

Do chimpanzees use their gestures to instruct each other?

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Several years ago, we asked ourselves the following question: when chimpanzees co-ordinate their activities to achieve what on the surface appears to be a common goal, is this co-operation mediated by an understanding of each other's mental states? In this chapter, we offer our preliminary answer to this question—a question that remains undeniably important in efforts to reconstruct the evolution of social understanding.

Co-operative behaviour among chimpanzees (and other nonhuman species) is fairly common. First, chimpanzees and other social primates form complex, shifting social coalitions which involve both related and unrelated individuals. When called into action, such coalitions typically manifest themselves as two or more individuals acting in a co-ordinated manner against another. The complexity of the behaviours that emerge from such coalitions may tempt the inference that the animals involved are reasoning about the moment-to-moment goals of their coalition partners, as well as how these tactics fit with an overall strategic objective (see de Waal 1982). Second, chimpanzees regularly hunt for food, and in many cases these hunts involve collaboration among several individuals. Here, the individuals involved may deploy different, but complementary roles in order to successfully catch the prey (see Boesch 1994).

Although the sophistication of such carefully-timed and co-ordinated behaviours among chimpanzees is impressive, recent experimental evidence has tended to suggest that these animals do not explicitly reason about the mental states of others (for recent reviews see Povinelli and Prince 1998; Tomasello and Call 1997). Despite this general trend, however, one early experimental study of co-operation among chimpanzees conducted by Meredith Crawford (1937) did provide some tantalizing (if limited) evidence that these animals might appreciate limited aspects of the attentional states of a co-operative partner. In particular, some of the results of this work suggested that the chimpanzees used their naturally-occurring gestures (albeit infrequently) to direct the behaviour of their partners. Interpreting these results has proven difficult, however. Were these gestures produced to influence the other chimpanzee's mental state, or just his or her behavioural state, or both? In reflecting on this question, we decided to investigate our chimpanzees' use of gestures in a co-operative task in which one chimpanzee would be experienced (and thus would know how to perform the task) and another chimpanzee would be naive (and thus would not know how to perform

the task). We reasoned that this pedagogical context might provide greater motivation for the experienced chimpanzee to use simple instructive gestures (showing, pointing, leading) to direct his or her partner.

Before we report the results of this experimental research, we consider the emergence of human infants' use of gestures (such as pointing) to influence the mental states of others, and grapple with several theoretical problems related to comparing human and nonhuman social understanding.

GESTURING TO MENTAL STATES?

Before children use words to direct the actions of others, they use gestures. Like words, these gestures influence various mental states of the adult to whom they are typically directed. However, because adults attribute a wide range of meanings to these gestures, it is difficult to know at what point the infants themselves are intentionally trying to influence or appeal to the mental state of the addressee. The case of pointing is particularly instructive. Elizabeth Bates and her colleagues offered a (now widely-adopted) scheme in which pointing and other gestures (such as reaching) are divided into proto-imperative versus proto-declarative acts (Bates *et al.* 1975). However, a uniform application of this distinction has proven difficult. For example, some researchers have argued that the first pointing gestures of an infant merely reflect that infant's desire to obtain a particular object, or to elicit some emotionally salient reaction from an adult, with no explicit consideration of any psychological states of the addressee (i.e. that they are proto-imperative; Moore and Corkum 1994; Vygotsky 1962). In contrast, some see even the earliest pointing gestures as motivated by the infant's understanding of the referential significance of the gesture and/or the subjective states of the addressee (i.e. that they are proto-declarative; e.g. Werner and Kaplan 1963). Other researchers have focused on the form of the gesture, and have argued for a distinction between arm extensions with and without index finger extension (i.e. points versus reaches) with only the former reflecting the infant's understanding of the psychological states of his or her communicative partner (e.g. Franco and Butterworth 1996). Still others believe that the crucial criterion for inferring the level at which an infant is considering the partner's psychological states, is whether or not the gesture is accompanied by the infant alternating his or her gaze between the object/event and the addressee (Bates 1976; Franco and Butterworth 1996; Gomez *et al.* 1993). Finally, it is even possible that proto-imperative and proto-declarative gestures imply similar levels of understanding of the psychological (i.e. attentive) states of others (Gomez *et al.* 1993).

A number of problems exist with these proposed means of determining the function/meaning of infants' early gestures. First (and perhaps foremost), it is clearly not possible to carve up reaches and points as gestures that have uniquely imperative or declarative functions, respectively. After all, the function of any given gesture would appear to depend on the context in which it is used. For example, in typical infant development, the pointing gesture is often used in a non-declarative manner (Bates *et al.* 1975). Furthermore, individuals with autism regularly use the pointing gesture in

imperative contexts, but rarely, if ever, in situations in which the central goal of the social interaction is to share interest with others (Baron-Cohen 1989; Goodhardt and Baron-Cohen 1993; Mundy *et al.* 1986). In addition, reaches are deployed in situations where the child is checking the attention (and possibly even the knowledge state) of their partner (O'Neill 1996). Second, the pointing gesture itself may occur without alternating gaze, in much the same manner that reaching gestures can. There would seem to be no reason why the topographic form of the hand uniquely determines whether an infant is reasoning about the attentional state of a communicative partner. Third, monitoring the eyes or face of another (i.e. gaze alternation) may not be a reliable indicator of a capacity to understand the other's attentional state (Moore and Corkum 1994; Povinelli and Eddy 1994; Tomasello 1995). It is possible that the production of both proto-imperative and proto-declarative gestures on the one hand, and gaze-monitoring on the other, are separately functioning systems which initially become linked not because of the emergence of the infant's understanding of the mental states of others, but due to an increasing sophistication at predicting the effects of their gestures on the behaviour of others. However, several lines of research implicate eighteen to twenty four months of age as a period in which infants become explicitly aware that specific gestures such as looking and pointing are connected to internal attentional states (e.g. Akhtar and Tomasello 1996; Baldwin 1993; Moore *et al.*, in press; Tomasello and Barton 1984).

USING GESTURES TO INSTRUCT OTHERS

In considering whether chimpanzees gesture in order to influence the mental states of those around them, we have considered the case of pedagogy. In a theoretical consideration of the topic, Premack (1984) argued that true pedagogy involves several elements: appreciating the mental state of the student, training or planned intervention into the student's behaviour, and, finally, evaluation or judgement (to determine whether further intervention is necessary). The case of pedagogy is of central interest to us because it provides a context in which communicative gestures abound, and frequently have clear external referents. For example, in the case of creating material artefacts (e.g. baskets, stone tools, clay pots), gestures by a teacher may frequently be of the type, 'I want *x*', or of the type, 'Look at *x*', or in more complicated cases, a combination of the two ('I want you to look at *x*'). Thus, pedagogical situations may be an especially rich arena in which to examine the appearance and use of gestures that have traditionally been considered to have imperative and declarative meanings.

The remainder of this chapter is divided into three parts. First, we briefly examine the existing evidence concerning the nature of chimpanzees' understanding of their own naturally-occurring gestures. Next, we describe a study that we recently conducted to help clarify the interpretation of previous work which had examined chimpanzees' gestures during co-operative tasks. The results suggest that chimpanzees do not readily exhibit gestures which might be thought of as serving to instruct others—even in situations designed to maximize their likelihood of doing so. Third, and finally, we offer an evolutionary account of how human and chimpanzee

communicative gestures can appear so similar from a structural point of view, and yet differ so dramatically in the psychologies that attend them.

DO CHIMPANZEES UNDERSTAND THAT THEIR GESTURES INFLUENCE THE MENTAL STATES OF OTHERS?

Let us begin by asking a seemingly simple question: do chimpanzees gesture in ways that convince us that they are attending to the psychological states of others? Consider the case of pointing. If we ignore (for the moment) whether chimpanzees display the same topographic form of the pointing gesture (index finger extension), several general statements can be made. First, none of the long-term field studies of chimpanzee social behaviour have reported evidence that this species exhibits pointing as part of their natural gestural repertoire (e.g. Goodall 1986; Nishida 1970), nor have more focused investigations of chimpanzee development reported the emergence of such gestures (Plooij 1978; Tomasello *et al.* 1994).

