

The Performance of Bonobos (*Pan paniscus*), Chimpanzees (*Pan troglodytes*), and Orangutans (*Pongo pygmaeus*) in Two Versions of an Object-Choice Task

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The object-choice task tests animals' ability to use human-given cues to find a hidden reward located in 1 of 2 (or more) containers. Great apes are generally unskillful in this task whereas other species including dogs (*Canis familiaris*) and goats (*Capra hircus*) can use human-given cues to locate the reward. However, great apes are typically positioned proximal to the containers when receiving the experimenter's cue whereas other species are invariably positioned distally. The authors investigated how the position of the subject, the human giving the cue and the containers (and the distance among them) affected the performance of 19 captive great apes. Compared to the proximal condition, the distal condition involved larger distances and, critically, it reduced the potential ambiguity of the cues as well as the strong influence that the sight of the containers may have had when subjects received the cue. Subjects were far more successful in the distal compared to the proximal condition. The authors suggest several possibilities to account for this difference and discuss our findings in relation to previous and future object-choice research.

Keywords: communication, cross-body pointing, gaze following, experimenter-given cues object-choice task

Mounting experimental evidence suggests great apes have difficulty in using human informative gestures in the so-called object-choice task (see Call & Tomasello, 2005; Miklósi & Soproni, 2006). The task involves an experimenter hiding a reward in one of two (or more) opaque containers that are then presented to a subject. The experimenter provides a communicative cue, such as pointing or gazing, to indicate where the reward is hidden and the subject is allowed to choose just one container in an attempt to find the reward. Although cues are conspicuous, great apes generally fail, which is surprising given that they can follow the experimenter's gaze to specific locations outside of their own field of view (Bräuer, Call, & Tomasello, 2005; Okamoto-Barth, Call, & Tomasello, 2007; Povinelli & Eddy, 1996).

By contrast, domestic dogs (*Canis familiaris*) are adept at using human-pointing cues to find hidden rewards; this is even the case for puppies as young as 6 weeks who have had minimal human contact (e.g., Hare, Brown, Williamson, & Tomasello, 2002; Riedel, Schumann, Kaminski, Call, & Tomasello, in press). However, human-raised wolves (*Canis lupus*) do not perform as well in the task (Hare et al., 2002; Miklósi et al., 2003; but see Viranyi et al., 2008). This suggests that the aptitude of dogs to act on human

communicative cues has evolved during the domestication process that favored traits linked to understanding human gestures (Hare et al., 2002). More interesting, domestic goats were able to successfully use an experimenter's pointing cue to locate hidden rewards (Kaminski, Riedel, Call, & Tomasello, 2005), thus lending some credence to the domestication theory. However, nondomesticated species such as dolphins and fur seals also can use human-given cues quite effectively (Herman et al., 1999; Scheumann & Call, 2004; Tomasello, Hare, & Agnetta, 1999; Tschudin, Call, Dunbar, Harris, & van der Elst, 2001). How can the discrepancy between the primate and nonprimate data be resolved, particularly for nondomesticated species?

One possibility is that extensive contact with humans may foster the ability to follow human-given communicative cues such as pointing. In favor of this is that all the marine mammals referred to above were part of public shows in which they had ample experience of humans pointing. However, apes and monkeys tested in various studies were similarly experienced. What may be a more plausible explanation is that primates have been mostly tested with a proximal setup in which the subjects are seated in reaching distance of the containers when choosing, whereas nonprimate species were tested by a paradigm in which the subject has to move toward one of the containers to select it. Thus, a difference in setup may have contributed in significant ways to the conflicting results of different studies. In fact, Barth, Reaux, and Povinelli (2005) found that when chimpanzees were required to enter the testing arena in each trial and approach one of two containers on a platform indicated by the experimenter, they performed significantly better than in the traditional setup. Note the only thing that changed was whether the subject entered the testing arena and saw the experimenter's cue after every trial or instead she stayed inside

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the room between trials. Barth et al. suggested that seeing the experimenter focusing his attention toward a location “directed their attention (and hence primed their responses) toward the position of the correct container” (p. 90). In contrast, such effect was dampened in the traditional setup because subjects may have received more equivocal information owing to the experimenter’s movements and orientation during the trial preparation.

