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Looking into primate theory of mind

(Commentary to Jill Byrnit: Primate theory of mind: A state-of-the-art review)

Byrnit's review of research on theory of mind in primates is thought-provoking in several ways, and a good example of the kind of comparative developmental approach that is needed for any comprehensive account of the evolution of mental abilities. By moving back and forth between findings in humans and in nonhuman primates, the review provides an accurate overall picture of how knowledge in the area has been progressing, although it is clear that in many cases "progress" equates to controversy, contradictory claims, and confusion. Byrnit makes the point that it is not simply more data that are needed, but better data, and these should be obtained in more naturalistic situations than some of the experimental paradigms that have been used to assess primates' mind-reading abilities.

The data that are available are fragmentary. Some of the "key" findings in the literature pertaining to primate social cognition sorely require replication. Dasser's (1987) work on longtailed macaques' abilities to match slides based on the relatedness of the depicted group-members comes to mind here. Although widely cited, not only has this work never been replicated, as Byrnit points out, but the data are based on very few individuals. Fortunately, there are other sources of evidence that monkeys recognize something about the social relationships between other group-members. Byrnit cites Cheney and Seyfarth's (1980) well-known example of adult female vervet monkeys looking towards the mother of a juvenile whose vocalization has just been played back through a hidden speaker. Incidentally, this is a superb example of clever experimentation in a naturalistic context. It is also worth pointing out that observational (i.e., non-experimental) studies also contribute importantly. For example, in many primate species the victim of aggression may retaliate against the aggressor's kin; even the victim's kin might later attack the original aggressor's kin (reviewed in Tomasello & Call, 1997). Byrnit rightly acknowledges the limitations of anecdotal reports as evidence, but she also overlooks systematic observational studies as a complementary source of information about behaviour that may be tap into theory of mind mechanisms. To give an example specifically concerning theory of mind, extensive and quantified observations of social behaviour in groups of macaques and chimpanzees led de Waal and Aureli (1996) to conclude that the phenomenon of consolation - one individual behaves in a friendly way towards another after the latter has received aggression from a third individual - occurs in the apes but almost never in the monkeys. Consolation is considered important as it probably indicates empathy on the part of the individual doing the consoling, and empathy in turn is considered to be limited to species and individuals that

are sufficiently self-aware and that have theory of mind (Gallup, 1982).

Although it is a competent comparison of humans and great apes on several dimensions related to theory of mind, Byrnit's review misses out much relevant work on non-great ape primates; relevant because many studies suggest important differences between monkeys on the one hand, and great apes on the other, in skills and abilities that are relevant to mind-reading. One fundamental difference is in terms of self-awareness, as measured by visual self-recognition. Put simply, many great apes show that they recognize their own mirror image as a reflection of their own body, whereas there is no convincing evidence that monkeys have the same degree of self-awareness (Anderson, 1994; Gallup et al., 2002). Almost 25 years ago Gallup (1982) hypothesized that organisms capable of self-recognition would be uniquely capable of a range of behaviours that today we group under the concept of theory of mind, including empathy and deception. Although deception is known to be widespread in the animal kingdom, it is interesting that the most advanced forms of tactical deception, including cases of counter-deception (implying an understanding of the other's intention to deceive) appear limited to great apes (Byrne and Whiten, 1992).

Byrnit draws on Meltzoff's (1995) work on human infants' successful imitation of incompleting acts as evidence that 18-month-olds interpret people's actions as goal-directed and intentional. If true imitation does indeed imply understanding of intentionality, it is worth looking more closely at the comparative primatological literature on imitation. This indicates that great apes can learn to imitate gestures, including arbitrary acts, whereas monkeys do not appear to be capable of imitation (Myowa-Yamakoshi & Matsuzawa, 2000; Russon & Galdikas, 1993; see Mitchell & Anderson, 1993, for an elaborate, failed attempt to teach a monkey to imitate). Interestingly, however, although monkeys do not appear to imitate the actions of other individuals, they do appear to recognize when they are being imitated by somebody else (Paukner et al., 2005). Of course this result needs not imply any understanding of intentionality; instead, simple sensitivity to the temporal and physical contingencies between one's own actions and those of the imitator can explain the effect.