On the one hand, chimpanzees do possess at least one gesture that structurally resembles pointing: *holding out a hand* (Bygott 1979). However, this gesture does not appear to be used as a generalized indicating or referencing device, but rather appears to be used for the purpose of food-begging, solicitations for bodily contact, or as a means of recruiting allies during conflicts (de Waal 1982; Goodall 1986). Finally, and in contrast to the previous statements, chimpanzees living in captivity do exhibit gestures that look very much like pointing, although they seem to be restricted to their interactions with humans (see Fig. 19.1; Call and Tomasello 1994; Gomez 1991; Krause and Fouts 1997; Leavens *et al.* 1996; Povinelli and Eddy 1996a; Povinelli *et al.* 1992; Savage-Rumbaugh 1986; Woodruff and Premack 1979).

Although there is agreement that chimpanzees exhibit the kinds of gestures depicted in Fig. 19.1, which are often accompanied by gaze-alternation between the desired object and the communicative partner, there is considerable disagreement about the nature of the psychological processes shaping and attending these behaviours. On the one hand, some researchers have leaned heavily on the *argument by analogy* and have concluded that the degree of similarity between human and chimpanzee communicative gestures is so great that the psychological processes underwriting and attending the behaviour between the two species must also be similar (for a particularly straightforward statement of this position as applied to the question of whether chimpanzees 'point', see Leavens *et al.* 1996). Simply put, the argument by analogy states that if we know that a given behaviour in humans is caused by mental state *x*, then the presence of the exact same behaviour in another species provides good evidence that this species also experiences mental state *x* (Hume 1739–1740/1978; see also Darwin 1871; Romanes 1882, 1884; for a formal statement of the argument by analogy as a proof of the existence of other minds, see Russell 1948).

We question this conclusion from several directions. First, as a logical position, the argument by analogy (especially when applied to other species) can be shown to be inherently weak (Povinelli and Giambrone, in press). Second, there are numerous empirical reasons for doubting whether chimpanzees interpret their pointing-like

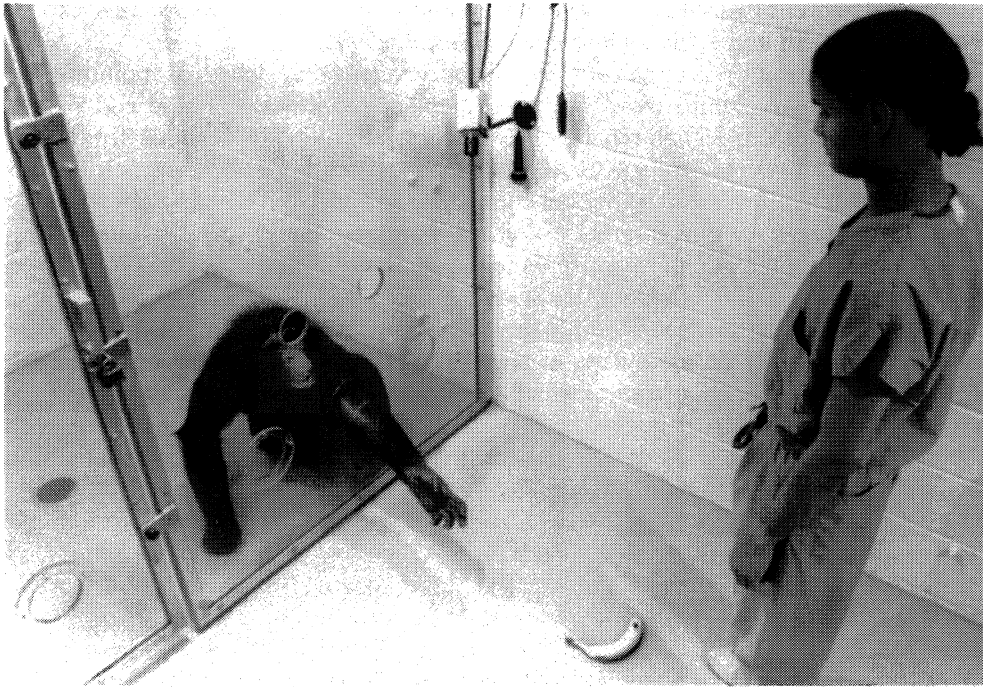


Fig. 19.1. In captivity, chimpanzees use gestures that resemble pointing, and these gestures are frequently accompanied by gaze-alternation between the communicative partner and the desired object. Whether they interpret these gestures in the same manner as human infants and children, however, is a separate question.

gestures in a manner similar to ours. To begin, when humans use pointing gestures to inform chimpanzees about the location of hidden food rewards, chimpanzees appear to rely not on the referential aspect of the pointing hand/finger, but upon its proximity to a particular location. Indeed, despite previous claims that chimpanzees comprehend the referential aspect of pointing (e.g. Call and Tomasello 1994; Menzel 1974; Povinelli *et al.* 1992), more recent studies which have controlled for the distance between the pointing hand and the potential hiding locations have revealed that, unlike two-year-old human children, chimpanzees use simple distance-based cues to guide their searches (see Fig. 19.2; Povinelli *et al.* 1997). Third, an extensive series of recent studies has strongly suggested that even in the context of deploying their most common pointing-like gesture (see Fig. 19.1), chimpanzees appear to be oblivious to the subjective attentional state of their communicative partner (Fig. 19.3; see Povinelli 1996; Povinelli and Eddy 1996a; Reaux *et al.* 1999; Theall and Povinelli in review). Finally, there is good reason to question whether the gaze-alternation that often accompanies such gestures indicates an appreciation of the communicative partner's subjective attentional state. Several lines of evidence suggest that although chimpanzees possess excellent gaze-following abilities, they do not appear to understand the

attentional aspect of gaze (Fig. 19.4; Povinelli and Eddy 1996a, see especially, Experiment 12; Povinelli and Eddy 1996b; Povinelli *et al.* 1999).

How, then, can we account for the incontrovertible evidence of pointing-like gestures in captive chimpanzees? As we explain in more detail at the end of this chapter, we propose that chimpanzees construct pointing-like gestures from their existing behavioural repertoire because humans consistently respond to their actions (such as reaching) in a manner that the chimpanzees themselves do not understand or intend. Indeed, as we have argued elsewhere, this may also be true of the earliest pointing gestures in human infancy (Povinelli *et al.* in press; Vygotsky 1962). However, by eighteen to twenty four months of age human infants may 'redescribe' these gestures in light of their developing theory of mind (e.g. Karmiloff-Smith 1992). Indeed, if these later developments in social understanding are unique to humans, then the behaviours of chimpanzees which structurally resemble pointing may never be understood in a similar manner. The fact that captive chimpanzees do not seem to produce these gestures for their chimpanzee peers, but rather seem to restrict them to their interactions with humans, would seem to be consistent with this view.

EVIDENCE OF PEDAGOGICAL GESTURING IN CHIMPANZEES IN A CO-OPERATIVE TASK?

Despite the fact that current research suggests that chimpanzees may not understand that their gestures influence the mental states of others, it is possible that this is because nearly all such studies have required chimpanzee subjects to reason about human experimenters, not fellow chimpanzees (for an elaborated discussion of this potential problem, see Povinelli 1996; Povinelli and Eddy 1996a, Chapter VI). Thus, one possible context in which we might search for evidence that chimpanzees are capable of reasoning about the attentional states of others is in their relatively spontaneous interactions with each other, and, in particular, during their execution of co-ordinated, co-operative tasks.

Sixty years ago, Meredith Crawford (1937, 1941) published a series of studies that examined the ability of young chimpanzees to learn how to co-operate to solve problems. Crawford defined co-operation as 'a description of behavior patterns appearing in situations requiring teamwork—the co-ordinate activity of two individuals working for a common incentive object' (Crawford 1937, p. 3). Since his two studies, there have been few experimental investigations of co-operative behaviour in chimpanzees that have been designed with the aim of determining whether they can reason about a co-operative partner's mental states (Chalmeau 1994; Chalmeau and Gallo 1996; Povinelli *et al.* 1992), despite the fact that Crawford's findings have important theoretical implications about the extent, and limitations, of chimpanzees' social understanding.

