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PAPER

Apes' and children's understanding of cooperative and competitive motives in a communicative situation

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Abstract

*Chimpanzees (*Pan troglodytes*) and bonobos (*Pan paniscus*) (Study 1) and 18- and 24-month-old human children (Study 2) participated in a novel communicative task. A human experimenter (E) hid food or a toy in one of two opaque containers before gesturing towards the reward's location in one of two ways. In the Informing condition, she attempted to help the subject find the hidden object by simply pointing to the correct container. In the Prohibiting condition, E held out her arm toward the correct container (palm out) and told the subject firmly 'Don't take this one.' As in previous studies, the apes were at chance in the Informing condition. However, they were above chance in the new Prohibiting condition. Human 18-month-olds showed this same pattern of results, whereas 24-month-olds showed the opposite pattern: they were better in the Informing condition than in the Prohibiting condition. In our interpretation, success in the Prohibiting condition requires subjects to understand E's goal toward them and their behavior, and then to make an inference (she would only prohibit if there were something good in there). Success in the Informing condition requires subjects to understand a cooperative communicative motive – which apparently apes and young infants find difficult.*

Introduction

There is growing evidence that nonhuman primates, perhaps especially apes, understand the instrumental actions of others in terms of goals and/or intentions. They distinguish purposeful from accidental actions (Call & Tomasello, 1998); they understand the end toward which failed attempts are aimed (Tomasello & Carpenter, 2005); and they distinguish when someone is unwilling to do something versus unable to do it (Call, Hare, Carpenter, & Tomasello, 2004). Human infants show these same kinds of understandings from around 9 to 15 months of age (Behne, Carpenter, Call & Tomasello, 2005; see Tomasello, Carpenter, Call, Behne & Moll, 2005, for a review).

But in nonhuman primates it is difficult to find evidence that they show human-like skills in understanding the communicative goals or intentions of others, especially when cooperative motives are involved. For example, in the classic object choice task food is hidden in one of several opaque containers, and then a human attempts to cooperatively help the subject to find it by informing her of the food's location by giving some communicative cue – and the subject then chooses one (and only one) container. Despite being highly motivated for the food, apes generally are not very skillful in using what for humans are fairly obvious cues like the human pointing to the correct container, or staring at it, or placing a marker on top of it (Barth, Reaux & Povinelli, 2005; Tomasello, Call & Gluckman, 1997; Call, Hare & Tomasello, 1998; Call, Agnetta & Tomasello, 2000; Hare, Brown, Williamson & Tomasello, 2002; Peignot & Anderson, 1999; Povinelli, Reaux, Bierschwale, Allain & Simon, 1997; Povinelli, Bierschwale & Cech, 1999). Human children perform much more consistently in all versions of this task at a fairly young age (Tomasello *et al.*, 1997), in some cases even before language acquisition begins (Behne, Carpenter & Tomasello, 2005). And domestic dogs also do much better in all versions of this task than do chimpanzees (Miklósi, Polgárdi, Topál & Csányi, 1998; Hare, Call & Tomasello, 1998; Hare & Tomasello, 1999; Hare *et al.*, 2002), presumably because they have been selected (domesticated) to interact with humans cooperatively and to read their cooperative communicative cues.

It is important to note that apes' struggles in this task are not due to their inability to follow the directionality of the cues. Apes follow gazing and pointing to outside

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locations quite readily (e.g. Tomasello, Call & Hare, 1998; Itakura, 1996; Povinelli & Eddy, 1996, 1997). It is simply that in this context they do not know that the human intends his looking, pointing, or placing of a marker to be taken as a cooperative communicative act informing them of the location of the food. One hypothesis is thus that they do not understand cooperative communicative intentions. Support for this proposal is provided by a recent study of Hare and Tomasello (2004). In a replication of the basic object choice task, chimpanzees failed to locate hidden food when a cooperative human pointed to its location (with gaze alternation). However, when a competitive human reached for the container with the hidden food in an unsuccessful attempt to get it for himself (without gaze alternation), the same chimpanzees suddenly knew where the food was – even though the superficial behavior of an arm extended toward the location containing food was highly similar in the two cases. One interpretation of these results is that chimpanzees understand the other's goals when they are competing, but they do not understand the other's communicative goals when these emanate from a cooperative (helping) motive. That is, in the case where someone is reaching for a bucket, the chimpanzee understands that the goal of the reaching is to get what is in the bucket and then infers that it must be something good, like food. In the case where someone is pointing, there is no goal other than communication; and so in this case the chimpanzee must understand directly the pointing gesture as a cooperative communicative act (intended to help by informing) if it is to know that there is food inside the bucket.

In the current study we directly compared members of both *Pan* species (chimpanzees and bonobos) and 18- to 24-month-old human infants in a novel communicative task inspired by the Hare and Tomasello (2004) study. In this case, however, the human experimenter, using the basic object choice procedure, attempted to communicate with the subject in both conditions (unlike Hare and Tomasello in which the human in one condition was not attempting to communicate). Before the food was hidden, in one condition (Informing) an experimenter established a cooperative relationship with the ape and then simply pointed to the container with food, attempting to cooperatively inform the ape of the food's location, as in the classic object choice procedure. In the other condition (Prohibiting), however, an experimenter established a competitive relationship with the ape and then verbally and behaviorally attempted to prohibit the ape from approaching one of the containers, holding out her arm toward the bucket and saying something like 'No! Don't take this one!' (The warm-up procedure had to be slightly different for the children.) Note that in this case the experimenter was not attempting to inform the subject of the food's location cooperatively; rather, she was attempting to prevent her from approaching one of the buckets. A natural inference is of course that she would only attempt to prohibit an approach to a bucket if it actually contained something worthwhile, such as food. But the location of food is not what she intended to communicate, it is only an inference from her actions.

