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Chimpanzees know what others know, but not what they believe

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ABSTRACT

There is currently much controversy about which, if any, mental states chimpanzees and other nonhuman primates understand. In the current two studies we tested both chimpanzees' and human children's understanding of both knowledge–ignorance and false belief – in the same experimental paradigm involving competition with a conspecific. We found that whereas 6-year-old children understood both of these mental states, chimpanzees understood knowledge–ignorance but not false belief. After ruling out various alternative explanations of these and related findings, we conclude that in at least some situations chimpanzees know what others know. Possible explanations for their failure in the highly similar false belief task are discussed.

1. Introduction

In 1978, Premack and Woodruff asked, "Does the chimpanzee have a theory of mind?" This question sparked much research, most immediately on human children with a focus on their understanding of false beliefs (Wimmer & Perner, 1983). More recently, research has focused on how young children understand the psychological states of others more generally, including everything from goals and intentions to perceptions, knowledge, and beliefs.

Human infants begin to understand that others have goals quite early, before the first birthday (e.g., Behne, Carpenter, Call, & Tomasello, 2005; Gergely, Nadasdy, Csibra, & Biro, 1995), and they understand others' rational choices of means toward goals (intentions) soon after (Gergely, Bekkering, & Kiraly, 2002; Schwier, van Maanen, Carpenter, & Tomasello, 2006). Infants understand that others see things from around the first birthday as well (e.g., Brooks & Meltzoff, 2002; Moll & Tomasello, 2004), and they understand that others have perspectives that differ from their own by at least the second birthday (Level 1: Moll & Tomasello, 2006). Of particular importance to the current studies, recent research has shown that infants at around the first birthday even understand that others know things, that is, that others' actions are governed by things they saw some moments before (e.g., Moll & Tomasello, 2007; Onishi & Baillargeon, 2005; Tomasello & Haberl, 2003). In contrast, if one requires children to express their knowledge in action (as in most of the studies cited above), they show no understanding of false beliefs – that others' actions are governed by things the child knows are not true – until much later at around 4 years of age (see Wellman, Cross, and Watson (2001), for a review and meta-analysis). Importantly, in a direct comparison Wellman and Liu (2004) found that children develop an understanding of knowledge–ignorance before they develop an understanding of false beliefs.

As for Premack and Woodruff's original question about chimpanzees, there has been controversy from the beginning. Thus, Savage-Rumbaugh, Rumbaugh, and Boysen (1978) presented data from their chimpanzees suggesting that the Premack and Woodruff (1978) goal-understanding tasks could be solved through simple association. Subsequent experiments on other mental states also yielded negative results. Most prominently, Povinelli and Eddy (1996) found that juvenile chimpanzees begged food from a human gesturally even when he was blindfolded or had a

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bucket on his head, suggesting no understanding of visual perception. Similarly Povinelli, Rulf Alyssa, and Bierschwale Donna (1994) found that when chimpanzees saw two humans pointing to different locations to indicate the location of a single piece of hidden food – and one of those humans had watched the original hiding process whereas the other had not – they followed the two humans' pointing gestures indiscriminately, suggesting no understanding of the distinction between knowledge and ignorance. And Call and Tomasello (1999) found that whereas 5-year-old children passed a nonverbal false belief test readily, chimpanzees failed it.

All of these data led researchers to the conclusion that chimpanzees and other nonhuman primates do not understand the psychological states of others (Heyes, 1998; Povinelli & Vonk, 2003, 2004; Tomasello & Call, 1997). That is, nonhuman primates can predict others' actions in many situations based on past experience (and perhaps some specialized cognitive adaptations), but they do not go beneath the surface to an understanding of the goals, perceptions, knowledge, and beliefs that guide others' actions. But as always, negative experimental results have many possible interpretations, and there have always been a number of informal observations by fieldworkers suggesting that perhaps chimpanzees and other nonhuman primates can understand some mental states in some situations. Most prominently, Byrne and Whiten (1990) reported a number of informal observations from fieldworkers on so-called tactical deception, which might, in some interpretations, suggest some form of mental state understanding.