In his initial studies, Crawford (1937) reported several intriguing instances of what appeared to be one animal soliciting another animal to assist in a co-operative task. He presented five young chimpanzees with a box-pulling task which required the animals to pull in a box baited with food that was too heavy for a single animal to

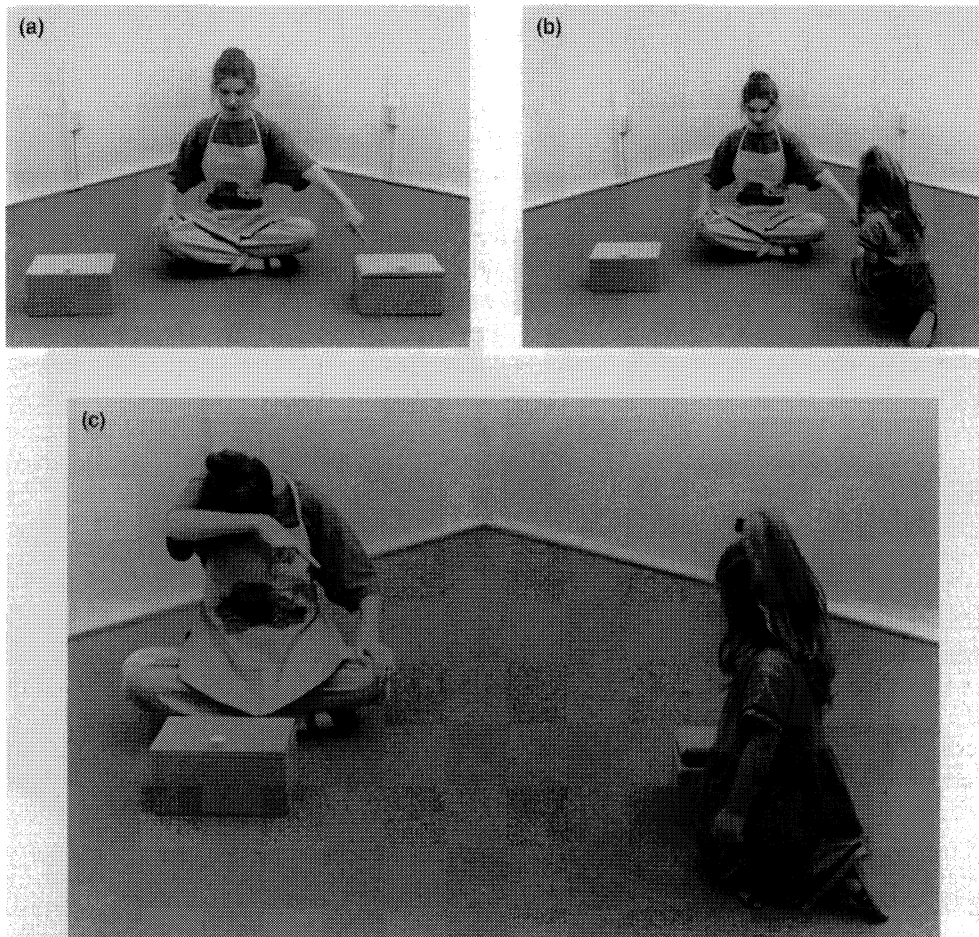


Fig. 19.2. Even in very unusual configurations, human toddlers will choose locations referenced by an adult pointing gesture. In contrast, chimpanzees learn and follow rules such as 'pick the box closest to the experimenter's hand/finger', ignoring the referential significance of the gesture.

move. Crawford described three stages in the development of chimpanzees' cooperative behaviour during this task. The first stage consisted of the simultaneous pulling response of the animals to an external cue (the verbal command, 'Pull!') by the experimenter. The second stage was marked by one animal watching the other animal pull in order to co-ordinate his or her pulling with that of his or her partner. The third stage was reached when 'an animal, with manual gestures, solicited from the partner help in pulling' (Crawford 1937, p. 19). These solicitation gestures included, for example, the behavioural sequence of an animal leaving the area of the box and the ropes, touching the other animal, returning to the ropes, picking up a rope, and then looking back at the animal who had just been touched. Another instance consisted of



Fig. 19.3. Like human infants, chimpanzees (and other nonhuman primates) follow the gaze of others. Despite this, experimental research suggests that they do not come to interpret gaze as a projection of the mental state of attention.

one animal repeatedly putting her hand around the neck of a second animal in situations where that animal was at the ropes but not pulling. This touching action appeared to have the effect of turning the animal's attention back to the task of pulling the ropes. Crawford concluded that the use of solicitation was a generalized method of problem solving that the animals readily applied with any partner, largely because when an animal began to solicit one partner, this behaviour was then shown with subsequent partners as well.

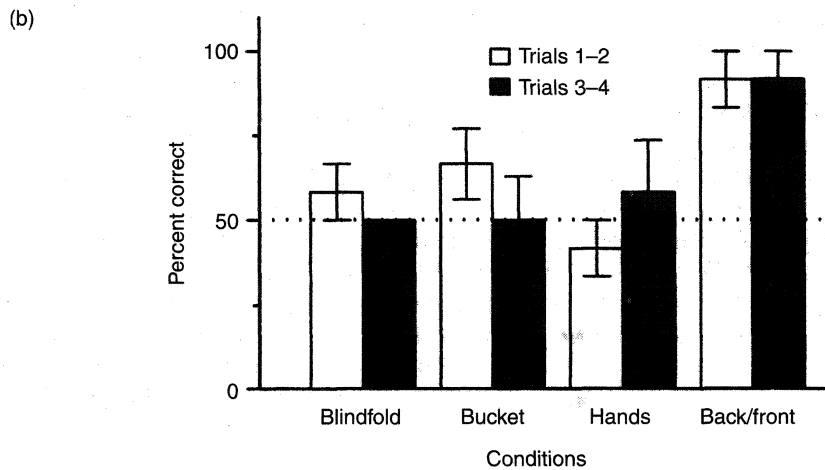
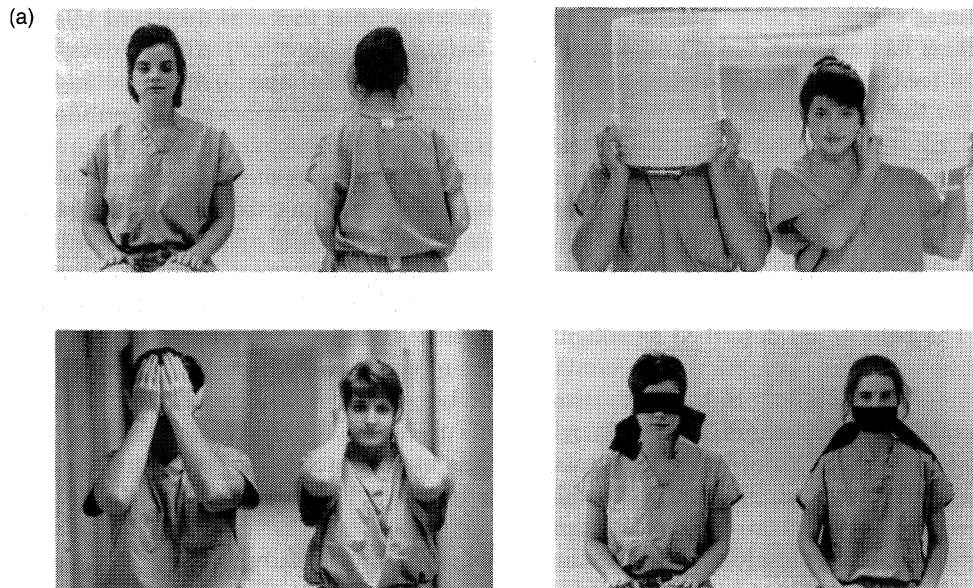


Fig. 19.4a-b. Chimpanzees are just as likely to deploy their requesting gestures to someone who cannot see them as to someone who can.

