Chimpanzees understand psychological states – the question is which ones and to what extent

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New data suggest that relatively drastic revisions are needed in our theoretical accounts of what other animal species understand about the psychological states of others. Specifically, chimpanzees seem to understand some things about what others do and do not see, or have and have not seen in the immediate past, as well as some things about others' goal-directed activities. This is especially so in competitive situations. They clearly do not have a human-like theory of mind, however, and so the challenge is to specify precisely how ape and human social cognition are similar and different.

In our 1997 book, *Primate Cognition* [1], we reviewed all the available evidence and concluded that non-human primates understand much about the behavior of conspecifics but nothing about their psychological states. Indeed, our more general hypothesis was that non-human primates cannot deal cognitively with unobservable causes at all, either in the physical realm or the psychological realm. Thus, they learn very quickly about the relationship between various types of antecedent and consequent events – for example, they learn that when there is a noise nearby their conspecifics will flee – but they do not understand such events in terms of their underlying psychological causes, such as the way that others perceive and are frightened by noises. This position has been echoed by Povinelli and colleagues in several places [2,3].

In the last five years, however, new data have emerged that require modification of this hypothesis [4]. The form that a new hypothesis should take is not entirely clear, but we are now convinced that at least some non-human primates – the research is mainly with chimpanzees – do understand at least some psychological states in others. This does not mean that chimpanzee social cognition is the same as human social cognition, but it does mean that telling them apart just got harder.

Changing findings

At the time we wrote our 1997 book, two of the very few laboratories actively investigating the social cognition of apes using experimental methods were ours and Povinelli's. And both laboratories were turning out negative findings with some regularity. Our laboratory had much trouble finding any evidence that chimpanzees or other apes understood the intentions or goal-directed actions of others as they attempted to learn from them socially (see [5] for a review) or as they attempted to cooperate with them (two failed experiments, never published). For their part, Povinelli *et al.* [6] found, contrary to their own previous findings, that chimpanzees do not seem to understand that humans who have witnessed an event know more about it than those who have not. And Povinelli and Eddy [7] reported a series of experiments in which chimpanzees begged for food indiscriminately from humans who either could or could not see them (e.g. one was looking at them but another had a bucket on her head).

Both of our laboratories also had trouble finding skilled chimpanzee behavior in the so-called object-choice paradigm. In this paradigm a human (or in one case a chimpanzee) either looks at, points to, or places a marker on top of one of two opaque containers – and from previous experience the subject knows that there is food in one of them. In this situation chimpanzees most often choose randomly, seemingly failing to read an obvious communicative cue (see [8] for a review), or else they can be shown to be using a learned discriminative cue [2]. In all, experiments from both laboratories provided no evidence that chimpanzees or other apes understand any psychological states at all.

But a variety of observations suggested to us that chimpanzees might understand some things about the visual perception of others. For one thing, we had found in a study of gestural communication that chimpanzees produce visually based signals only when the recipient is already looking and so potentially able to see them [9,10]. And what Povinelli and Eddy [7] actually found in their communication experiment was that chimpanzees did discriminate situations in which one human was facing them and another had her back turned; their lack of skill in other conditions concerned more subtle discriminations involving the role of the eyes specifically [11]. On the basis of these observations, we decided to embark on a program of research investigating what chimpanzees know about what others can and cannot see.

Understanding what others see

In our first study, we simply showed experimentally that chimpanzees and other primates systematically follow the

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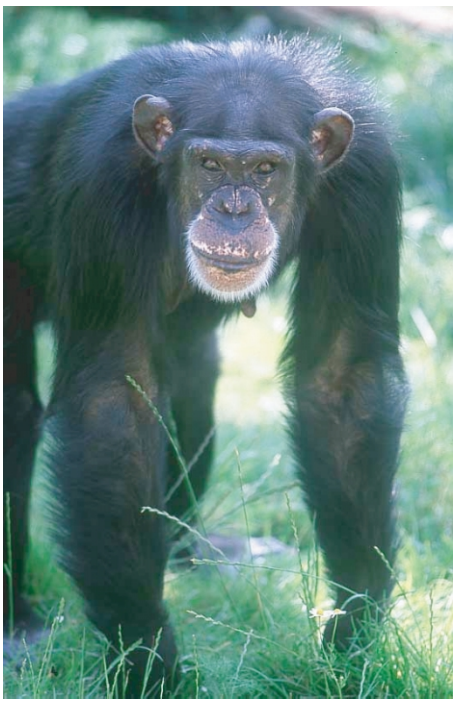

Fig. 1. *Pan troglodytes* or common chimpanzee.

gaze direction of conspecifics [12] (Fig. 1). But this behavior could simply reflect a tendency to look in the direction others are looking, and then to search randomly for something interesting – with no understanding of specifically where the other is looking. In a follow-up study, therefore, a human looked behind a barrier, down into a gutter, or into an adjoining room, to see if chimpanzees would move so as to obtain a good viewing angle on the specific target the human was looking at [13]. They did. In another study, chimpanzees even looked back to the experimenter if they followed his gaze direction and found nothing there [14]. But it is still possible that these studies demonstrate only that chimpanzees look to specific locations that others are looking at – so-called geometric gaze following – without understanding anything about the content of what others are seeing (i.e. without a mentalistic interpretation).

