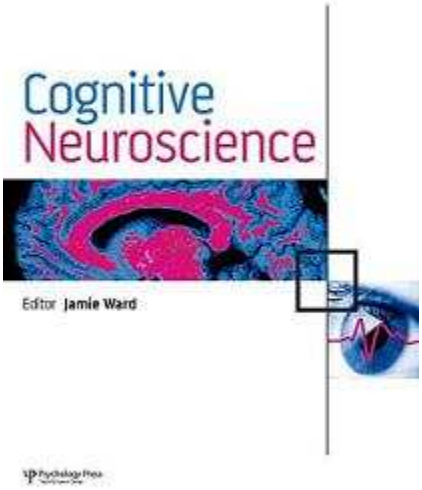

Do body-part concepts depend on the EBA/FBA?

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Do body-part concepts depend on the EBA/FBA?

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Abstract: Downing and Peelen argue that the EBA/FBA represent body-part shapes in a highly schematic manner that is independent of personal identity, emotional expression, movement pattern, and action goal, and that cuts across visual and haptic modalities. According to the Grounded Cognition Framework, these properties make the EBA/FBA suitable for processing body-part shapes not only for perceptual purposes, but also for conceptual purposes. Any account of the neural substrates of body-part concepts must, however, accommodate significant crosslinguistic diversity in this semantic domain. Hence, an alternative possibility is that the shape components of body-part concepts depend on areas adjacent to the EBA/FBA.

A prominent theory of conceptual knowledge is the Grounded Cognition Framework, which maintains that concepts are not completely divorced from modality-specific systems for perception and action, but instead overlap with them to some degree (Martin, 2007; Barsalou, 2008; Kiefer & Pulvermüller, in press). Consider, for example, an fMRI study by Chao et al. (1999) that focused on the perceptual and conceptual processing of animals and tools. Perceptual processing was probed with passive viewing tasks and match-to-sample tasks, and conceptual processing was probed with picture naming tasks and property verification tasks. Across all of the tasks, perceptual as well as conceptual, greater activation for animals was found in a lateral portion of the mid-fusiform gyrus, whereas greater activation for tools was found in a medial portion of the mid-fusiform gyrus. These regions probably represent the shapes of animals and tools, and the fact that they were activated not only by pictures, but also by words, supports the Grounded Cognition Framework. Moreover, several other studies have generated convergent results which suggest that the word-induced fusiform activations reflect the retrieval of shape properties for conceptual purposes, and are not due to mere "imagery" (Martin, 2007).

Although much has been learned about the neural substrates of the shape properties of animal and tool concepts, almost nothing is known about the neural substrates of the shape properties of body-part concepts, as expressed by terms like *arm, hand, leg,* and *foot.* This gap in the literature is surprising, given the tremendous interest in body representation that has recently emerged. There is some neuropsychological evidence that body-part concepts depend on the lateral/ventral occipitotemporal cortices, among other regions (Kemmerer & Tranel, 2008). To my knowledge, however, no studies have tested the hypothesis, derived from the strongest form of the Grounded Cognition Framework, that the shape properties of body-part concepts rely specifically on the EBA/FBA or on neighboring areas that also seem to contribute to body-part perception.

According to Downing and Peelen (this issue), the EBA/FBA are tuned to the domain of body-part shapes in several ways: they capture "bare bones" schematizations of these objects, as shown by their sensitivity to silhouettes, cartoons, and stick figures; they respond to body-part shapes regardless of personal identity, emotional expression, movement pattern, and action goal; and they generalize across visual and haptic modalities. Interestingly, these representational capacities appear to make the EBA/FBA well-suited to processing body-part shapes for both perceptual and conceptual purposes. Hence, an advocate of the Grounded Cognition Framework might predict that understanding a word like *leg* involves activating the same patches of the EBA/FBA, or the same population codes in these regions, that are engaged during the perceptual recognition of legs.

It is noteworthy, however, that although most languages have words that segment the body according to salient perceptual discontinuities, there is still substantial variation. To take a few examples, Savosavo has a single category for leg that begins at the hip joint and encompasses the foot, ignoring both knee and ankle discontinuities; Yélî Dnye has one term for the upper leg and another term for the lower leg plus the foot, thus respecting the knee discontinuity but ignoring the ankle discontinuity; Jahai recognizes all three parts—upper leg, lower leg, and foot; and Tidore has one term that covers the foot, lower leg, and lower part of the thigh, and a separate term for "groin" that includes the upper part of the thigh, thus making a category distinction in the absence of a corporeal discontinuity (Majid, 2010).

Any account of the neural underpinnings of body-part concepts must accommodate this diversity. Perhaps language is one of the experiential/cultural factors that, according to Downing and Peelen, influences the EBA/FBA. Alternatively, there may be multiple occipitotemporal body-part maps, and the shape properties of body-part concepts may be subserved by areas near the EBA/FBA. In this situation, the relationships between perceptual and conceptual body-part representations would probably be looser, but they would still be quite close, consistent with a weaker form of the Grounded Cognition Framework. The key point is that both of these possibilities, and others, are ripe for investigation.

Barsalou, L.W. (2008). Grounded cognition. *Annual Review of Psychology, 59,* 617-645.

Chao, L.L., Haxby, J.V., & Martin, A. (1999). Attribute-based neural substrates in temporal cortex for perceiving and knowing about objects. *Nature Neuroscience, 2,* 913-919.

Kemmerer, D., & Tranel, D. (2008). Searching for the elusive neural substrates of body-part terms: A neuropsychological study. *Cognitive Neuropsychology, 25,* 601-629.

Kiefer, M., & Pulvermüller, F. (in press). Conceptual representations in mind and brain: Theoretical developments, current evidence, and future directions. *Cortex.*

Majid, A. (2010). Words for parts of the body. In B. Malt & P. Wolff (Eds.), *Words and the mind* (pp. 58-71). Oxford University Press.

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