Our hypothesis, based on existing studies with apes and children, was that chimpanzees and bonobos would successfully use the given cue in the case in which they had to make an inference from a competitive action from the human (Prohibiting condition), but they would not be successful in the case in which they had to read the human's cooperative communicative intentions directly (Informing condition) – despite the similarity of overt behaviors in the two cases (looking at bucket containing hidden food with arm extended toward it). Children, on the other hand, should be successful in the informing condition from a fairly young age (Behne, Carpenter & Tomasello, 2005). They should also be successful in the prohibiting condition at some point, although it is not clear whether young children should find this condition easier or more difficult than the informing condition.

Study 1: Apes

Methods

Subjects

Ten chimpanzees (*Pan troglodytes*) and two bonobos (*Pan pansicus*) participated in this study. There were seven females and five males ranging from 4 to 27 years of age (Table 1 shows each subject's sex, age and rearing history). Two additional chimpanzees and one bonobo were excluded from the study because they either did not

Table 1 *Species, age, sex and rearing history of each subject*

Name	Species	Age (years)	Sex	Rearing history
Fraukje	Chimpanzee	27	Female	Nursery
Corry	Chimpanzee	26	Female	Nursery
Jahaga	Chimpanzee	10	Female	Mother
Gertruida	Chimpanzee	10	Female	Mother
Fifi	Chimpanzee	10	Female	Mother
Sandra	Chimpanzee	10	Female	Mother
Frodo	Chimpanzee	9	Male	Mother
Patrick	Chimpanzee	6	Male	Mother
Brent	Chimpanzee	4	Male	Mother
Alexandra	Chimpanzee	4	Female	Nursery
Joey	Bonobo	20	Male	Nursery
Limbuko	Bonobo	8	Male	Nursery

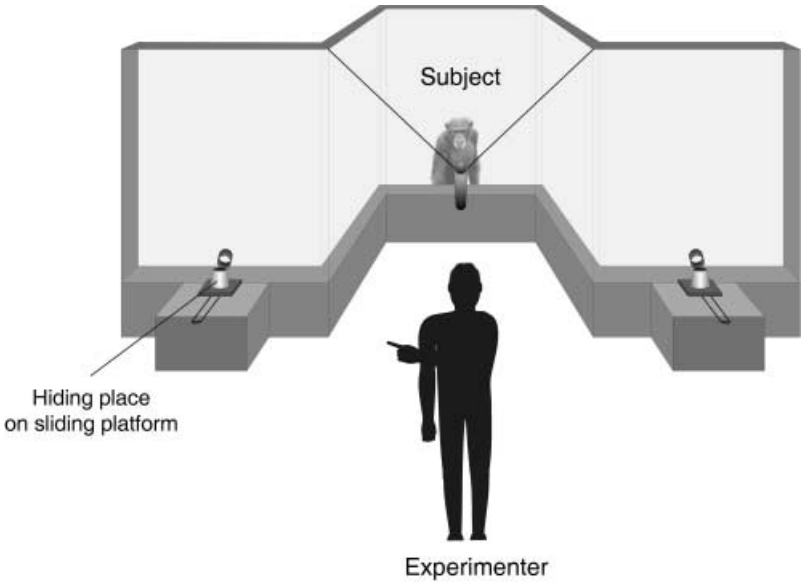

Figure 1 *The experimental set-up with the position of the two tables, the subject and the experimenter informing.*

approach in the competitive introduction or were not interested at all in drinking juice. All subjects were housed at the Wolfgang Köhler Primate Research Center in the Leipzig Zoo, Germany. They lived in social groups and had access to indoor and outdoor enclosures. Subjects were individually tested in a familiar indoor testing room and could stop participating at any time. Water was available ad libitum and subjects were not food deprived for testing. Several subjects had participated in at least one other object choice study in which gazing, pointing or marker cues were given (Barth *et al.*, 2005; Hare *et al.*, 2002; Hare & Tomasello, 2004).

Materials

Figure 1 shows the experimental set-up. Two wooden tables (80 cm × 40 cm × 50 cm) with a sliding wooden platform (18.5 cm × 12 cm) were used. Two red opaque cups (10 cm × 10 cm × 8 cm) served to cover the food reward and each was attached with hinges to one end of the sliding wooden platform. These hinges enabled the subject to flip the cup and retrieve the reward hidden underneath. The sliding wooden platform on each table was pushed forward in order to let the subject have access to the cups; in addition it was possible to pull it back in order to prevent the subject from reaching the cups. Each table was placed in front of a Plexiglas testing window (69 cm × 48 cm) with one hand hole (10 cm × 4 cm). This hole allowed the subjects to reach their hand out to flip over the box. The two tables stood on the left and right side of a test booth, 120 cm apart from each other. Inside this test booth a plastic tube (4 cm in diameter, 170 cm long) was attached to the cage in order to center the subject before each trial by giving them juice through the tube. The baiting procedure was hidden from the subjects' view by two blue plastic screens (75 cm × 50 cm). Banana pieces served as rewards.