Although these solicitation gestures may indicate that chimpanzees are capable of manipulating each other's behaviour, there are numerous reasons to be cautious about interpreting them as evidence that chimpanzees are capable of co-ordinating their own perspective on a task with that of another conspecific. First, of Crawford's (1937) seven pairings of animals, only two used solicitation gestures, and only two other pairs reached stage 2. Second, the more precursory behaviour of simply watching the other

animal was not a behaviour that appeared quickly, or one that was displayed reliably once it had emerged. Even in the most rapid case, it was only after twenty five sessions of fifteen to thirty minutes duration, that the first instance of one animal watching the other for a few seconds was observed, and it did not reliably appear again until after forty four sessions. The relatively late appearance of such behaviours in this training raises the clear possibility that they emerged from a process of conventionalization, rather than being actively deployed as a means of influencing the intentions of their partner. That is, the reward contingencies of the task itself may have caused the animals to use existing behavioural patterns in an atypical manner, and more importantly for our purposes, without reasoning about their partners' psychological states.

The behaviours described as solicitation gestures also varied quite widely in their form, with some being less than convincing as attempts to manipulate the other. For example, one animal, Bula, left the area of the box and ropes and went to her partner, Kambi, and then stood, squatted, or jumped up and down, before returning to the ropes. However, Crawford (1937) was cautious in interpreting the meaning of these solicitation gestures, noting that the more convincing solicitation gestures appeared to be largely confined to one particular pair of animals. He suggested that the behaviours appeared to be closely related to other social responses already well documented in chimpanzees, such as begging for food, or tandem-marching.

Moreover, because solicitation was responded to with some activity, but not necessarily with the same behaviours each time, he argued that the meaning of these gestures was probably most appropriately summarized as 'do something for me'. As he noted: 'Certainly there seemed to be no predicative function involved. The solicited animal did not seem to know what to do, and only after trying a number of responses under continued solicitation, was the pulling-in behaviour given, after which solicitation ceased' (Crawford 1937, p. 68). Indeed, in a later study, Crawford (1941) placed the two animals that had previously used solicitation gestures in a situation in which one animal needed to communicate to the other that a specific coloured button (from an array of four) needed to be pushed in order to release food from a vendor. Although there were some instances of one animal appearing to push the other animal in the direction of one of the four coloured buttons, when the animals were prevented from physically manipulating each other by a wire screen, no attempts were ever made to direct a partner to the particular button that needed to be pushed.

RE-EXAMINING CHIMPANZEES' USE OF GESTURES IN CO-OPERATIVE SITUATIONS: AN EXPERIMENTAL APPROACH

We recently conducted an experiment to clarify several ambiguities in Crawford's (1937, 1941) results, as well as those of more recent researchers (e.g. Chalmeau 1994; Chalmeau and Gallo 1996; Povinelli *et al.* 1992). We re-designed Crawford's studies to explore more directly how chimpanzees interpret the actions of a conspecific with whom they are co-operating. In particular, rather than focusing on the *acquisition* of co-operative behaviour, we sought to examine the behaviour of pairs of chimpan-

zees in situations in which only one member was experienced with the means to solve the problem. To this end, we modified Crawford's (1937) box-pulling task in two crucial ways. First, only two animals (of the seven participating in our study) were taught how to co-operate in order to retrieve the box. After acquiring this skill, these two 'experienced' animals were then separately paired with each of the other five 'naive' animals who had not received any experience trying to pull the box with another animal. With this method we sought to determine whether experienced animals would use their gestures to direct the behaviour and attention of naive partners to the relevant dimensions of the task, such as ushering them to the ropes, or perhaps even more specifically, (a) handing them a rope or (b) demonstrating the pulling action with a rope and then offering it to them.

A second difference between our study and Crawford's (1937) investigation, is that we elected not to overtrain the experienced animals on the task of co-operating to pull the box together. Instead, we trained them only until they were performing their co-operative acts reliably. We explicitly chose this strategy because we wanted to avoid the problem of having these two animals unknowingly train themselves to exhibit solicitation gestures in this context, and thus having these gestures become routinized. Rather, we sought to determine whether the experienced animals, when confronted with the incompetence of a naive partner, would (a) solicit the naive animal to assist them, and/or (b) attempt to direct the naive animals' attention to the relevant dimensions of the task.

METHOD

Subjects

The subjects were one male (Apollo) and six female (Kara, Candy, Jadine, Megan, Brandy, Mindy) chimpanzees ranging in age from six years three months (6;3) to 7;1 when the study began. Two of the subjects were selected to serve as the experienced subjects, and the remaining five served as the naive subjects. The experienced subjects were chosen by selecting the oldest subject (Kara) and then randomly selecting another subject from the group (Brandy). The subjects were born and reared at the University of Southwestern Louisiana New Iberia Research Center. The subjects had been reared together since infancy, and became part of a long-term cognitive research program when they were two to three years old. A detailed history of their rearing and experimental histories can be found elsewhere (Povinelli and Eddy 1996). Prior to the research reported here, the subjects had never participated in studies exploring co-operative abilities.

Apparatus and test setting

A large box (52 × 40 × 57 cm) was constructed into which weights could be placed (see Fig. 19.5). A top covered the front third of the box and served as a location to place food rewards. Two 165 cm length ropes were attached to the bottom front of the

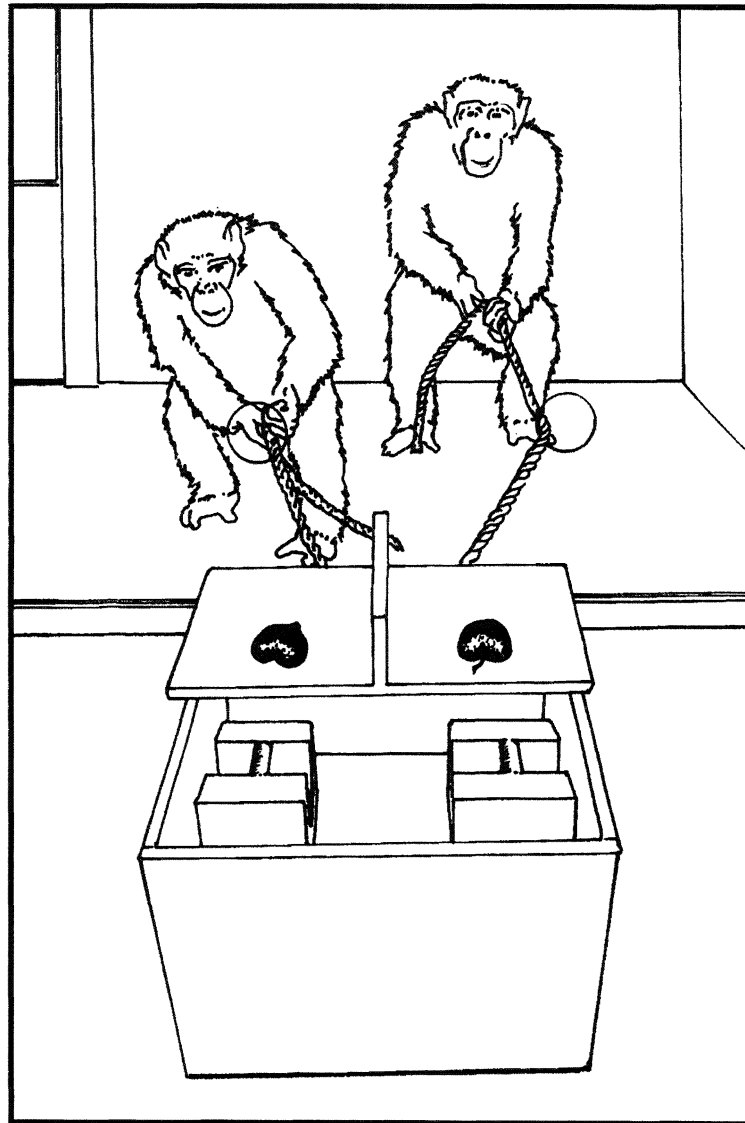


Fig. 19.5. General setting and apparatus for the co-operative box-pulling task. Final stages of training for the two experienced subjects (Kara and Brandy) is depicted. Box is too heavy for one subject to retrieve alone. (Figure redrawn from photograph.)

box. A graded set of weights were used to adjust the weight of the box (see below). All training and testing took place inside a plexiglas test unit, with which the animals were intimately familiar (see Fig. 19.5). The plexiglas test unit contained several holes through which the subjects could easily reach.