Hare, Call, Agnetta, and Tomasello (2000) and Hare, Call, and Tomasello (2001) noted that almost all of the experiments with negative results from the laboratory required cooperative communication with humans (e.g., interpreting a pointing gesture, requesting food, etc.), whereas many of the potentially positive informal observations from the wild involved competition with conspecifics. They therefore devised experiments in which chimpanzees competed with one another for food. Of particular importance in the current context, Hare et al. (2001) investigated chimpanzees' understanding of knowledge. They placed a subordinate and a dominant chimpanzee into rooms on opposite sides of a third room. Each had a guillotine door leading into this middle room which, when opened at the bottom, allowed them to see into the middle room – and to see the other individual looking under her door as well. There was one piece of food in this middle room, which the subordinate could always see on her side of one of two barriers. The dominant could never see the food at the moment of choice, but in one condition she had witnessed the hiding process a few moments before (her door was open at that time and the subordinate could see this), and in another condition not (because her door was down). The doors for both individuals were then opened (subordinates had a slight headstart so that they could not react to the dominant's behavior). The clear finding was that in the trials in which the dominant had not previously witnessed the food being hidden, subordinates went for the food; in the trials in which the dominant had witnessed the food being hidden some moments before, subordinates stayed away. Subordinates seemingly knew whether or not the dominant knew the food was there, even though he could never seechoice.[1]

There were several additional control conditions in the two Hare et al. studies that ruled out various more conservative, less mentalistic interpretations of these results. However, one final conservative interpretation is the so-called evil eye hypothesis. Perhaps subordinates believe that any piece of food observed by a dominant is 'contaminated' – it is forbidden once the dominant has put the evil eye on it – and so the only safe food is food that he cannot see and indeed has never seen. In a final study of Hare et al. (2001), both the dominant and the subordinate watched the food being hidden behind one of the two barriers, as usual; the dominant's evil eye was thus placed on it, and so on this interpretation the subordinate should avoided it at all costs. But then in one experimental condition only the subordinate watched the food being moved to a new location (dominant's door down), whereas in another condition they both watched it being moved. Subordinates went for the food when only they alone had watched the moving process, not when both competitors had watched the moving process. Subordinates thus clearly did not believe in any dominant evil eye, since they went for the food whose movement to a new location the dominant had not witnessed (even though he had put his evil eye on it earlier). Nevertheless, one other more conservative explanation is still viable. It could be that chimpanzees have learned the behavioral rule: if a dominant individual orients to a piece of food *in a particular location*, then that food must be avoided (see Povinelli & Vonk,2003, 2004, and also Heyes, 1998, for more on the behavioral rules approach). To be completely confident that chimpanzees sometimes know what others know, we must rule out this alternative hypothesis.

In the current studies, we developed a new methodology – again based on competition with a conspecific – that enabled us to pursue two goals. First, it enabled us to directly compare the hypothesis that chimpanzees sometimes know what others know to the new evil eye hypothesis. Second, it enabled us to compare chimpanzees in both a test for knowledge–ignorance and a test of false belief understanding using the same basic methodology. The general method was a "game" in which subject and competitor took turns back-and-forth choosing from a row of three opaque buckets, some of which contained food. In the key condition in the test for knowledge–ignorance in Study 1, the task for the subject was to determine which bucket might still contain food after the competitor had chosen a bucket for himself – given that the subject had seen that competitor witnessing the hiding of one of

[1] Hare et al. (2000) focused on chimpanzees' understanding of visual perception. Karin-D'Arcy and Povinelli (2002) failed to replicate this study, but the size of their testing area was too small, which affected the nature of the competition. Braeuer, Call, and Tomasello (2007) replicated the original Hare et al. (2000) findings with a new set of chimpanzees using the correct spacing, and they also demonstrated the crucial role of space in the process. Also, recent studies show that chimpanzee sometimes attempt to conceal their approach to hidden food from a competitor, further evidence of an understanding of visual perception (Hare, Call, & Tomasello, 2006; Melis, Call, & Tomasello, 2006; see also Flombaum and Santos (2005), for similar evidence for rhesus monkeys).