Procedure and design

Each subject first participated in a warm-up, then in an informing and a prohibiting condition. Both the informing and the prohibiting conditions consisted of introduction trials as well as test trials and were conducted by different experimenters.

Warm-up. All subjects were familiarized with the apparatus first. Juice was poured through the tube in order to center the subject between the two tables. After the subject was centered, food was placed in one of the two hiding places in full view of the subject. The ape was allowed to take the food by reaching out of the Plexiglas window and flipping over the plastic container. The procedure was repeated until the subject consistently flipped over the baited cup first in order to retrieve the food item.

Introduction. Before the test trials an experimenter (E1 or E2) established a cooperative or competitive relationship with the subject by either giving her food or stealing food from her. In all these introduction trials, as in the warm-up, the experimenter gave the subject juice through the tube and afterwards placed a piece of banana visibly on one of the two tables. In the informing condition, the subject was allowed to retrieve the food by reaching through the Plexiglas window, whereas in

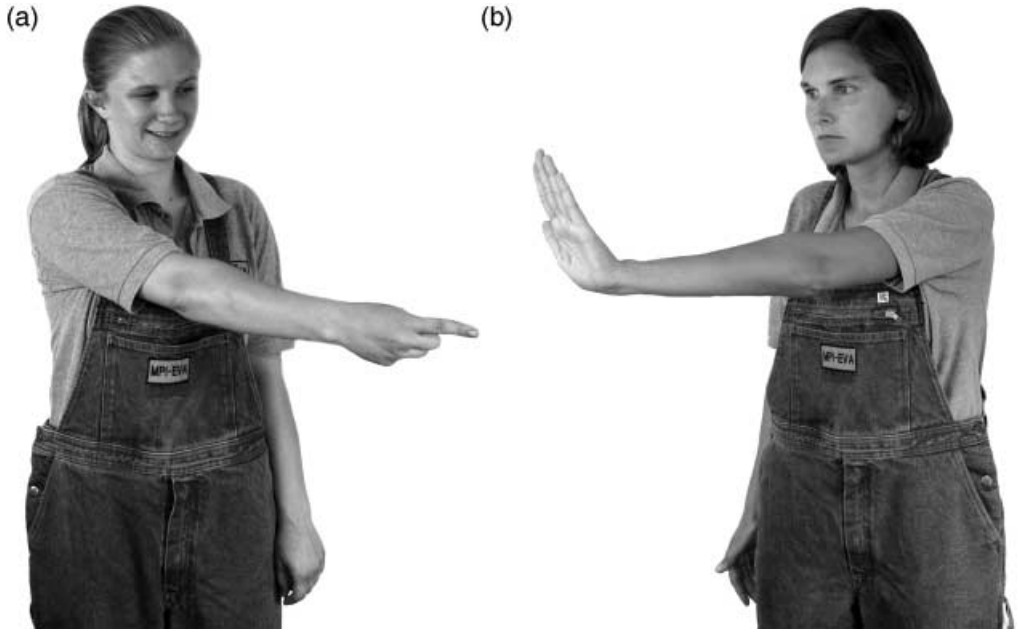

Figure 2 *Examples of the Informing (a) and Prohibiting (b) gestures.*

the prohibiting condition the experimenter removed the food by sliding away the food platform when the subject approached. Each subject received 10 introduction trials. In addition, 10 leaving trials were mixed within the introduction trials in which the experimenter left the room after giving the subject juice and – in the prohibiting condition – additionally placing a piece of banana on the table. The leaving trials ensured that each subject got the same amount of food in the cooperative introduction as in the competitive one and controlled for the motivation of the subject in the latter.

Test. Immediately after the introduction trials, subjects participated in the test trials. In all test trials a human experimenter gave juice to the subject before hiding a food item in one of two opaque containers behind a screen. Thereby the experimenter first placed a screen in front of each table and then gave juice to the subject. While the subject was drinking, the experimenter hid a food item in one of two containers while she always moved to the left cup first, and then to the right cup, regardless of where the food item was placed. Then the experimenter removed the screen and stood between the two tables, facing the subject to give either an informing or prohibiting cue.

Informing condition. The experimenter (E1) who had previously established a cooperative relationship with the subject attracted the attention of the subject by looking at her and calling her name. After the subject looked up from drinking the juice, E1 then pointed (80–100 cm distance to container) with her cross-lateral arm (with the index finger extended) to the baited container using a positive verbal tone while saying 'Look here' one time, and alternating her gaze three times between the subject and the food's location (see Figure 2a). After the cue was given the subject was allowed to choose one container by approaching either side then reaching through the Plexiglas to flip over one of the containers and retrieve its content. To prevent the subject from making a choice before the cue was given, the subject was distracted both with juice and by blocking her view and the hand holes with an opaque screen. If the subject touched the baited cup first she was allowed to retrieve the reward. If the subject chose the empty cup first the food was removed by E1.