However, this is inconsistent with the results of Herrmann and Tomasello (2006) who also compared the traditional setup with a novel setup in which the containers were located on two tables 120 cm apart with the experimenter positioned equidistant between the tables and forming a triangle with them. Subjects started the trial opposite to the experimenter’s position slightly beyond the two tables so that the subject, the experimenter, and the two tables formed the vertices of an asymmetric diamond. This made the movements and orientation during baiting less conspicuous than in the traditional setup, even more so because the experimenter who baited the boxes was not the same one that gave the cues. Herrmann and Tomasello found that the chimpanzees’ performance was at chance levels in both the traditional and the new setup. Although the distal setup may have improved performance, one feature that may have decreased performance is the position of the experimenter, located far from the subjects and the containers, therefore making cues less salient.

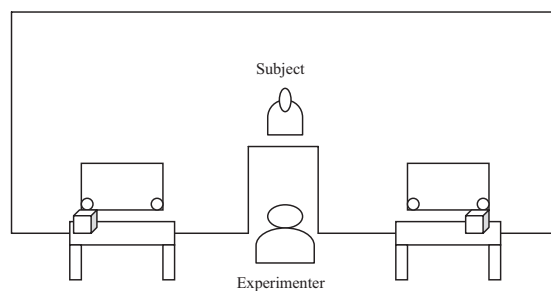
In the current study we tested the ability of great apes to use a pointing and gazing cue to locate a hidden reward. We reasoned that placing the containers away from the experimenter’s cue may enhance their performance because containers may be strong stimuli for subjects who usually have pretest experience with containers and their association with food rewards (e.g., in familiarization trials). Thus, when the experimenter provides a communicative cue during test trials it is possible subjects might be more attracted to the containers, by virtue of their proximity, and simultaneously less to the experimenter’s cue. Moreover, the containers and experimenter are typically along the subject’s line of sight, respectively, requiring subjects to look beyond the containers (stimuli) to encode any given cue that may be a difficult process if it involves overriding the attraction of the stimuli. To implement these modifications, we used the same basic setup as Herrmann and Tomasello (2006) except that we brought the experimenter closer to the subject to a location right between the two tables (see Figure 1a). This was crucial to enhance the salience of the experimenter (being nearer the subject) and to allow him to provide a more distinct cue by virtue of its position regarding the containers. Thus, our modified procedure (distal condition) had three main features: (a) Subjects were positioned distally to the containers, (b) containers were not placed in the subjects’ direct line of sight of the experimenter, and (c) the experimenter was positioned so that he was able to provide a highly distinct cue. We contrasted this modified procedure to the traditional object-choice procedure (proximal condition) by administering both conditions to the same subjects (Figure 1b).

Method

Subjects

Twelve chimpanzees (*Pan troglodytes*), 4 bonobos (*Pan paniscus*), and 3 orangutans (*Pongo pygmaeus*) housed at the

a) Distal condition



b) Proximal condition

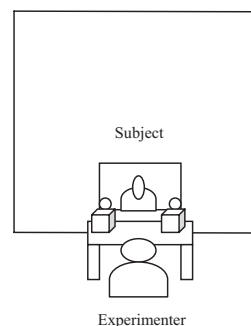


Figure 1. Experimental setup for each condition. (a) Distal condition: distance between containers = 250 cm; subject and each container = 165 cm, approximately; subject and experimenter = 110 cm, approximately; container and experimenter’s index finger = 100 cm, approximately. (b) Proximal condition: distance between containers = 60 cm; subject and each container = 30 cm, approximately; subject and experimenter = 60 cm, approximately; container and experimenter’s index finger = 40 cm, approximately.

