

Commentary

What's embodied and how can we tell?

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This paper by Daum, Sommerville, and Prinz (2009) presents an intriguing theory of the development of social cognition, distinguishing early developing *embodied* processing, based on perception and production of bodily states, from later-emerging *symbolic* processing, based on language. While this distinction is discussed predominantly in relation to social understanding, it is broadly applicable to cognition more generally. In emphasizing the sensory and motor bases of infants' and young children's cognitive abilities, this proposal echoes classic Piagetian theory (e.g. Piaget, 1937/1954). Importantly, however, it avoids Piaget's notion of qualitatively different developmental stages, suggesting instead that the embodied mode of understanding is essentially continuous from infancy through adulthood. This idea of continuity, shared with otherwise very different recent developmental theories (e.g. Spelke & Kinzler, 2007), is theoretically attractive in that it suggests that the study of infants and young children can provide direct insight into cognitive capacities which in adults are tightly integrated with other abilities and difficult to isolate experimentally. Specifically, Daum and colleagues suggest that preverbal infants may constitute a 'pure model' for embodied social cognition, uncontaminated (so to speak) by other types of processing. This is a fascinating proposal, with important methodological and theoretical consequences. In this commentary, I will discuss two major difficulties that pose limitations on this proposal as currently formulated, and end with a suggestion on how to conceptualize what's embodied.

CONTINUITY AND CHANGE DURING INFANCY

The first major difficulty in the use of infancy as a model of embodied cognition is the fact that infant cognition is a moving target, with dramatic changes throughout the preverbal period. For example, Piaget (1937/1954) famously partitioned prelinguistic infancy into six distinct stages, and while his specific theory is no longer widely accepted, his empirical observations of age-related differences are generally replicable. More recent theorists have described 'revolutions' in infant cognition around 2 months (e.g. Lavelli & Fogel, 2002; Prechtl, 1986) and around 9 months (e.g. Tomasello, 1999) of age, both involving dramatic changes in infants' social behaviour. More generally, large age-related changes are ubiquitous in the infancy literature, for virtually all cognitive abilities. It is clearly not the case the infant cognition (social or otherwise) is static until the onset of language-based symbolic processing. At which point, then, is the preverbal infant supposed to be a pure model of embodied social cognition?

Confronted with any particular pattern of infant behaviour, it is often difficult to determine to what extent it is a manifestation of general processes, essentially continuous with (and able to shed light upon) adult cognition, as opposed to a specific reflection of the infant's particular point in development. In most cases, both interpretations are likely to be true to varying degrees. Thus, the analysis of an infant behaviour or ability can rarely be considered on its own, but must be

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placed in the context of larger developmental patterns. The concern, here, is that the use of infants as a 'pure model' of adult social cognition presupposes the solution to problems in developmental psychology that are at least as difficult as the problems in adult social psychology which it aims to inform.

IS THIS ABILITY EMBODIED?

A second major difficulty concerns how a psychologist, confronted with a particular ability (whether in infants or in adults), determines whether or not that ability reflects an embodied mode of understanding. For example, Daum and colleagues point to the dissociation between the apparent sophistication of young infants' physical reasoning when tested in looking-time paradigms (e.g. Baillargeon, 1986; Spelke, Breinlinger, Macomber, & Jacobson, 1992) with the dramatic failures of much older toddlers on analogous reaching tasks (e.g. Berthier et al., 2000; Keen & Shutts, 2007) as a potential example of emerging symbolic processing interfering with earlier developing embodied processing. While this is an intriguing hypothesis, it is problematic in that there is no apparent reason to suppose that the abilities revealed with looking-time techniques reflect embodied processing. Nor is it clear what evidence would count either for or against this hypothesis. There are also empirical problems with this specific proposal, in that the dissociation between looking and reaching measures of physical reasoning exists at earlier ages, with apparent understanding of the permanence of occluded objects emerging substantially earlier with looking (e.g. Baillargeon, 1986) than reaching (e.g. Piaget, 1937/1954) measures. This decalage within preverbal infants suggests that there are important differences between looking and reaching measures, not resulting from interference from language-based symbolic processing. Furthermore, one would expect, if anything, reaching—rather than looking—to be more reflective of embodied processing. Thus, if infants' physical reasoning abilities resulted from the embodied mode of processing, one would predict the opposite pattern of better performance on reaching than looking measures. That is, the performance of infants would be predicted to be analogous to the performance of patients with visual form agnosia, such as patient DF, who is able to successfully place a card in an angled slot while being completely unable to report what the angle is perceived to be (Milner & Goodale, 1995).