Prohibiting condition. The experimenter (E2) who had previously established a competitive relationship got the attention of the subject by looking at her and calling her name. Then, E2 gestured (80–100 cm distance to container) with her cross-lateral arm at the baited location (her palm was always directed towards the box), using a negative verbal tone to say 'No, don't take this one' once before turning away from the subject (see Figure 2b). During the gesturing, E2 looked straight at the rewarded box and avoided eye contact with the subject. While turning around and looking away, E2 was able to monitor subjects' behavior by looking at a screen that showed the images of the recording cameras. In this way the subject could potentially steal the food by approaching the baited side then reaching through the Plexiglas to flip over the container and retrieve its content. If the subject retrieved the food, E2 turned around and banged

on the Plexiglas panel while protesting about the stolen food. If the subject touched the baited cup first she was allowed to retrieve the reward. If the subject chose the empty cup first, E2 turned around and removed the food.

Each subject was tested on three different days. On the first day the warm-up was conducted. Following the warm-up either the prohibiting or the informing condition (introduction and test trials) was presented to the subject. On a consecutive testing day the second condition took place. Each subject received 10 trials of both conditions. The order of the two conditions was counterbalanced across subjects. The position of the reward (left vs. right) was randomly determined with the constraints that it appeared the same number of times on each side and could not be hidden more than twice in a row on the same side.

Scoring and analysis

Subjects' responses were coded live. A correct response was scored if the subject first chose (approached and opened) the baited cup. All trials were videotaped and a second observer independently scored 20% of the trials; inter-observer reliability with the main observer was 100%. Three apes stopped participating before finishing 10 trials and the analysis for these subjects was calculated based on the completed trials (Corry completed seven trials in the informing and six in the prohibiting condition. Joey completed four in the informing and seven in the prohibiting condition. Limbuko completed nine in the prohibiting condition). Therefore for each subject and condition a mean percentage of correct responses was calculated and compared to chance performance, using a one-sample *t*-test. Both conditions were compared to each other with a paired sample *t*-test. In addition, to control for learning effects on the subject's performance within the test trials, we compared the number of correct choices within the first five trials to that in the last five trials within both conditions using a paired-sample *t*-test. All statistical tests were two-tailed.

Results

First, a two-way ANOVA was conducted to analyze whether the order in which the subjects received the two conditions had an effect on their performance. No order effect was found, $F(1, 10) = 1.515$, $p = .247$. Therefore order was not taken into account in further analyses.

Figure 3 presents the mean percentage of correct responses in each condition. As a group, the two *Pan* species found significantly more food in the prohibiting condition than in the informing one (paired-sample *t*-test, $t(11) = 2.257$, $p = .045$). They performed above chance (50% chance in a one-sample *t*-test) in the prohibiting condition, $t(11) = 5.240$, $p < .001$ but not in the informing condition, $t(11) = 1.320$, $p = .214$.

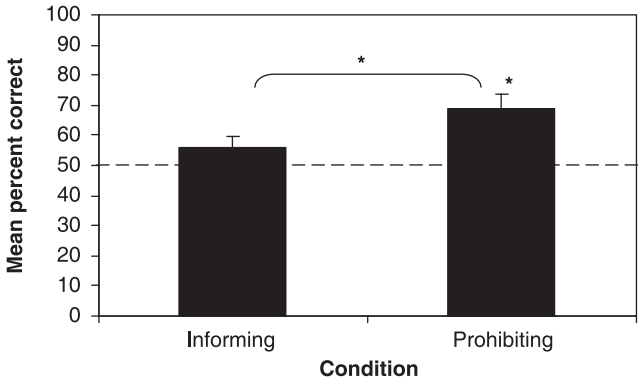

Figure 3 *Mean percentage of correct responses (+SE) across the two conditions for the apes* *p < .05.

Table 2 *Percentage of correct choices in the two conditions for each ape*

Name	Informing	Prohibiting
Fraukje	50	50
Corry*	43	67
Jahaga	50	90
Gertruida	50	70
Fifi	50	70
Sandra	90	60
Frodo	90	80
Patrick	50	80
Brent	50	60
Alexandra	50	60
Joey*	50	86
Limbuko*	50	56
Mean	56.08	69.08

* The superscripts indicate the three subjects that did not complete all 10 trials. Corry completed seven trials in the informing and six trials in the prohibiting condition. Joey completed four trials in the informing and seven trials in the prohibiting condition. Limbuko completed nine trials in the prohibiting condition.

Table 2 presents the results (mean percentage of correct trials) for each of the 12 apes in both conditions. On a descriptive level nine out of 12 apes had higher scores in the prohibiting condition than in the informing condition. Only two subjects showed the opposite effect, and one subject performed equally well in both conditions.

Finally, we compared the first five trials to the last five trials in the informing and prohibiting condition to analyze any possible learning effects (paired-sample *t*-test). There was no significant change in subjects' performance between the two halves within each condition (informing: $t(10) = 0.694$, $p = .503$; prohibiting: $t(11) = 1.839$, $p = .093$). Indeed, in the prohibiting condition they were

better in the first half (mean = 76.25%) than in the second half (mean = 60.83%).