Wolfgang Köhler Primate Research Center in the Leipzig Zoo participated, including 7 males, 12 females, juveniles, subadults, and adults. Subjects were housed in social groups of their respective species. During the day they were housed in 400 m² indoor and 4,000 m² outdoor areas that were furnished with natural vegetation, climbing structures, and enrichment devices. The subjects received fruits, vegetables, and cereals several times per day and had access to food and water throughout testing. Experiments were conducted from 2003 to 2004, and prior to this study some of the chimpanzees (see Table 1) had participated in four other studies on object choice (Barth, 2004; Hare et al., 2002; Hare & Tomasello, 2004; Herrmann & Tomasello, 2006).

Procedure

We tested subjects individually in familiar indoor test cages approximately (40 m² and 3.15m high). All subjects had passed a familiarization trial in which they correctly chose on four consecutive trials one of the two containers they had witnessed being baited (no occluder used). Subjects then received one of the following two conditions.

Distal. The subject, experimenter (E), and two tables were positioned as depicted in Figure 1a. The two containers were placed on top of a T-shaped occluder positioned in the recess. E

Table 1
Number of Correct Choices in Each of the Two 12-Trial Sessions Per Condition and Order of Condition Presentation

| Name | Species | Age/sex | First condition | Condition | | | |
|------------------------|------------|---------|-----------------|-----------|--------|--------|--------|
| | | | | Proximal | | Distal | |
| | | | | First | Second | First | Second |
| Annette | Chimpanzee | J/F | Distal | 8 | 8 | 12 | 12 |
| Fifi ^a | Chimpanzee | S/F | Distal | 5 | 5 | 10 | 9 |
| Padana | Orangutan | J/F | Distal | 7 | 5 | 7 | 7 |
| Dunja | Orangutan | A/F | Distal | 8 | 8 | 6 | 6 |
| Limbuko | Bonobo | S/M | Distal | 11 | 12 | 10 | 11 |
| Sandra ^a | Chimpanzee | S/F | Distal | 9 | 8 | 11 | 11 |
| Pia | Chimpanzee | J/F | Distal | 3 | 5 | 9 | 6 |
| Yasa | Bonobo | S/F | Distal | 4 | 7 | 7 | 6 |
| Alex | Chimpanzee | J/F | Proximal | 5 | 6 | 11 | 12 |
| Brent | Chimpanzee | J/M | Proximal | 5 | 6 | 7 | 6 |
| Alexandra | Chimpanzee | J/F | Proximal | 9 | 12 | 12 | 11 |
| Jahaga ^a | Chimpanzee | S/F | Proximal | 8 | 7 | 9 | 10 |
| Dorien | Chimpanzee | A/F | Proximal | 8 | 4 | 9 | 10 |
| Gertruida ^a | Chimpanzee | S/F | Proximal | 7 | 7 | 9 | 7 |
| Frodo | Chimpanzee | S/M | Proximal | 8 | 10 | 11 | 10 |
| Patrick ^a | Chimpanzee | J/M | Proximal | 6 | 9 | 6 | 6 |
| Toba | Orangutan | S/F | Proximal | 5 | 7 | 8 | 9 |
| Kuno | Bonobo | S/M | Proximal | 7 | 5 | 8 | 12 |
| Joey | Bonobo | A/M | Proximal | 2 | 7 | 9 | 11 |

Note. Ten out of 12 or 18/24 are values significantly above chance (binomial test: $p < .05$). J = juvenile; F = female; S = subadult; A = adult; M = male.

^a These subjects participated in two previous studies on proximal object choice.

baited, in view of the subject, one container, closed its lid and placed it behind the occluder. The second container was shown to the subject so that the subject could see that it was empty before its lid was closed and placed behind the occluder. E then either switched or pretended to switch the positions of the containers. This controlled for the possibility that the subjects were keeping track of the baited container when it was placed behind the occluder. E then placed one container on the left table and one on the right table directly in front of the farthest hole of the Plexiglas windows. The subject was positioned equidistant between the two containers by E giving the subject fruit juice through the recess wall. Once the subject had finished drinking, E turned his head and looked at the baited container and simultaneously pointed, with his index finger, across his body to the baited container (this pointing cue was selected because it easily allowed E to maintain the same distance from the tip of his finger to the container throughout testing). E maintained the cue until the subject went to one of the tables and made a choice; indicated by the subject inserting a finger through the window's hole and touching the container. If correct, E opened the chosen container and gave the subject the reward and then also opened the remaining container and showed the subject it was empty. If incorrect, E opened the chosen container, showed the subject it was empty and then he opened the baited container and showed the subject the reward before returning it to the food bucket.

