Conceptual knowledge: Grounded in sensorimotor states or a disembodied deus ex machina?

Ezequiel Morsella,[a, c] Carlos Montemayor,[b] Jason Hubbard,[a] and Pareezad Zarolia[a]

[a]Department of Psychology; San Francisco State University, San Francisco, CA 94132-4168; [b]Department of Philosophy, San Francisco State University, San Francisco, CA 94132-4168; [c]Department of Neurology, University of California, San Francisco, CA 94132.

morsella@sfsu.edu **cmontema@sfsu.edu**

jashubbard@gmail.com **pzarolia@gmail.com**

http://bss.sfsu.edu/emorsella/

Abstract: If embodied models no longer address the *symbol grounding problem* and if a "disembodied" conceptual system can step in and resolve categorizations when embodied simulations fail, then perhaps the next step in theory-building is to isolate the unique contributions of embodied simulation. What is a disembodied conceptual system incapable of doing with respect to semantic processing or the categorization of smiles?

One challenge encountered when reverse engineering the brain is that the same function (e.g., categorizing an enjoyment smile) can be carried out by vastly different mechanisms (e.g., visual feature analysis, conceptual processing, or embodied simulation). This gives the brain tremendous flexibility and the ability to compensate for failed mechanisms. To the detriment of the scientist, it also makes it difficult to experimentally isolate the mechanism(s) underlying a

given function (e.g., the categorization of smiles) and identify the conditions under which a given function will be carried out by one mechanism versus another. With this in mind, Niedenthal et al. should be commended for their trailblazing contribution that specifies both the conditions under which embodied simulation is likely to occur (e.g., following eye contact) and the neural-physiological components of this intricate and counterintuitive mechanism.

When appreciating such an advancement, it is worth keeping in mind that the primary explanatory value of embodied approaches to knowledge representation (e.g., Barsalou 1999; Glenberg 1997) rested in their ability to address the *symbol grounding problem* (Harnad 1990) faced by "propositional" (aka "amodal") accounts of mental representation (e.g., Landauer & Dumais 1997), in which meaning is represented by arbitrary symbols (e.g., binary digits) that do not retain any of the properties of the sensorimotor states that gave rise to them (see review in Markman & Dietrich 2000). Similar to "analogical" and "modal" accounts, embodied models propose that meaning is constituted by (or "grounded in") sensorimotor information, such as that furnished by facial expressions. Since their advent, embodied models have been challenged on empirical grounds. Regarding emotion, for example, an extensive study revealed that people with bilateral facial paralysis stemming from Moebius syndrome can categorize the facial expressions of others without difficulty (Bogart & Matsumoto, in press). Moreover, the ability of subjects to express facial expressions does not influence accuracy. Similarly, in semantics, it remains unclear whether lesions of action-related regions of the brain lead to impairments regarding the semantic-conceptual knowledge of action: Patients suffering from deficits as a result of brain lesions can show impairments in the way they use certain objects but, revealing the abilities of a "disembodied" conceptual system, can nonetheless name those objects or even recognize the pantomimes associated with them (Mahon & Caramazza 2008).

In response to such challenges, embodied approaches now propose that sensorimotor information plays a more humble role: In their article, Niedenthal et al. portray sensorimotor information not as that which constitutes meaning, but merely as auxiliary information that is "referred to" when semantic processing is challenged, as when categorizations are difficult to make. In these accounts, sensorimotor information is demoted to a kind of supplementary information that, just like any kind of information, can at times facilitate or interfere with semantic processing. When the strategy of embodied simulation fails, it is the conceptual system that arrives at the scene to solve the categorization, much like a deus ex machina.

The question now is whether the conceptual system is always necessary for categorization. From one standpoint, the answer is *yes*: Until a token facial expression is *typed* as a member of a given category (an inherently conceptual process), the organism cannot know (consciously or unconsciously) the meaning of the observed expression. If the conceptual system must always be at the scene, then what is its nature and how does it solve the symbol grounding problem? Embodied approaches were expected to answer this by demonstrating, for example, that disrupting the sensorimotor states on which a conceptual process is grounded will not just modulate the process, but will also eradicate it. It seems that, apart from modulations that could be construed as priming or its opposite (i.e., interference), there is no evidence of conceptual processing requiring sensorimotor states. Apart from the aforementioned neurological evidence, this is evident with respect to abstract concepts (e.g., that of *if* and *justice*) and everyday phenomena such as *imageless thought* (e.g., a state of uncertainty or readiness; cf., Hilgard 1987). Regarding imageless thought, Woodworth (1915) concluded, "I know of no reason in neurology or psychology for supposing that the elements of conscious content are contributed solely by the sensory receiving centers" (p. 137).