Discussion

The apes in this study found it easier to locate hidden food by making an inference from the experimenter's prohibitions than they did from being informed of its location directly by means of a pointing gesture. This result corroborates the findings of Hare and Tomasello (2004). In that study, as in previous studies (cited in the introduction), chimpanzees displayed chance performance with a pointing cue, but above-chance performance when they could make an inference from reaching behavior (if she is reaching effortfully toward that bucket, there must be something good in it). The difference is that in the Hare and Tomasello (2004) study the reaching action was not a communicative act, and therefore not directed to the subject. In the current study, the prohibition was a communicative act directed toward the subject; it just was not a cooperative communicative act of informing. A second difference is that in the Hare and Tomasello (2004) study the ape had to read the intentions of the human experimenter or conspecific toward the food bucket to know where the food was. In the current study, however, the experimenter had no intentions toward the food bucket; instead her intentions were directed toward the ape and her behavior. To find the hidden food in this study, the ape could not just make an inference from a reaching behavior toward an object but had to make an inference from the experimenter's goal/intention toward herself.

Together with Hare and Tomasello (2004), the current results suggest that simply 'reading cues' is not enough to pass an object choice task. It is not that apes simply need more indications of the direction they should forage in, since in both of these studies the arm extension was similar in the two conditions and looking behavior actually gave more information in the informing condition (only in this condition did E1 alternate her gaze between the subject and the baited bucket). It seems that the apes simply do not understand an informing (cooperative/helping) intention in this context. This might be because informing involves a cooperative motive of sharing information, in this case about a valued food resource. Chimpanzees are mainly competitive in their natural interactions, especially when food is involved, and being informed of food's location is not something they experience regularly (Hare, 2001). In both the current study and in Hare and Tomasello (2004), chimpanzees and bonobos performed more skillfully in the competitive context. It might also be that their better performance in this context is attributable partly to a higher motivation level when competing, and so they paid more attention to E's behavior toward the bucket. Thus, in Hare and Tomasello (2004) chimpanzees' performance in a competitive context even increased in a simple discrimination task in which no communication was involved. But there was clearly no lack of motivation in the informing condition, in the sense that the apes were clearly highly motivated for the food (equally in the two conditions). If the hypothesis is that apes engage with the other more deeply in competition than cooperation, and this is why they paid more attention and so did better in the prohibiting condition, then we agree and think that this is an important part of the process we are investigating.

In terms of experience with humans, the chimpanzees and bonobos in the current study had had experience of being both prohibited and informed. The human caretakers in the apes' previous experience had repeatedly prohibited them from various locations and activities throughout their lives, although never before in an object choice task. In addition, all of these subjects had participated previously in many dozens of trials in similar object choice tasks with informing cues – in which they received feedback about the real location of the food after every trial. In general, if apes understood that the human was attempting to help/inform them of the location of hidden food, it would seem likely that any directional indication could be used as helpful information, if not on the first trial then soon thereafter.

Study 2: Human children

Methods

Participants

Forty-eight children participated in this experiment. There were 24 18-month-old children (M = 18 months, range = within 2 weeks of 18 months) and 24 24-month-old children (M = 24 months, range = within 2 weeks of 24 months), with equal numbers of females and males at each age. Thirteen additional 18-month-olds and 12 24-month-olds were excluded from the final sample because they did not participate in the introduction or the test trials, or did not return for the second condition. Children received a small gift for their participation.

Materials

Two wooden tables (59 cm × 43 cm × 41 cm) were used, standing 80 cm apart from each other. Three different pairs of boxes were used as hiding places: two grey/red

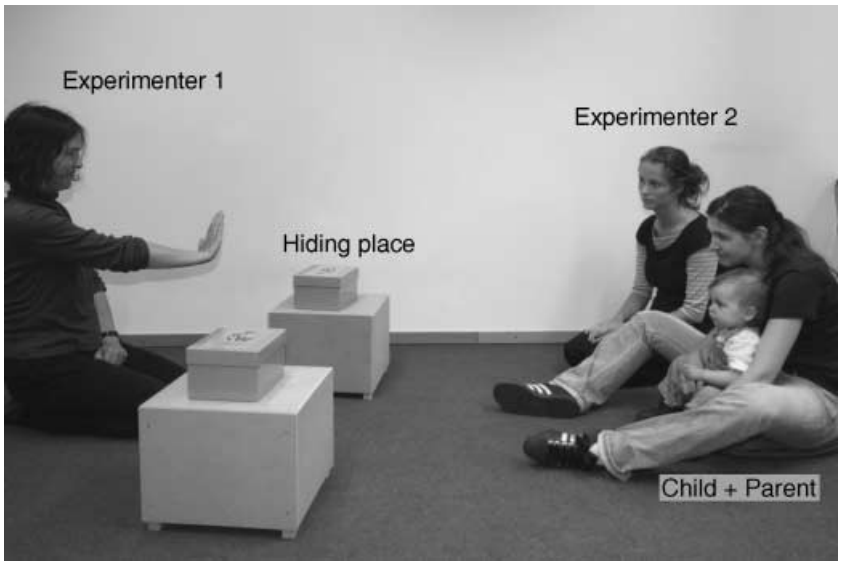

Figure 4 *The experimental set-up with the position of the two tables, the participant and the experimenters E1 and E2.*

colored paper boxes (12 cm × 9 cm × 10 cm), two orange/white colored paper boxes (22 cm × 17.5 cm × 12.5 cm) and two multicolored paper boxes (31.5 cm × 18 cm × 9.5 cm). Each pair of boxes was used for two trials. All boxes had a lid at the top which could be opened. Ten different toys were used as hiding objects.