For the distinction between embodied and symbolic modes of processing to be useful in generating testable experimental hypotheses, it must be clear what sort of evidence could, at least in principle, allow a researcher to determine whether or not any particular ability is embodied. Consider some additional examples not discussed by Daum and colleagues. Newborn infants distinguish patterned from solid-coloured visual stimuli (Fantz, 1963). They also distinguish visual stimuli in the general configuration of a face from scrambled faces (Johnson, Dziurawiec, Ellis, & Morton, 1991). Furthermore, newborns (von Hofsten & Ronnqvist, 1993) and even fetuses (de Vries, Visser, & Prechtl, 1982) show sophisticated manual motor coordination. Do such abilities reflect the operation of the embodied mode of processing? It is not clear what evidence would speak to this question.

On the one hand, Daum and colleagues described embodied processes as based on perception of production of body states and actions. It seems unlikely that pattern vision of the sort described by Fantz is based on perception of bodies. The perception of faces, by contrast, while not quite *based* on bodily perception, simply *is* bodily perception; motor coordination, analogously, simply *is* bodily movement. Does this qualify those abilities as embodied? This does not seem to capture all that is meant by embodiment. Mirroring, for example, which the authors discuss at length, appears to be embodied in virtue of the *interrelation* of perception and action: Perception of action appears to involve motor processes (and, perhaps, *vice versa*). This would suggest that such unimodal perceptual and motor capacities do not reflect the embodied mode of processing.

Elsewhere, however, Daum et al. appear to characterize embodied processing in large part by exclusion, as whatever is *not* based on symbolic or linguistic processes. Indeed, in places they seem to imply that *all* infant social cognition, and at least some non-social cognition (such as physical reasoning), is based on embodied processing. If we take language to be essential to symbolic processing and suppose the distinction between symbolic and embodied processing to be dichotomous, then the cognitive abilities of preverbal infants are, trivially and by definition, embodied. If, in contrast, this distinction is not intended to be dichotomous, it is important to identify what sort of processing, other than embodied processing, preverbal cognition might be based upon, and to develop criteria that will allow researchers to determine which abilities in infancy reflect embodied processing.

WHAT'S EMBODIED: A SUGGESTION

While Daum and colleagues distinguish their use of the concept of 'embodiment' from its use in the wider adult cognition literature, their usage shares many of the problems of ambiguity common in that literature (cf. Wilson, 2002). One way to characterize what is commonly meant by an 'embodied' representation is a case where a perceptual or motor representation appears to be employed for a purpose *other than its primary purpose*. Involvement of primary motor cortex in motoric behaviour is unremarkable; its involvement in visual apparent-motion of bodies (Stevens Fonlupt, Shiffrar, & Decety, 2000), on the other hand, is a striking example of 'embodied mirroring'. Involvement of primary visual cortex in visual tasks is expected; its involvement in tactile discrimination (Zangaladze, Epstein, Grafton, & Sathian, 1999), conversely, illustrates 'embodied intersensory perception'. This proposal is not without problems, not least being the requirement of normative judgments by the psychologist as to which functions of mental representations or brain areas are primary, and which secondary. Nevertheless, this characterization seems to capture what is frequently meant in claims of 'embodiment', as well as the reasons for the excitement and interest that such claims have generated.

In conclusion, this paper by Daum and colleagues represents a major contribution to our efforts to understand social cognition, both developmentally and in adults. These authors, furthermore, provide a useful conceptualization of how studies in developmental psychology can be used to inform adult social psychology. This is an exciting proposal, with important consequences for both fields. Fulfilment of this promise, however, will require increasing precision about what counts as evidence for or against embodiment.

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