Procedure

Training to retrieve unweighted box

This phase was conducted in two parts. In the first part, the box-and-rope apparatus was introduced to the two experienced subjects separately. The box was placed 120 cm from the front of the plexiglas partition (approximately 60 cm beyond the subjects' maximum reach), and the ropes were placed through two holes in the partition (see Fig. 19.5). A subject was then ushered into the test unit and the shuttle door was closed behind her. The trainer placed a food reward on top of the box and drew the subject's attention to it. The trainer used a variety of methods to demonstrate how to pull the box toward the partition in order to retrieve the food (e.g. using the ropes to pull the box toward the partition, pushing the box, playing with ropes, etc.). After initially experiencing the training individually, the subjects were paired together for one session in order to allow the less adept subject to witness the other subject pulling the box to within reach. Once the subjects were comfortable being closed in the test unit, pulling the box to within reach, and retrieving the food (Kara = 4 sessions, Brandy = 3 sessions), they advanced to the second part.

In the second part, formal training was conducted in sessions (typically one per day) consisting of eight trials. On each trial the box, ropes, and food were configured as before while the subject waited in the outdoor run. The trainer then opened the shuttle door, the subject entered, and the door was closed behind her. Without prompting from the trainer, the subject's task was to pull the box to within reach and retrieve the food reward. If the subject retrieved the reward within sixty seconds the trial was scored as correct; if they did not, the trial was scored as incorrect. At the end of each trial, the subjects were ushered outside so that the next trial could be configured. The subjects were required to complete two consecutive sessions with a cumulative total of 15/16 correct responses or better before advancing to the next phase.

Training to retrieve weighted box

The purpose of this phase was to determine the maximum weight of the box that each of the two subjects could individually retrieve. Each subject was tested separately in sessions consisting of eight trials. The weight in the box was gradually increased until on two separate trials the subject tried, but failed, to retrieve the box. (Additional details of this training procedure are available from the authors.)

Co-operative training to retrieve weighted box

Having established the maximum weight that each of the experienced subjects could retrieve on her own, we next trained these subjects to co-operate in order to pull a box that was too heavy for either of them to retrieve alone. The subjects were tested together in sessions of five to ten trials. Each trial began with the subjects waiting in the outside area, while a trainer placed food on the box and weighted it according to a predetermined schedule. The weight of the box was increased across trials and

sessions in order to scaffold the animals up to their maximum combined ability. From the first session forward the subjects acted together by both pulling on a separate rope on each trial, although at the initial weight levels their actions were not well synchronized. As the weight of the boxes increased, however, the synchrony of their pulling actions improved until their efforts became fluid and well co-ordinated. The heaviest box successfully retrieved by the two subjects was 114 kg, and this was only with great difficulty. The subjects failed on four separate trials when the box was weighted to 136 kg. The subjects were trained for a total of fifteen sessions.

Pretest orientation to box and ropes for naive subjects

To familiarize the naive subjects with the general conditions of the task, but not with the actual rope-pulling/food-retrieval process, each of the five naive subjects was paired with one of the experienced subjects and ushered into the test unit. The box was already positioned flush against the plexiglas with the ropes completely inside the test unit (thus preventing the naive subjects from pulling the box or witnessing the experienced subject pulling the box). The trainer handed both subjects food rewards *ad libitum*. Each trial lasted two minutes. The five naive subjects received two four-trial sessions of this type, one with each of the two experienced subjects. The naive subjects were thus familiarized with the procedure of being closed in the test unit with another animal, and had an opportunity to inspect and manipulate the ropes before actual testing began.

Testing

Each of the experienced subjects was paired in an exhaustive, random order with each of the naive subjects, as well as the other experienced subject, on four separate occasions. Each pairing constituted a test session and was composed of four trials. Three of these trials were test trials in which the box was too heavy to be pulled by the experienced subject alone. On the remaining trial, the box was light enough for the experienced subject to retrieve the box by pulling it toward her, without assistance from the other subject. This trial served as a means of keeping the experienced animal motivated to at least attempt to retrieve the box during each session. This trial was randomly assigned as either Trial 2 or 3, within the constraint that across sessions it occurred equally often in both positions.

Each trial began with a pair of subjects in the outdoor waiting area. The rope-and-box apparatus was set up in front of the test unit as in Phase 2. The trainer then opened the shuttle door allowing the pair to enter the test unit. Once inside, the shuttle door was closed behind them, and remained closed for four minutes. The trainer sat in a neutral position against the back wall of the room and stared at the box. If the subjects did not successfully pull the box in after two minutes, the trainer waited for any attempt to pull the rope by either subject, and if they did attempt to pull it, he pushed the box approximately 30 cm toward the subjects, and then returned to his position along the wall. The purpose of this procedure was to maintain the experi-

enced animal's interest in the possibility of moving the box. A visual record of each trial was acquired using a remote video system.

Coding of videotapes

All videotapes were coded by a student who was blind to the purpose of the study. For each pair of animals, each of the four five-minute trials per session was coded. Coding began from the moment the enclosure door opened and the animals entered the test lab. Coding stopped once the animals were ushered out of the enclosure after four minutes, or once one or both of the animals first obtained the food from the box, whichever came first. During the four minute duration of the trials, the animals performed many actions that were not related to the task at hand (e.g. swinging from the top of the cage). To focus the coding process on behaviours relevant to our research questions, we defined a number of target behaviours that we believed were related to the goal of co-operatively pulling in the box:

Solicitation

This was defined as any gestures used by one animal to indicate to the other animal to come over to the ropes or to pay attention to the ropes. These included both solicitation and proto-declarative gestures.

Physical manipulation

This was defined as any physical contact by one animal with the other with the goal of ushering the other animal to the ropes. Physical contact in the context of fighting or playing was not included.

Offers/takes rope

This was defined as any instance in which one animal either offered a rope to another animal, or took a rope from the other animal.

Alone pulling at the ropes

Each instance in which either animal was alone at the ropes pulling on one or both of the ropes was noted. The pulling actions ranged from tugging at the ropes lightly (but not simply handling the ropes) to 'all-out' pulling in which the animal was upright on his or her legs and pulling forcefully with both hands in a characteristic 'tug-of-war' stance. The situation of being alone pulling at the ropes was defined in terms of the other (non-pulling) partner's distance from the ropes. If that partner was not within arm's reach of the ropes, then the pulling partner was defined as being alone pulling at the ropes.

Looks to partner while alone at the ropes

A look was defined as a visual orientation towards the other animal of a duration of more than one second that involved a definite head turn. Each instance in which an animal at the ropes (while pulling or not) looked at their partner who was not within arm's reach of the ropes was noted.

Looks to partner while both at the ropes

Each instance in which one animal looked at the other animal while both were within arm's reach of the ropes was noted. This variable would capture any instances of what Crawford (1937) described as one animal 'watching' the other.

Reliability coding

Thirty per cent of the sessions were coded independently by a second student who was also blind to the purpose of the study. Percent agreement for each of the variables coded was: 100% for physical manipulation, 100% for solicitation gestures, 100% for offers/takes rope, 96% for alone pulling at the ropes, 87% for looking to partner while alone at the ropes, and 84% for looking to partner while both at the ropes. In all cases the data from the first coder were used for analysis.

RESULTS

Our main results concern whether the experienced animals attempted to influence the attention and behaviour of the naive animals, and not so much whether the experienced-naive pairs succeeded in co-operating to retrieve the weighted boxes. Nonetheless, we begin by describing these general results to provide an overall framework for what occurred during testing.

Successful box retrievals

First, as we expected, the experienced-experienced pair of animals (Kara-Brandy) were successful on 5/6 of the heavy box trials they received in Sessions 1 and 2 combined. Second, of the ten pairings that occurred in Session 1 (Kara with her five naive partners and Brandy with her five naive partners), eight were never successful in retrieving the heavy box. One of the pairings (Brandy-Megan) resulted in 2/3 successful heavy box retrievals, and one resulted in 3/3 successful heavy box retrievals (Kara-Megan). In both cases, an analysis of the videotape revealed that the naive animal that was involved (Megan), apparently discovered how to pull on the ropes quite independent of any actions taken by her partners. Finally, of the ten pairings that occurred in Session 2, seven were never successful. One pairing was successful on two trials (Brandy-Megan), and two of the pairings (Kara-Megan and Kara-Apollo) were successful on three trials. To summarize, in the vast majority of cases, the experienced-

naive pairs did not successfully retrieve the heavy boxes, although the experienced-experienced pair did so readily.