Procedure and design

The participants were tested in the Developmental and Comparative Psychology Department at the Max Planck Institute for Evolutionary Anthropology. Each participant was accompanied by a parent throughout the study. Parents were told not to influence or help their children in any way to make their choice. There were always two female experimenters present, a cue-giver (E1) and an assistant experimenter (E2). The experimental set-up is shown in Figure 4. Each participant participated in an informing and a prohibiting condition. Both the informing and the prohibiting conditions consisted of introduction trials and test trials.

Warm-up. Before the introduction and test trials E1 (cue-giver) and E2 (assistant) played with the children so that the children were familiar with the experimenters.

Introduction. After this warm-up, a pair of open boxes was placed on the two tables, with a toy inside one box. E2 then inspected both boxes together with the child and showed the child that only one toy was always present. In addition, E2 showed the child how to open and close the boxes. E1 changed the pairs of boxes with its content. Each participant was familiarized with all three pairs of boxes.

Test. Immediately after the introduction trials, subjects continued on to the test trials. In all test trials an experimenter E1 put a toy in one of two open boxes that had been placed on two separate tables. E1 hid the toy from the subject's view by concealing it in her right hand. In each trial E1 inserted her closed hand in both boxes in succession and closed the lids of both boxes while leaving the toy in one of them. After the baiting process E1 kneeled at a set point behind the tables, equidistant from each table and facing the participant who was sitting on the lap of the parent. E1 then gave either an informing or a prohibiting cue to the participant and afterwards left the room. At that time the child was allowed to make its choice by approaching one side and opening one of the two boxes. During the hiding process and the cue-giving the child sat equidistant between the two tables on the lap of its parent, who made sure that the child did not start to retrieve the toy before the cue was given. E2 sat next to them, tried to draw the child's attention to E1 during the hiding process and, after the given cue, encouraged the child to find the hidden toy. In cases where the child had problems opening a box or did not find the hidden toy, E2 helped to retrieve the toy.

Informing condition. In all trials E1 presented a toy, telling the child about her intention to hide the toy in one of the two boxes. After the hiding process E1 looked at the child and said their name to attract their attention. Then, she pointed (110 cm distance to box) with her cross-lateral arm (with the index finger extended) to the baited box, used a positive verbal tone while saying 'Look here' one time, and alternated her gaze three times between the child and the toy's location.

Prohibiting condition. In all trials experimenter E1 talked to herself about a little toy that she held in her hands. While talking, E1 decided to place the toy in one of the two boxes. After the hiding process E1 prohibited the child from taking the toy by first looking at the child and calling the name of the child, gesturing (110 cm distance to box) with her cross-lateral arm (her palm was facing at the box) 'no' at the box where the toy was placed and using a negative verbal command while saying once 'No, don't take this one'. During the gesturing, E2 looked straight to the rewarded box and avoided eye contact with the subject.

Each participant experienced six trials of each of the two conditions, with each condition on a separate day. On the first day either the prohibiting or the informing condition with introduction and test trials was presented to the subject. The second condition – with switched roles of experimenter E1 and E2 – took place on a different day. The order of the two conditions was counterbalanced across participants. The position of the toy (left vs. right) was randomly determined with the constraints that it appeared on each side the same number of times and could not be hidden more than twice in a row on the same side. For half of the participants the first toy was placed in the right box and for the other half in the left box. Both boxes were touched by E1 in each trial but with a counterbalanced order.

Scoring and analysis

As with the apes, subjects' responses were coded live. A correct response was scored if the subject's first choice was the box where the toy was hidden. A choice was defined by opening or attempting to open one box. All trials were videotaped and a second observer independently scored 20% of the trials; inter-observer reliability with the main observer was 100%. Some children didn't participate in all six trials and the analysis for these children was calculated based on the completed trials. Therefore, for each participant and condition a mean percentage of correct responses was calculated.

Results

First, a two-way ANOVA was conducted to analyze whether the order in which the participants received the two conditions had an effect on their performance. No order effect was found in either age class (18-month-olds: $F(1, 22) = 0.617$, $p = .441$; 24-month-olds: $F(1, 22) = 0.436$, $p = .516$). Therefore order was not taken into account in further analyses.

Figure 5 presents the mean percentage of correct responses across conditions and age class. Twenty-four-month-old children as a group found the toy significantly above chance (50% chance in a one-sample *t*-test) in the informing condition, $t(23) = 3.890$, $p = .001$, but not in the prohibiting condition, $t(23) = 0.888$, $p = .384$. The reverse result was found in the 18-month-old children. They used the prohibiting cue above chance level, $t(23) = 3.135$, $p = .005$, but not the informing one, $t(23) = 1.635$, $p = .116$ (one-sample *t*-test, all two-tailed).