Monkeys sometimes behave in ways that suggest that they do not take others' points of view into account. For example, many monkeys become silent and cryptic when faced with danger, and although with experience these behaviours might be employed more flexibly, they can also be seen as largely hard-wired adaptations to potential risk. In

one experimental study, a human systematically prevented longtailed macaques from drinking juice from a bottle attached to the mesh of a cage. When given the option of drinking behind an opaque screen that hid the monkey from the human or without such cover, however, the monkeys showed no preference for concealment (Kummer et al., 1996). This failure to hide may indicate limited perspective-taking abilities in the monkeys, and is in contrast with accounts of hiding in great apes, who may hide themselves and objects from others in a variety of contexts. However, as we will see later, there is other evidence that does indeed suggest perspective-taking abilities in macaques.

Although I agree with Byrnit's reservations about the power of anecdotes, I offer one to illustrate an impressive case of hiding and theory of mind in a great ape. Linden (2000) describes how a zoo-housed adult male orangutan escaped from a new enclosure on several consecutive nights, a feat which had his caretakers baffled; they could not discover how he managed to flick open the lock of the enclosure door. Each morning the orangutan was led back into the enclosure, where he would follow the caretakers around and peer at the ground and in corners along with them as they tried to discover what tool the ape might be using to open the door. Eventually the orangutan's secret was discovered: for several days he had been carrying around in his mouth a discarded piece of wire, which he removed, unfolded, and used to flick the lock when nobody was around in the evening, before folding it back up and concealing it inside his mouth again! The reader will surely agree that it is difficult not to attribute advanced planning abilities to this individual, along with intentionality - understanding that the caretakers were looking for the tool and would surely have deprived him of it earlier if they had known where to look.

As pointed out by Byrnit, it is not always clear that what initially looks like a case of mental state attribution is in fact that, even in well-controlled experiments. The questions surrounding the demonstration that chimpanzees but not rhesus macaques responded differently to a "knower" and a "guesser" in Povinelli's often-cited studies are dealt with in the review, but there is newer evidence that is worth considering. Kuroshima et al. (2003) tested tufted capuchin monkeys on variants of the knower-guesser paradigm, and discovered that one monkey successfully discriminated between a knower and a guesser. In fact in view of the control procedures used in Kuroshima's experiments the finding appears more convincing than for chimpanzees. What are the implications of the finding that capuchin monkeys may be capable of distinguishing others' knowledge states? Might capuchin monkeys be similar to chimpanzees, and superior to macaques in terms of mental state attribution? As should be expected by now, things are not quite so simple. Although undoubtedly clever in several ways compared to other monkeys (Anderson, 1996), capuchins are firmly in the same camp as other monkeys on some critical domains, such as self-recognition (Anderson & Marchal, 1993; de Waal et al., 2005) and, as outlined below, understanding the seeing-knowing relationship of conspecifics.

As a case of good practice in experimentation on primate theory of mind, Byrnit describes the innovative

studies by Hare et al. (2000, 2001) on chimpanzees' abilities to modify their food-related behaviour as a function of whether they have seen that another chimpanzee can see (or has seen) the food items available. The evidence from these studies is highly suggestive that chimpanzees take into account what other individuals might have seen when planning their course of action, as subordinates will preferentially target food items that a more dominant individual has not seen. However, even here, as Byrnit acknowledges, the data are not unanimous (see Karin-D'Arcy and Povinelli, 2002, for an alternative account of what chimpanzees may do in these circumstances), but again there is the interesting possibility of a gap opening up between the behaviour of monkeys and apes in these kinds of circumstances. Hare et al. (2003) ran pairs of capuchin monkeys in the competitive food-getting situation used with chimpanzees, but found no evidence that the monkeys based their choice of food item on whether the competitor could see the food. It would definitely be worthwhile to get more data on how monkeys behave in these kinds of situation.