Analysis of behavioural interactions

Our main results concern what the experienced animals did in response to the naive animals' lack of joint action. In order to explore this, we separately compared the behaviours of the two experienced animals (Brandy and Kara) with the behaviours of the five naive animals with whom they were each paired. (Due to extraneous factors, the results for one pairing with Brandy [Session 1, Trial 2] are not available. Thus, the results of this trial are based on her pairings with the remaining four naive animals.) Only the results for the three trials in each session on which the box was maximally weighted were used in the analyses (i.e. we excluded the one trial per session in which the box was light enough for the experienced animal to pull).

Physical manipulation and solicitation gestures

The most critical variable coded was whether the experienced animals attempted to physically direct or solicit the naive animals' attention to the relevant features of the task. The results indicated that they did not. *Across all sessions and trials, not a single instance of physical manipulation or the use of a solicitation gesture was observed.* Thus, the most direct means by which the experienced animal could have attempted to influence the behaviour of its naive partner was simply never observed—despite the fact that these behaviours were part of their natural behavioural repertoire.

Takes or offers rope

Another fairly direct manner in which the experienced animal might have directed the naive partner to the task would have been to hand him or her the ropes. Indeed, eight instances of taking a rope were recorded. However, five of these were of an experienced animal *taking* a rope from a naive partner, and three were of a naive partner taking a rope from an experienced partner (without a prior offer). Across all sessions and trials, there was only a single instance of a rope offer, and this was of a naive animal offering a rope to the experienced partner.

Pulling while alone at the ropes

Figure 19.6 shows the mean frequency with which Kara and Brandy and the other animals paired with them were alone pulling at the ropes across each of the three heavy box trials of Sessions 1 and 2. Apart from Trial 1 of Session 2 for Brandy and her partners, as expected, the experienced animal was always observed to be alone pulling at the ropes more often than the naive animal. This is important because it nicely demonstrates a fact that is obvious from observing the video records; namely, that the experienced animals were motivated and interested in retrieving the box even when they were paired with the naive animals. The mean frequencies of alone pulling

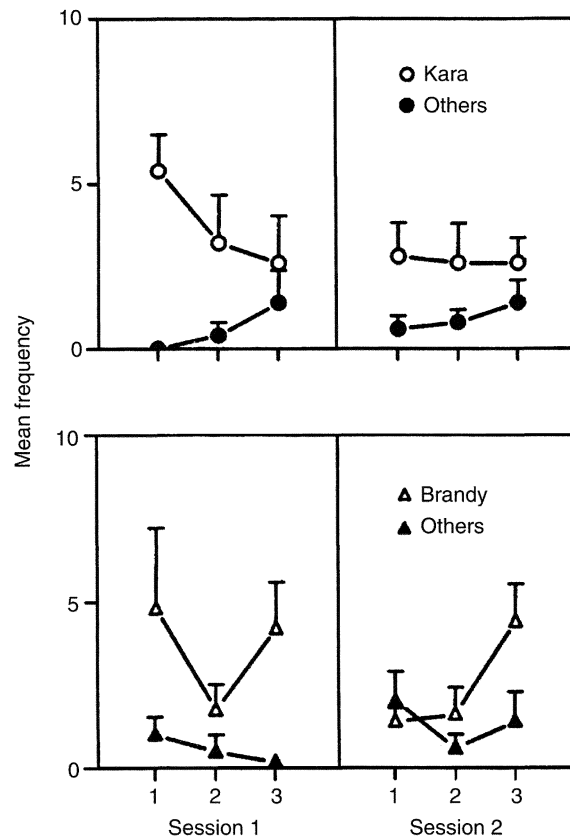


Fig. 19.6. Mean frequency (\pm SEM) of the behaviour, Alone Pulling at the Ropes, for experienced subjects (Kara, Brandy) and their respective naive partners across individual trials of Sessions 1 and 2.

at the ropes, collapsed across trials for Sessions 1 and 2 for Kara and Brandy versus their naive partners, are shown in Table 19.1.

Paired *t*-tests confirmed that Brandy was alone pulling at the ropes significantly more often than her naive partners in Session 1 ($t[13] = 2.96, p = .01$), but not in Session 2 ($t[14] = 1.36, n.s.$). However, Kara was alone pulling at the ropes significantly more often than her naive partners in both Session 1 ($t[14] = 3.59, p = .003$) and Session 2 ($t[14] = 2.63, p = .02$).

The effort that the experienced animals expended in generally fruitless attempts to pull in the maximally weighted box stands in stark contrast to the small number of times the naive animals attempted to do likewise. One might have expected that, over the six total trials (Sessions 1 and 2 combined), the naive animals might have attempted to mimic this behaviour. However, there was little indication that this occurred. First, on 82% of the trials, the naive animals made no attempts at all to pull at the ropes, as compared with 32% of the trials for the experienced animals.

Table 19.1. Mean frequency of target behaviours in Study 1 (box-pulling task)

Target behaviour	Session	Kara	Kara's partners	Brandy	Brandy's partners
pulling (alone at ropes)	1	3.73	0.60	3.58	0.53
	2	2.67	0.93	2.47	1.33
looking to partner (alone at ropes)	1	2.67	1.33	2.75	1.27
	2	3.60	1.73	2.93	3.20
looking to partner (both at ropes)	1	0.60	1.53	0.87	0.80
	2	2.60	3.67	1.40	2.73

Second, Fig. 19.6 reveals no clear pattern indicating an increase in attempts by the naive partners to pull on the ropes across trials. Finally, although 'all-out' pulling was observed with the experienced animals, this behaviour was never seen with the naive animals.

Looking while alone at the ropes

Figure 19.7 depicts the mean frequency with which Kara and Brandy and the other animals paired with them looked at their partner while alone at the ropes for each of the three heavy box trials of Sessions 1 and 2. Perhaps the most obvious result is that the experienced animals were more likely to look at their naive partners than their naive partners were to look at them when alone at the ropes, especially during the first trial of Sessions 1. Indeed, Kara displayed a steady decline in her looking behaviour across trials within each session. This is important, because this decline was not the result of an increase in the number of successful retrievals. In addition, for both Kara and Brandy the frequency of looks to their partner quickly declined, but this decline was not followed by an increase in solicitation or instances of physical manipulation of the partner. Thus, it seems difficult to argue that this looking behaviour was simply one of several solicitation behaviours along a spectrum from passive to active. Alternatively, this decline in looking may be because the experienced animals implicitly understood that the partner should be near the ropes, but did not explicitly represent this fact.

The mean frequencies of looking while alone at the ropes, averaged across the three trials of Sessions 1 and 2 for Kara and Brandy versus their naive partners, are summarized in Table 19.1. Kara looked more often at her naive partners than her naive partners looked at her in both Session 1 ($t[14] = 1.78, p = .048$, one-tailed) and Session 2 ($t[14] = 1.54, p = .07$, one-tailed). Similarly, Brandy looked more often at her naive partners than they looked at her in Session 1 ($t[13] = 2.139, p = .03$), but not in Session 2, and indeed, these results were in the opposite direction ($t[13] = 0.147$, n.s.).

