

Precursors to theories of mind in nonhuman brains

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Abstract:

I agree with Heyes that behavioural tests that can distinguish mentalistic from non-mentalistic alternatives should be sought. However I suggest that the theoretical issue is less about the passing of behavioural tests than it is about the internal mechanisms which enable the passing of the tests, and that it may be helpful to try and assess the internal mechanisms directly by measuring brain activities.

The theory of “having a theory of mind” is incredibly loose, and needs to be tied down even with human subjects. However, there is overwhelmingly greater evidence for the development of mental state concepts in human infancy, and a certainty that such concepts function in human adults. There is also some support for the notion that there is a theory of mind ‘module’ in the human case, or at least a network of links between the various separately measurable social skills (Karmiloff-Smith et al. 1995; Fletcher et al. 1995). As a particular case, contrary to the suggestion and the end of 2.1, there is data from large samples of children which has been taken to support a very close correlation between mirror self-recognition and sensitivity to imitation (Asendorpf and Baudonniere, 1993; Asendorpf, Warkentin and Baudonniere, 1996) and a large literature relating imitation and other theory of mind tests (e.g. Azmitia and Hesser, 1993; Vonhofsten and Siddiquit, 1993; Loveland et al. 1994; Smith and Bryson 1994).

This literature contrasts starkly with the very limited corpus of positive behavioural evidence for mental state concepts corresponding to ‘want’ and ‘know’ even in chimpanzees, and the consensus that social attribution and mirror self recognition are absent in other non-human primates and large-brained higher vertebrates (Povinelli, 1989; 1993; Povinelli and Preuss 1995). There is little room for argument about whether support for the mentalistic theories requires behavioural evidence to distinguish mentalistic capacities from alternative: — we should surely presume that natural selection is not intelligent enough to be anything but behaviourist. Therefore if mentalistic capacities are the result of selection they could only have arisen if they produce behavioural effects which increase the inclusive fitness of the individuals that possess them. The only reservation I have about the study of perspective-taking proposed by Heyes is that the distinction between red-rimmed and blue-rimmed goggles seems rather remote from any naturalistic function that precursors to perspective-taking in wild chimpanzees might serve. One-way and two-way silvered screens are suggested as alternatives and these would seem better as a starting point, as more similar to completely opaque or partly opaque vegetation. However, in any such stringent test, it seems quite probable, on the basis of reports published so far, that chimpanzees would fail the test.

In that case, should all discussion and experimentation on mentalistic cognitive processes in non-human primates cease? It is unlikely that they would, since although the experimental manipulations suggested by Heyes are helpful, there are implicit and sometimes explicit theoretical assumptions related to the 'theory of mind' tests which are wider than any particular crucial experiment. One underlying assumption is that non-human primates have enlarged brains by general mammalian standards, and that the expansion of primate neocortex is to some degree related to sociality (Humphrey, 1976). Data to test these assumptions are still fairly limited (Barton, 1996), but presumably the large brain size of primates is not an accident, and a function relation with sociality could hold even if primate mentalistic capacities were very severely limited by comparison with those demonstrated by the passing of false-belief tests by human 10-year olds. Phylogenetic relatedness itself means that there is special value in examination of the brain mechanisms of cognition in primates, and the details of brain functioning, rather than the behavioural effects of brain functioning, is an independent route to follow for evidence for similarity between human and nonhuman mechanisms, even where human capacities may be qualitatively different from those of any other extant species. There is continuing interest in human and primate brain mechanisms for self-related aspects of visual attention, and visually controlled reaching and grasping (Graziano et al. 1994; Hietanen and Perrett 1996; Johnson et al. 1996; Jeannerod et al. 1995; Kertzman et al. 1997; Witte et al. 1996). There is already substantial evidence for a commonality in human and nonhuman primate brain mechanism in at least some precursors to theory of mind tests.

In particular the integration and transformation of visual information into representation of motor activity would be a prerequisite for imitation under most definitions. Cells in macaque temporal cortex recognize direction of motion and view of the body, and a proportion of these continue to be selective when the information is limited to the movement of light patches attached to the points of limb articulation (Oram and Perrett, 1994). Even more closely related to precursors for imitation of object manipulation, there are cells in parietal cortex which respond to objects according to type of manipulation (Murata et al. 1996). These provide input to cells in premotor cortex of macaques, which discharge either when the animal performs a grasping action itself (even in the dark) or when it observes the human experimenter, or another monkey perform the action (Rizzolatti et al. 1996). It has not unreasonably been proposed that these cells may be part of an observation/execution matching system (Gallese et al. 1996) which shows some degree of comparability between macaques and humans (Fadiga et al. 1995; Grafton et al. 1996).

This does not imply at all that macaque capabilities for the purposive imitation of grasping and gripping actions remotely equal those of humans and in a sense this sort of special purpose sensory-motor transformation system is the alternative to sweeping mentalistic accounts. There is also no reason to suppose that some degree of multi-modal transformation of information does not occur in the brains of rats (Chuder et al. 1995) and indeed even in the superior colliculus of lower vertebrates (Spreckelsen et al. 1995). But in terms of research strategies I would argue that a promising avenue of progress in primate research related to theory of mind theories in humans would be investigation of commonalities of brain mechanism. If functional brain imaging studies of children, chimpanzees and macaques exposed to mirror self recognition circumstances becomes feasible, and the pattern of activity observed in ostensibly self-recognizing children and chimpanzees were found to be similar, but something quite different was correlated with face touching in macaques, I would regard this as evidence complementary to that obtained by purely behavioural controls.

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