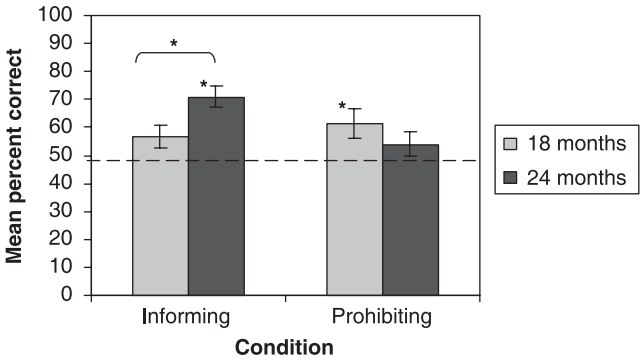

Figure 5 *Mean percentage of correct responses (+SE) across the two conditions for each age group (18 months and 24 months)* *p < .05.

To analyze the effect of age and condition together a 2 × 2 mixed ANOVA, with condition (informing and prohibiting) as a within-subject variable and age (18 months and 24 months) as a between-subjects variable, was conducted. A significant interaction between condition and age was found, $F(1, 46) = 8.117$, $p = .007$. Post-hoc analyses (Fisher's LSD) of the interaction between condition and age showed a significant difference in the performance of the two age classes within the informing cue. The 24-month-olds found the toy significantly more often than the 18-month-olds in the informing condition ($p = .038$). The two age classes did not significantly differ from each other in their performance on the prohibiting condition ($p = .188$). A comparison between the two conditions within each age class revealed that 24-month-olds performed better in the informing condition than in the prohibiting condition ($p = .003$). However, no significant difference between conditions was found for the 18-month-olds ($p = .372$).

Finally, we compared the first three trials to the last three trials in the informing and prohibiting condition to analyze any learning effect. A two-way ANOVA showed no main effect in performance between the two halves within each condition (informing: $F(1, 45) = 1.059$, $p = .309$; prohibiting: $F(1, 46) = 1.038$, $p = .314$), and no interaction with age (informing: $F(1, 45) = 0.430$, $p = .515$; prohibiting: $F(1, 46) = 0.000$, $p = .999$). Thus no learning took place during either condition.

Discussion

The behavior of children in this study was surprising in several ways. First, the 18-month-olds were above chance in the prohibiting condition, but not the informing condition. In a previous study, Behne, Carpenter and Tomasello (2005) found that 18-month-olds were capable of using an informative pointing gesture to find hidden toys. However, in that study the pointing gesture was continuously available as the child searched, whereas in the current study the adult pointed to the correct location and then turned around and left the room (this was done to match the adult's behavior in the prohibiting condition – in which the adult had to leave the room so that the child had the opportunity to defy the prohibition). It seems that for children this young an informing communicative act needs to be given continuously.

On the other hand, the 18-month-olds successfully made the inference that 'if the adult is prohibiting me from that bucket, then it must have the toy in it'. It is not clear why this should be easier for 18-month-old infants, but one possibility concerns the different emotional involvement of the adult in the two conditions. The adult is relatively impassive in the informing condition, but emotionally charged in the prohibiting condition. It is well known that children this young can engage in social referencing, in which they attribute either a positive or negative valence to an object based on the adult's interaction with it (Walden & Ogan, 1988). It is thus possible that the adult's prohibition leads the child *at that moment* to attribute some kind of emotional valence to the prohibited bucket – which it retains up to the moment of choice – whereas this does not occur when the adult is simply informing.

The 24-month-olds behaved differently. They were above chance in the informing condition, thus demonstrating an ability to use a pointing gesture to locate the hidden toy even when that gesture was not present during the search. Surprisingly, however, these same children did not locate the hidden toy successfully in the prohibiting condition. One possibility is that these children simply took the prohibition more seriously than the younger children, and so avoided searching there. And indeed it was the impression of the experimenters that the older children were more reluctant to approach the containers at all in this condition. This impression was also supported by some cases in which children either were afraid to open the rewarded box after approaching it or refused to take the toy once they had opened the correct box. One child even touched the prohibited box first while saying 'here' but then opened the other one. One of the pilot subjects did not approach at all in the prohibiting condition but indicated the rewarded box by pointing toward it.

The other possibility is that these slightly older children expect the adult to help them in the finding game, and indeed they were given this impression in the warm-up to the current experimental task. They were thus confused by the prohibiting behavior, and so were unsure what it was supposed to be communicating. This finding is thus somewhat reminiscent of the finding of Namy and Waxman (1998) that young children's comprehension of novel communicative gestures as symbols declines with age as they become more and more used to the conventional use of linguistic symbols.

In any case, the overall pattern of results is that the younger children resemble the apes, whereas the older children show the exact opposite pattern: they comprehend the informing cue better. It would thus seem that, in this context at least, young children initially find it easier to read and make inferences from the imperative prohibition of behavior than they do to read cooperative communicative intentions – though they soon begin to relate more naturally to cooperative communicative acts.

General discussion

The current studies highlight the uniqueness of the way human beings communicate with one another. It is well known that, at least among primates, only humans engage in declarative communication in which the constitutive motive is either to share experience with someone or to inform them of something they need to know (Gómez, Sarriá & Tamarit, 1993). These motives to share experience and to help others by informing them are very likely impaired in children with autism (Baron-Cohen, 1995). And great apes who have been taught some human-like linguistic skills nevertheless rarely, if ever, use their linguistic skills with the motive to share experience with others or to inform them helpfully (Tomasello & Call, 1997).