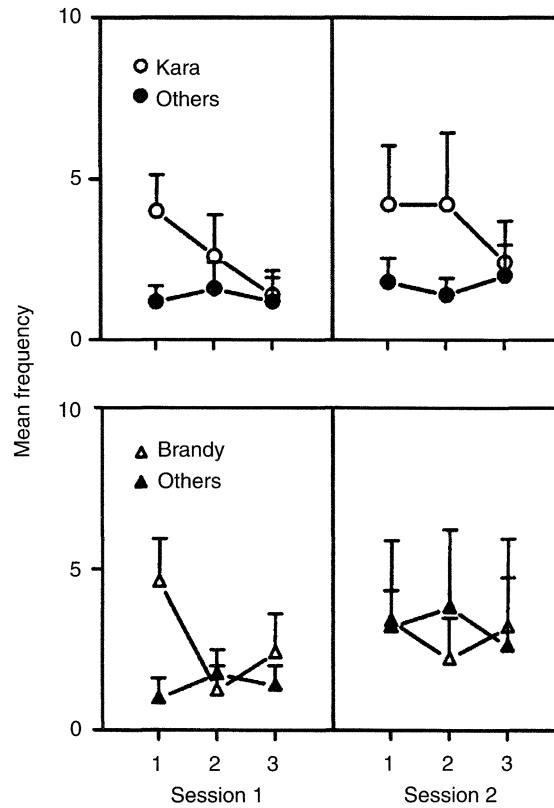


Fig. 19.7. Mean frequency (\pm SEM) of the behaviour, Looks to Partner while Alone at the Ropes, for experienced subjects (Kara, Brandy) and their respective naive partners across individual trials of Sessions 1 and 2.

This latter result was due to a large number of looks ($N = 13$) by one of the naive animals on one trial.

Overall, the behaviour of the animal at the ropes looking to his or her partner who was not at the ropes was observed on approximately the same percentage of trials for the experienced (46%) and naive (54%) animals. However, as shown in Fig. 19.7, the experienced animals were more likely to show this looking behaviour several times throughout a trial than the naive animals were (see also Table 19.1).

Looking behaviour while both animals are at the ropes

Figure 19.8 shows the mean frequency with which the experienced versus naive animals looked at each other while both were at the ropes (pulling or not) across each of the three trials of Sessions 1 and 2. The results for this pattern of looking behaviour differ sharply from those of the previous two. Instead of the experienced animals looking more at the naive animals (see Figs 19.6 and 19.7), on nine of the

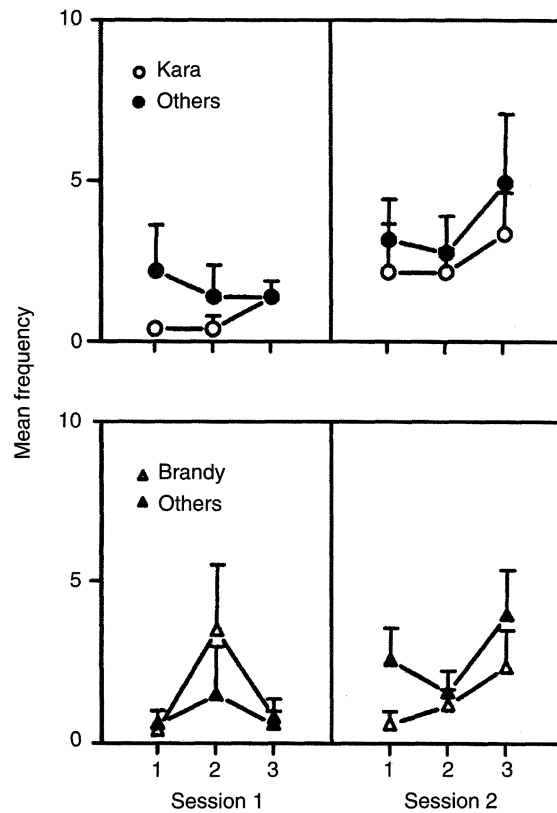


Fig. 19.8. Mean frequency (\pm SEM) of the behaviour, Looks to Partner while Both at the Ropes, for experienced subjects (Kara, Brandy) and their respective naive partners across individual trials of Sessions 1 and 2.

twelve trials shown in Fig. 19.8, the naive animals looked more often at the experienced partner than vice versa. The mean frequencies of the experienced animals and their partners (collapsed across trials within each session) of looking at a partner when both animals are at the ropes, are presented in Table 19.1. The difference in frequency between the experienced and naive animals was significant only for Session 2 for the trials involving Brandy ($t[14] = 2.142, p = .05$), and approached significance for the trials of Sessions 1 and 2 involving Kara ($t[14] = 1.58, p = .07$; $t[14] = 1.45, p = .08$, both one-tailed).

Discussion

The results of our study indicated that the two experienced animals did not use their existing behaviours to either physically re-direct or manually solicit specific behaviours from their naive partners. On the other hand, they did exhibit higher rates of looking at their naive partners when they themselves were alone at the ropes (see Fig. 19.7).

This may have either been a subtle form of solicitation, or a mere recognition that something about the situation was not as it should be (i.e. there was not another animal pulling on the ropes alongside them). Indeed, the fact that the experienced animals' looks to their partners were less frequent when their partners were at the ropes (but not pulling) suggests that in terms of their understanding of the requirements for success, the experienced animals were satisfied with their partner's proximity alone. Indeed, even in the face of repeated failures to retrieve the box by simply pulling by themselves, the experienced animals made no attempts to manually solicit help from their partners, exhibited no instances of physically manipulating their partners toward the task, and made no attempts to gesture toward relevant features of the task (e.g. the ropes, the box, or the food rewards on top of the box).

The main purpose of these studies was to determine whether chimpanzees who were experienced with a given task would spontaneously recruit existing behaviours, such as solicitation gestures and physical manipulation, to solicit or direct a naive partner who was unfamiliar with the task. Our goal was not to demonstrate that chimpanzees could learn to co-operate with each other, or that they could use solicitation gestures, or even that they could physically manipulate each other—these facts have been amply demonstrated in previous studies (e.g. Chalmeau 1994; Crawford 1937; Povinelli *et al.* 1992). Rather, our goal was to use co-operative tasks to ask a different, but straightforward, question: What would a chimpanzee who was experienced on a task spontaneously do to influence the behaviour of a naive conspecific? We explicitly decided not to train the two experienced animals to the point at which they had conventionalized solicitation gestures. Thus, our animals did not have a set of highly scripted behavioural routines that we had shaped in the context of this task which they might then automatically deploy when faced with a naive partner. Thus, our aim was to determine whether the experienced apes would spontaneously deploy these behaviours, before they became conventionalized, when paired with a naive partner. Thus, our findings emerged in the context of pairing an experienced animal with a naive animal—in a sense, a 'teaching opportunity' for the experienced animal. Earlier research had involved pairings of two highly trained animals, or an animal with an adult human, in highly scripted situations.

Although in this sense our results may seem to differ from those of Crawford (1937), who did observe some limited instances of solicitation, we believe that this difference stems from our decision not to provide the experienced chimpanzees with extensive training on the task. Indeed, we have no doubt that if we had trained our experienced animals as extensively as did Crawford, such gestures would have become conventionalized in the context of this task. However, the fact that the experienced animals did not spontaneously recruit behaviours already in their repertoire to assist them in achieving their goal, is consistent with the idea that they were not able to appreciate their partner as a separate psychological agent, whose subjective state needed to be co-ordinated with their own. Indeed, even though Crawford's (1937, 1941) animals did display some instances of solicitation and physical manipulation after extensive shaping, they never attempted to indicate what to do in particular (i.e. their communication did not appear to have a predicative function).

In any event, our results help to clarify some of these previous findings. For

example, Crawford's (1937, 1941) studies found limited evidence of the use of solicitation gestures between two highly experienced animals in a co-operative problem-solving task. Köhler (1927) and Gómez (1991) both reported instances of apes leading humans to locations where the humans could act in ways that would benefit the ape. Rather than standing in contrast to such findings, our studies extend such observations by revealing important potential limitations of chimpanzees' ability to use even such solicitation gestures. In particular, these gestures may emerge through a process of conventionalization (Smith 1977), not a spontaneous reaction to a completely novel problem. Indeed, in a longitudinal project designed to track the development of the communicative gestures of chimpanzees in spontaneous social interactions, Michael Tomasello and his colleagues have concluded that conventionalization is the dominant means through which such gestures are conserved across generations (Tomasello *et al.* 1994). What does appear to emerge quite automatically, however, is the looking pattern that both we and others have observed. Either one animal learns to watch the other animal in order to co-ordinate and time its own behaviour (e.g. Chalmeau 1994; Chalmeau and Gallo 1996; Crawford 1937, 1941), or, as in our studies, the experienced animal looks repeatedly to the naive animal while alone at the apparatus. This looking pattern has also been observed between apes and humans in other problem-solving situations (e.g. Gómez 1991).

