. (2008). Action verbs and the primary motor cortex: A comparative TMS study of silent reading, frequency judgments, and motor imagery. *Neuropsychologia* 46:1915–1926.

TRANEL, D., KEMMERER, D., ADOLPHS, R., DAMASIO, H., & DAMASIO, A.R. (2003). Neural correlates of conceptual knowledge for actions. *Cognitive Neuropsychology* 20:409–432.

VIGLIOCCO, G., WARREN, J., SIRI, S., ARCIULI, J., SCOTT, S., & WISE, R. (2006). The role of semantics and grammatical class in the neural representation of words. *Cerebral Cortex* 16:1790–1796.

VIVONA, J.M. (2006). From developmental metaphor to developmental model: The shrinking role of language in the talking cure. *Journal of the American Psychoanalytic Association* 54:877–902.

VIVONA, J.M. (2009). Leaping from brain to mind: A critique of mirror neuron explanations of countertransference. *Journal of the American Psychoanalytic Association* 57:525–550.

WESTEN, D., & GABBARD, G.O. (2002a). Developments in cognitive neuroscience: I. Conflict, compromise, and connectionism. *Journal of the American Psychoanalytic Association* 50:53–98.

WESTEN, D., & GABBARD, G.O. (2002b). Developments in cognitive neuroscience: II. Implications for theories of transference. *Journal of the American Psychoanalytic Association* 50:99–134.

WILLEMS, R.M., & HAGOORT, P. (2007). Neural evidence for the interplay between language, gesture, and action: A review. *Brain & Language* 101:278–289.

WILSON, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review* 9:625–636.

ZWAAN, R.A., & TAYLOR, L.J. (2006). Seeing, acting, understanding: Motor resonance in language comprehension. *Journal of Experimental Psychology: General* 135:1–11.

11 Bala Avenue
Bala Cynwyd, PA 19004
E-mail: jvivona@tcnj.edu