A way forward? Identifying the limitations of "disembodied" processing.

Perhaps a critical next step in theory-building for embodied approaches is to identify the unique contribution(s) of embodied simulation. What is it that a disembodied conceptual system is incapable of doing with respect to semantic processing or the categorization of smiles? Emotion research has broached this topic by revealing some limits of language, a form of propositional processing. Evidence suggests that linguistic processing does not lead to the same kinds of emotional effects and forms of affective learning as modal stimuli (LeDoux 1996). Olsson and Phelps (2004) demonstrated that, through vicarious classical conditioning, subjects can acquire a learned fear response toward a subliminal stimulus by perceiving someone else receive a shock after being presented with that stimulus. However, simply telling subjects about the contingency between stimuli did not lead to this form of vicarious conditioning to subliminal stimuli. This suggests that the phylogenetically old systems mediating fear conditioning may not understand language, although they can process the meaning of basic perceptual events: "classical conditioning and observational learning … might be supported by an evolutionarily old system that predates the emergence of language" (Olsson & Phelps 2007, p. 1099).

That language fails to yield the vicarious conditioning afforded by observational learning may be because language comprehension yields "faint" activations of analogical, sensorimotor-like symbols (Boroditsky & Ramscar 2002; Zwaan 2008) or, at odds with embodied accounts, because linguistic-semantic knowledge is simply distinct from sensorimotor knowledge. Regarding the pioneering investigation by Niedenthal et al., the next advancement may be to isolate that which only embodied simulations can achieve. It may be that aspects of social mimicry and empathy require embodied simulation, or that the three smile-categorization mechanisms operate differently with respect to subliminal or supraliminal stimuli, with the

conceptual deus ex machina being able of arriving at the scene only when the theater lights of consciousness are on.

References

Barsalou, L. W. (1999) Perceptual symbol systems. *Behavioral and Brain Sciences* 22:577–609.

Bogart, K. R. & Matsumoto, D. (in press) Facial mimicry is not necessary to recognize emotion: Facial expression recognition by people with Moebius syndrome. *Social Neuroscience.*

Boroditsky, L. & Ramscar, M. (2002) The roles of body and mind in abstract thought. *Psychological Science* 13:185–89.

Glenberg, A. M. (1997) What memory is for. *Behavioral and Brain Sciences* 20:1–55.

Harnad, S. (1990) The symbol grounding problem. *Physica D* 42:335–46.

Hilgard, E. R. (1987) *Psychology in America: A historical survey.* Harcourt Brace, Jovanovich, Inc.

Landauer, T. K. & Dumais, S. T. (1997) A solution to Plato's problem: The latent semantic analysis theory of acquisition, induction, and representation of knowledge. *Psychological Review* 104:211–40.

LeDoux, J. E. (1996) *The emotional brain: The mysterious underpinnings of emotional life.* Simon and Schuster.

Mahon, B. Z. & Caramazza, A. (2008) A critical look at the embodied cognition hypothesis and

a new proposal for grounding conceptual content. *Journal of Physiology–Paris* 102:59–70.

Markman, A. B. & Dietrich, E. (2000) Extending the classical view of representation. *Trends in Cognitive Sciences* 4:470–75.

Olsson, A. & Phelps, E. A. (2004) Learned fear of "unseen" faces after Pavlovian, observational, and instructed fear. *Psychological Science* 15:822–28.

(2007) Social learning of fear. *Nature Neuroscience* 10:1095–1102.

Woodworth, R. S. (1915) A revision of imageless thought. *Psychological Review* 22:1–27.

Zwaan, R. A. (2008) Experiential traces and mental simulations in language comprehension. In: *Symbols, embodiment, and meaning*, ed. M. DeVega, A. M. Glenberg & A. C. Graesser, pp. 165–80. Oxford University Press.