Finally, our results are consistent with the view that chimpanzees do not actively teach one another. Even among enculturated chimpanzees, no convincing attempts of teaching have ever been reported (for a range of views on this topic, see Boesch 1991; Byrne 1995; Cheney and Seyfarth 1990; Povinelli and Godfrey 1993; Premack 1984; Tomasello *et al.* 1993). In our study, the absence of attempts by the experienced animals to physically manipulate the behaviour of their naive partner strongly suggests that the chimpanzee's communicative abilities are limited, as Crawford (1937) first stated, to 'a signaling function' and are not 'adequate for directing an animal to perform an act new to it' (p. 84). Even when these gestures are used between two animals highly trained on a specific task, they carry only the meaning 'do something for me' and thereby set off patterns of activity already well-learned and routinized.

Research with preschool human children, in contrast, suggests that by about twenty four to thirty months of age, peers are capable of co-ordinated, joint problem solving which involves one child directing the other (e.g. Brownell and Carriger 1990). This research has suggested that co-ordinated, joint problem solving is related to an ability to represent others as causing their own behaviour (Brownell and Carriger 1990), and that regulation of a peer's activity emerges only after a readiness to imitate a peer's actions (Eckerman and Didow 1996; Eckerman *et al.* 1989). The latter findings pose an especially interesting possibility with respect to potential differences between chimpanzees and children. Indeed, one recent review of the primate literature concludes that if one rules out cases in which apparent copying of motor behaviour can be explained by priming or stimulus enhancement, then few clear cases (if any) exist of one chimpanzee copying the novel acts of another conspecific (Byrne 1995; see also Tomasello and Call 1997; Tomasello *et al.* 1993). If, as Eckerman and her colleagues (Eckerman and Didow 1996; Eckerman *et al.* 1989) have found, regulation of a peer follows the emergence of a readiness to imitate a peer's actions, perhaps it is

the case that the inability of chimpanzees to effectively influence a naive partner's actions is related to a more general inability (or lack of interest) in readily imitating the novel actions of another conspecific.

UNDERSTANDING OTHER MINDS: A HUMAN COGNITIVE SPECIALIZATION?

The findings that we have reported here add to a growing body of evidence suggesting that humans may have evolved a psychological specialization in representing other minds (Povinelli and Preuss 1995; Povinelli and Prince 1998; Tomasello *et al.* 1993). Indeed, there is some reason to believe that this difference may simply be symptomatic of a much more profound difference between humans and other primates, one connected to an ability to represent *theoretical* causes of both social and physical events. For example, chimpanzees may have just as much difficulty in representing unobservable physical causes (gravity, force, space) as psychological ones (attention, desire, belief). If true, their apparent inability to use their communicative gestures in ways that would suggest that they represent the shared attention between themselves and others—the purported psychological basis for the appearance of proto-declarative gestures in human infancy—may be part of a much more fundamental psychological difference between their species and our own.

Some may object to our general conclusion, and insist that, no matter what the results of laboratory experiments, the fact that chimpanzees deploy a rich array of gestural communicative signals, the fact that they practice deception, the fact that they engage in apparently deliberate attempts to work their way up through their dominance hierarchies, and the fact that in social interactions with humans they display behaviours that are undeniably similar to our own, all provide a firm basis for suspecting that they represent each other as psychological agents. Indeed, one version of this argument indicts the entire experimental approach. This argument proceeds as follows: *Every experiment in which chimpanzees participate is contrived by humans and is thus laden with assumptions and biases which obscure the psychological operations that underwrite their more natural and spontaneous social behaviour. Furthermore, because we can use our introspective faculty to identify the psychological states that cause similar social behaviours in ourselves, it is illogical to deny the presence of similar states in chimpanzees.* As we have seen, of course, this is the argument by analogy.

Historically, one of the most persuasive aspects of the argument by analogy has been that there appeared to be no better explanation for the behavioural similarity between humans and other animals (see Povinelli and Giambrone, in press). However, there *is* an alternative point of view—one that reconciles the remarkable similarity between humans and other primates with the striking dissimilarities revealed by recent experimental research, including the research reported here (for a full treatment of this alternative, see Povinelli and Giambrone, in press; Povinelli and Prince 1998). On this view, humans and chimpanzees are seen as having inherited a wide range of social behaviours from their common ancestor—behaviours that evolved over the sixty

million years of primate evolution that preceded the appearance of humans and chimpanzees. It is possible, however, that these behaviours were originally generated by low-level psychological mechanisms unrelated to an explicit representation of other minds. In short, these existing, low-level psychological mechanisms may have been recruited to support increasingly sophisticated social behaviours, which themselves became more and more tightly canalized as struggles for scarce resources became increasingly ruthless. Furthermore, these behaviours did not evolve simply to enhance the social primate's ability to emerge victorious from a particular conflict, but also to repair the damages to intra-group social relationships that inevitably follow such conflict (de Waal 1986). In any event, rather than being *prima facie* evidence for the kinds of social understanding present in humans, it is possible that these sophisticated social behaviours evolved and were in full operation long before the ability to explicitly represent other minds became possible.

Finally, it is possible to imagine that, for one reason or another, it may have been only a single primate lineage—the human one—that went on to evolve the ability to represent these ancient behaviours in mentalistic terms. This ability, in turn, may have put us in the unique position of being able to re-interpret behavioural acts that had been around for millions of years in new ways. One way of thinking about this 're-interpretation hypothesis' is to suppose that humans uniquely evolved a mechanism for describing behaviours in increasingly explicit ways—a hypothesized process in human cognitive development that Karmiloff-Smith (1992) has labelled 'representational redescription'. Indeed, if our re-interpretation hypothesis is correct, it may be that one of the most fundamental cognitive specializations of the human species was to evolve the neural means for redescribing behaviours that evolved tens, and in some cases, hundreds, of millions of years before humans appeared on the scene. This does not mean that these redescriptions or re-interpretations provide a less 'accurate' account of the true causes of behaviour. After all, in one sense at least, by inventing this explicitly psychological theory of behaviour (a theory of mind), humans may have come one step closer toward a fully accurate description of the causes of behaviour (Povinelli 1993). And, in terms more relevant to the evolutionary process, this kind of social understanding may have provided us with greater control over these already-existing behaviours—ultimately allowing us to reorganize those behaviours in novel, more efficient, and ultimately more productive ways (see Povinelli and Giambrone, *in press*; Povinelli and Prince 1998). One illustration of this difference between humans and chimpanzees may be the inability of our chimpanzees to use their relevant, existing behavioural actions to influence the actions of their naive partners in the experiment we reported here.

This re-interpretation hypothesis places in a much clearer light our original goal of trying to identify contexts in which chimpanzees might use their natural gestures in ways that would imply that they reason about each other's mental states. It forces us to acknowledge the sterility of the debate concerning the fairness of applying different standards when evaluating the capacities of humans infants and chimpanzees. It provides a coherent theoretical foundation for not insisting on a completely uniform psychological interpretation of what appear to be the shared communicative gestures of humans and other species. The behavioural form of a given gesture and the

psychological mechanism which is presumed to attend/cause it, can no longer be treated as a single, unitary phenomenon. Indeed, on close inspection, the separate evolutionary history of the low-level psychological mechanisms controlling the gestures, and our theory-laden interpretation of those gestures, may be apparent even in our species—both during the course of our development, and in our use of these gestures in our everyday adult lives.

Acknowledgements

This research was supported in part by NIH Grant No. RR-03583-05 to the University of Southwestern Louisiana New Iberia Research Center, NSF Young Investigator Award SBR-8458111 to DJP, and a grant from the Natural Sciences and Engineering Council of Canada to DKO. Order of authorship was determined randomly. We thank James E. Reaux, Anthony Rideaux, and Donna Bierschwale for professional support, and Julie Kanter, Frank Reille, and Elicia Lacey for assistance in testing the chimpanzees. Original artwork is by Donna Bierschwale. Correspondence concerning this article should be addressed to Daniel J. Povinelli, Division of Behavioral Biology, University of Southwestern Louisiana New Iberia Research Center, 4401 W. Admiral Doyle Drive, New Iberia, Louisiana 70560, or sent by e-mail to doneill@watarts.uwaterloo.ca.

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