A number of studies using the object choice paradigm have demonstrated that, apparently, great apes do not even understand the communicative signals of others when they are produced with these motives (see Call & Tomasello, 2005, for a review). This is not because they cannot follow the directionality of the signal, as all nonhuman primates follow the gaze direction of others reliably to external targets (Tomasello *et al.*, 1998). Their problem seems to be in understanding the meaning underlying the looking and/or pointing of a communicator – the communicator's cooperative communicative intentions. Importantly, in the study of Hare and Tomasello (2004), apes understood that if a competitor

was reaching to one of the opaque containers in an object choice task – with an outstretched arm not so different from pointing – her goal was to obtain something; and that information was sufficient to enable them to infer the food's location. But this only establishes that apes can comprehend an instrumental intention to grasp something in action in contrast to an informative communicative intention.

The current Study 1 compared apes' comprehension of two different types of communicative intentions, that is, two types that embodied different underlying motives: a more competitive motive (prohibiting) and a more cooperative motive (informing). Consistent with previous findings, the apes were not reliable in understanding the cooperative, informing intention. But they were reliable in understanding the competitive, prohibiting intention. This contrast highlights, once again, the distinction between declarative and imperative communication. Apes often point for humans imperatively, mainly so that humans will retrieve and give them food (see Leavens, Hopkins & Bard, 2005). They also do other imperative things, like leading a human to a door they want her to open (Gómez, 1990, 2004). And so perhaps it is not totally surprising that in the current study apes showed an ability to understand a negative imperative not to do something a competitive human did not want them to do. But in what does this understanding consist?

Imperatives come in two forms. First, adult humans often produce a kind of cooperative imperative, often realized in so-called indirect requests. For example, in many contexts 'I would like an apple' is not, despite appearances, a simple statement of fact, but rather it is an expression of the speaker's goal that the listener knows her desire for the apple and then cooperatively helps her to achieve it – what we might call a cooperative imperative. Second, imperatives can be simple action requests like 'Give me the apple'. In this case, the speaker is not revealing her desire and hoping for help, but rather she is directly telling the listener what to do. We think that apes produce and comprehend only these second, action imperatives. Thus, in the prohibition condition of the current study, they understood that the goal of the human was that they not do something – and they then went on to make inferences about why that was the human's goal. In contrast, apes seemingly did not understand the adult's informing gesture – nor could they have dealt with a cooperative imperative, we would hypothesize – because they do not understand the structure of a communicative act that simply makes information manifest, with the assumption that the listener will act cooperatively on this new information (Grice, 1957; Sperber & Wilson, 1986; Clark, 1996). Importantly, we do not believe that this lack of understanding of informatives is due to an inability to understand that others know things, since in the competitive task of Hare, Call and Tomasello (2001) chimpanzees knew when a competitor did and did not know the location of hidden food. Rather, our hypothesis is that they do not understand communicative acts with either a helping or a sharing motive.

Interestingly, some other animal species do well in the object choice task when the human informs them cooperatively of the location of the hidden food. But basically all of these successful species either have been domesticated by humans genetically (dogs, goats, cats) or else have been trained by humans during their ontogeny (trained dolphins, some apes with much human experience) (whereas at least one species of undomesticated mammal, wolves, do not do well in this task; Hare *et al.*, 2002). There are two main interpretations possible. First, perhaps these successful species and individuals have acquired facility with cooperative communicative signals, and so, in some sense, they understand the human's informing intention in this task. A second possibility, however, is that these animals understand the human's informing gesture as an imperative. They have either been bred or raised to follow directions from humans, and so they immediately see any directing gesture as a command – in this case to go to the designated location. On this second view, apes who have had only modest amounts of experience with humans – and who are certainly less docile toward humans than are domesticated animals – either do not see these as action imperatives, or else they may see them as action imperatives but not care what the human wants in this situation when food is involved (which they are busy trying to find, using their own wits).

The findings in Study 2 with children were not without surprises. The behavior of the 18-month-olds was interesting, and basically similar to that of the apes. Given that the informative cue was not present at the moment they searched (as in Behne, Carpenter & Tomasello, 2005), they had trouble understanding the informative cue. But they were able to understand the prohibition and infer from it the location of the toy. The 24-month-olds understood the informative intention, as predicted, but they did not perform well in the prohibiting condition – the major surprise. It is possible that they were poor at making inferences from the prohibition, but we think it more likely that they did understand and make the right inferences, but they were basically intimidated by the adult prohibition more than the younger children. It is also possible, as noted above, that as children learn more solidly about the conventional ways in which others communicate with them, less conventional ways become less transparent. Which of these interpretations

is correct is a question for future research. We should also mention the possibility that the older children understood the language of the experimenter better than the younger children (and the chimpanzees). But in that case we should expect them to do better in both conditions, which they did not.

In any case, we believe that the current results provide support for the general theoretical view that great apes possess more sophisticated cognitive skills in competitive than in cooperative contexts (Hare, 2001). In addition, they also provide support for the view that human beings are adapted for interacting with one another cooperatively in ways that other apes are not. This manifests itself in many aspects of their lives, including the way they communicate with one another using gestures and linguistic symbols, as well as the many ways they cooperate with one another in other types of collaborative activities (Tomasello *et al.*, 2005). Humans' unique skills and motives for cooperation emerge in human ontogeny during the second year of life and enable young toddlers to participate in new ways in the cultural and communicative activities and practices into which they are born.

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