Then came our breakthrough experiments. In the first set of studies we put a subordinate and a dominant chimpanzee in competition over food (see Box 1). The trick was that sometimes the subordinate could see a piece of food that the dominant could not see due to a physical barrier of some sort. The general finding was that subordinates took advantage of this situation in very flexible ways – by avoiding the food the dominant could see and instead pursuing the food she could not see (and even showing a knowledge that transparent barriers do not block visual access). In the second set of studies (see Box 2) a subordinate watched a human place food on her side of a barrier and also observed whether or not the dominant had watched the hiding process (the dominant's door was either open or closed during the hiding). When released to compete for the food, subordinates seemed to know whether the dominant had just witnessed the hiding process a moment before. That is, when her door was opened the subordinate avoided the food the dominant had seen being hidden (even though the dominant could not see it now) and instead pursued the food the dominant had not seen being hidden (also not currently visible to the dominant) – anticipating her competitive behavior on the basis of her presumed visual experience some moments before. And subordinates attached this knowledge not just to dominants in general, but to specific individuals (see control condition described in Box 2).

Recently, Povinelli and Giambrone [3] have offered a different explanation for the first set of experiments. They suggested that subordinates might simply prefer food next to barriers over food out in the open, without monitoring the dominant's perceptual access at all. We ran a control condition with subordinates in a non-competitive situation, and they did not prefer food next to barriers. But still it is possible that in competitive situations they do have

Box 1. Knowing what others see

A dominant and a subordinate chimpanzee compete for food, with only the subordinate having information about the location of the second piece of food [23] (Fig. I).

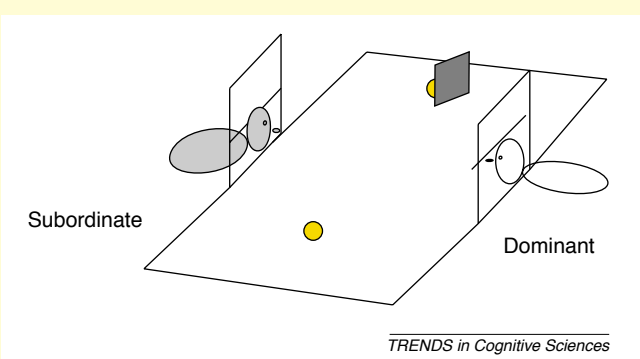

Fig. I. Experimental set-up in the food-competition experiments. Reproduced with permission from Ref. [4].

Method: Subordinate (S) and Dominant (D) chimpanzee in rooms on opposite sides of a middle room, each looking under cracked guillotine door to see food (F) and each other. S and D released into middle room, with S given a brief head start.

Main experiment: S and D see one F in open and only S sees other F on her side of barrier.

Result: S goes for F on her side of barrier more than F in open.

Interpretation: S knows what D can and cannot see.

Alternative hypotheses and control conditions

(1) *S is reacting to D's behavior*. But S has a head start and so is forced to choose before D's door is opened.

(2) *D looks under door at F in open and intimidate S*. But sometimes D's door is down when S makes her choice and so intimidation is not possible.

(3) *S prefers F next to a barrier*. But when S is given a choice of F in open or F on her side of a barrier in non-competitive situations, no preference.

(4) *S thinks barrier impedes D in getting F*. But when F is on S's side of a transparent barrier, S stays away from it.

Box 2. Knowing what others know

A dominant and a subordinate chimpanzee compete for food, with either one or both of them (in different experimental conditions) observing the hiding process [24] (Fig. I).

Method: same as in Box 1 except that there are two barriers and one F (on S's side of one barrier).

Main experiment: (a) *Control condition*: S and D watch hiding process; (b) *Experimental condition*: only S watches hiding process

Result: S goes for F more in Experimental condition than Control condition.

Interpretation: S knows what D has and has not seen in immediate past.

Alternative hypotheses and control conditions

(1) *S prefers F next to a barrier when competing*. But in both conditions F is situated identically – next to a barrier.

(2) *When D watches hiding she puts evil eye on F being hidden and S stays intimidated*. But (a) in a separate experiment the D who has witnessed the hiding process is switched (or not, in a control condition) for another D who has not witnessed the hiding process, and S goes for F more when D is switched than when not; and (b) in a separate experiment S and D watch F being hidden but only S watches it being moved to a new location – and S does not then avoid it even though D has looked at it previously.

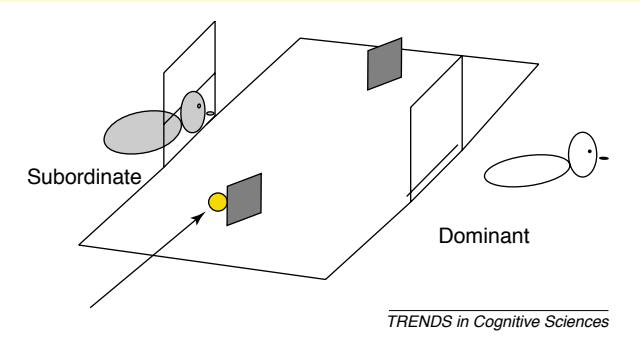

Fig. I. Experimental set-up in the second set of food-competition experiments. Reproduced with permission from Ref. [4].

such a preference. However, in the second set of experiments this explanation does not apply, since there was only one piece of food in both experimental conditions and both were next to a barrier. We therefore believe that these studies show what they seem to show, namely, that chimpanzees actually know something about the content of what others see and, at least in some situations, how this governs their behavior. Interestingly, they also seem to know this about themselves and their own behavior in some situations as well [15].