There have been other attempts to introduce a competitive slant to studies that look at whether monkeys process the attentional states of others. Using a variant of the object-choice task, Vick and Anderson (2003) found that it was easier for baboons to take a food item that the human was not looking at; if fixating a desired object signals attention to (and possibly possession of) that object by a dominant individual, then it is to the other individual's advantage to go for an alternative item. More recently, Flombaum and Santos (2005) have shown that rhesus monkeys are more likely to approach and snatch a piece of food from a nearby human who is not paying attention either to the food or the monkey than from one who is looking towards them. It is interesting to note that in this competitive situation rhesus monkeys appear to show more sensitivity to being looked at than the chimpanzees who begged for food from humans in the study by Povinelli & Eddy (1996)! These positive results with rhesus macaques also contrast with longtailed macaques' failure to hide themselves in order to drink easily, described above. Reasons for the difference await clarification.

In spite of the above cases of a competitive element seeming to facilitate the reading of gaze cues by nonhuman primates, I am less critical than Byrnit and others of the fact that the typical object-choice task is based on a co-operative relationship between the individual giving the cues and the subject. Co-operation is indeed a characteristic of chimpanzee societies, including in some feeding contexts such as the hunting of mammalian prey in the wild (Boesch, 1994) and food-getting tasks in captivity (Melis et al., 2006). Instead of being disadvantaged by the co-operative nature of the object-choice tasks, I would suggest that other aspects of the procedure might put the primate subjects at a disadvantage when it comes to exploiting attentional cues in order to find treats. The physical features of the objects used to contain the food items (Call et al., 1998), and the use of a screen during the baiting process (Vick & Anderson, 2003) might well influence the likelihood of obtaining effective exploitation of gaze cues. The timing of intra-trial events may

also be crucial: Vick & Anderson (2003) found that baboons' performance was disrupted by the absence of movement by the trainer while presenting gaze cues. Also, chimpanzees were shown to respond much better on object-choice trials in which they approached the human who was already presenting the cues compared to when they stayed in the experimental cubicle while the trainer prepared the next trial and presented the cues (Barth et al., 2005). Thus, it seems likely that more finely tuned procedures could improve performance on object-choice tests; competitive testing is not the only way to proceed.

It remains the case that there are striking individual differences in the facility with which individual primates pick up and exploit gaze cues in object-choice tasks. Byrmit considers whether so-called enculturation is responsible for the differences. This is an important issue, not least because it focuses attention on the socialization processes that take place during the development of eventual mind-reading organisms. For me there are two major questions concerning enculturation. First, there is a need to be clear about what the process involves. For Byrmit, it would seem that early, intensive and active experience in a linguistic environment is critical, and I would agree. However, this is not sufficient, as there must also be socially mediated interactions with a range of human artefacts and tools. Some of the great apes that have been studied from a theory of mind perspective do qualify as enculturated according to these criteria, but some do not. It would be useful to have a more detailed breakdown, if this is possible, of the degree of exposure to enculturating processes of the various apes that have been tested, and their competence on a range of tasks.

There is also the related issue of whether individuals of other species that have extensive social and linguistic input from humans might somehow be better equipped for mind-reading. The most obvious candidate for study in this context is the domestic dog, which some authors claim might be even more adept than nonhuman primates at reading human social cues (Hare et al., 2002). If this turns out to be true, then it would raise many questions about the role of genetic endowment, neural mechanisms, and ontogenetic experience in the attainment of advanced social cognitive abilities. Byrmit's review gives a flavour of what has been done, and points the way towards what is yet to be done. If, as seems likely, there are differences even among species of primates in their theory of mind abilities, can we recognize the origin of the differences? If we accept as a working hypothesis Baron-Cohen's (1995) four-mechanisms account of the development of theory of mind (and I have doubts about several aspects of this), how do we handle species differences? For example, are we to conclude that species A's Eye-Direction-Detector is only rudimentary, while species B only has a partially functioning Shared Attention Mechanism? It might not be too far fetched to suggest that diversity in forms of theory of mind might be revealed from intensified research efforts in this field. I look forward to further developments in this area. Thoughtful reviews such as the one by Byrmit will help the research effort.

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