Why were these experiments successful where others, including some of our own (for example, [16]), failed to show any evidence of chimpanzees understanding psychological states? The crucial factor, we believe, is that previous experiments required chimpanzees to follow a communicative sign to the location of food, and this situation is not well adapted to their natural cognitive abilities. In their natural habitats chimpanzees basically never indicate for one another the location of a food that they themselves could take. They compete for food, sharing it only in special circumstances, and communicating its location for others (while taking none themselves) virtually never. Our later experiments thus simulate more natural food competition situations, as opposed to unrealistic situations in which chimpanzees communicate about monopolizable food resources [17]. Interestingly, not all animals show this same advantage for competition over cooperation; in particular, domestic dogs use very powerful social-cognitive skills when communicating with humans (i.e. they outperform chimpanzees in object-choice tasks; see [18]).

Understanding intentional action

We have also been engaged in another line of research that has made us rethink our previous ideas about chimpanzee social cognition, although in this case we have much less data. The question is how chimpanzees understand intentional action, a complex and multi-dimensional question. In a recent study, we presented chimpanzees with a human who had food in his hands and then behaved in a variety of different ways indicating that he was either unwilling (three conditions) or unable (six conditions) to give them the food (Call *et al.*, unpublished results). We matched conditions with one another so that the general behavior of the human, including his looking activities, were similar across the various unwilling and unable conditions. The main finding was that chimpanzees were more impatient banged on the cage more, left the area sooner when the human was being intransigent (unwilling) than when the human was making a good faith effort (unable), even though in neither case did they get the food.

Importantly, the findings were strongest in those conditions in which the human specifically acted on the food – e.g. used it to tease the ape (unwilling) or had an accident with it (unable) or was trying to extract it from a tube (unable), as opposed to conditions in which there was little action – e.g. the human just stood there (unwilling) or could not see the food (unable). This is important because it means that the cue the apes used for identifying intentional behavior was perceptible in it – Searle's intention in action [19] – involving physical signs of such things as effort, trying, frustration, and satisfaction. This study thus provides important confirmation for our previously reported finding, using a different methodology, that chimpanzees discriminate between intentional and accidental actions – also manifest in perceptible characteristics of behavior [20].

A new hypothesis

We are currently collecting more data on what chimpanzees understand about what others can and cannot see in different situations, and so far the results tend to support our most recent positive findings. We are also exploring further what chimpanzees understand about intentional action, for example, whether they can read intentions based on contextual cues rather than on cues immanent in the behavior itself. We do not want to go too far in our theorizing until these results are collected, but for the

moment we feel safe in asserting that chimpanzees can understand some psychological states in others – the question is only which ones and to what extent.

With regard to visual perception, we propose that by monitoring the gaze direction of others (mostly head direction), chimpanzees know what others see, and they know that barriers at a certain angle block visual access. They also know whether an individual has seen something in the immediate past. With regard to behavior, chimpanzees know something about intention in action. They apparently can see such things as effort and frustration and satisfaction as signs of what the other person is doing and is about to do next. These two kinds of understandings are interrelated in that an individual chimpanzee can use information about what another sees to predict what he or she will try to do next – especially in competitive situations. We thus hypothesize that chimpanzees – and perhaps other animal species – possess a social-cognitive schema enabling them to go a bit below the surface and discern something of the intentional structure of behavior and how perception influences it.

But at the same time it is clear that chimpanzees do not have a full-blown, human-like theory of mind. For example, in contrast to human children chimpanzees may not understand in visual perception such things as attention (understanding that others may attend to different things within the same gaze direction) and perspective (imagining how things appear from different viewing angles). And again in contrast to human children, chimpanzees may not understand in behavior such things as prior intentions (not easily perceptible) and communicative intentions (intentions towards others' psychological states). And there is no evidence anywhere that chimpanzees understand the beliefs of others. It would thus seem that at some point in recent evolution human beings found a way to comprehend and deal with a much wider variety of psychological states than their nearest primate relatives – perhaps involving cooperative/communicative/cultural aspects (based on an appreciation of self–other equivalence [21]; see Povinelli and Vonk [22], this issue, for an alternative proposal.)

The stakes here are large. At issue is no less than the nature of human cognitive uniqueness. We now believe that our own and others' previous hypotheses to the effect that chimpanzees do not understand any psychological states at all were simply too sweeping. We believe that the way forward in research on chimpanzee social cognition is to 'turn up the microscope' so as to see which of the many different kinds of primate psychological states chimpanzees are able and not able to comprehend, and in what precise ways.

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