Proximal. The subject, experimenter, and one table were positioned as depicted in Figure 1b. E baited the containers, in front of the subject, using the same procedure as in the distal condition. E then placed one container in front of the left hole of the Plexiglas window and the second container in front of the window's right

hole. The subject was centered between the two containers by E giving juice through the mesh of the cage wall that was under the Plexiglas window. Once the subject had finished drinking, E gave the same cue and followed the same procedure as in the distal method.

Each subject received a total of 24 trials per condition in two 12-trial sessions. The reward used in all trials was a flattened grape that prevented any aural cueing to subjects by the reward moving inside the container. The reward appeared an equal number of times in the left and right side with the restriction that the baited container was never placed on the same side for more than two consecutive trials. Eleven subjects received the proximal method first followed by the distal method, and vice versa for 8 subjects.

Data Scoring and Analysis

We videotaped and scored live all trials. A second observer (the second author) independently scored 22% of the trials to assess interobserver reliability. Interobserver reliability was excellent (Cohen's $\kappa = 0.96$, $N = 204$). We scored the percentage of trials in which subjects selected the baited container. We used two-tailed nonparametric statistics to assess the effect of condition (Wilcoxon's test) and species (Kruskal-Wallis test) on the percentage of correct trials. We also analyzed whether subjects performed above chance levels both at the individual (binomial test) and group level (Wilcoxon's test).

Results

The order of the presentation of the conditions did not significantly affect performance in the distal (Mann-Whitney test: $Z =$

0.33, $p = .74$, $N = 19$) or the proximal condition (Mann–Whitney test: $Z = 0.66$, $p = .51$, $N = 19$). Similarly, species membership did not significantly affect performance, Kruskal–Wallis test: distal: $\chi^2(N = 19, df = 2) = 2.75$, $p = .25$; proximal: $\chi^2(N = 19, df = 2) = 0.32$, $p = .85$. Therefore we collapsed the data across order of presentation and species for subsequent analyses.

Figure 2 presents the median percentage of correct responses in each condition for each session. Overall subjects performed significantly better in the distal than the proximal condition (Wilcoxon's test: $Z = 2.90$, $p = .004$, $N = 19$). In addition, subjects performed above chance levels (expected = 12) in the distal (Wilcoxon's test: $Z = 3.53$, $p < .00$, $N = 17$) but not in the proximal condition (Wilcoxon's test: $Z = 1.82$, $p = .068$, $N = 14$). There was no significant improvement between sessions for any of the conditions (Wilcoxon's tests: distal: $Z = 0.03$, $p = .97$, $N = 14$; original proximal: $Z = 1.38$, $p = .17$, $N = 15$).

Individual analyses revealed that 11 (58%) and 3 (16%) subjects selected the baited container in at least 18 out of 24 trials (binomial test: $p < .05$, chance = 12 trials) in the distal and proximal condition, respectively.

Discussion

Subjects were far better at solving the distal object-choice condition than the proximal condition. The two conditions only differed in the position and the distance between the containers, the subject, and the experimenter. It is therefore a piquant finding that

such relatively modest differences had such a dramatic effect on the subjects' performance.

Various factors may have contributed to the positive results in the distal condition. One is the location of the containers in relation to the experimenter's. In the proximal object-choice method, both containers are placed on a table between experimenter and subject. This means that the containers and experimenter's cue invariably occupy the same visual plane except that the containers occupy the foreground while the cues appear in the background. Such an "attentional" disparity between containers and cues is further accentuated because containers are strongly associated with food rewards. Therefore, it is conceivable that the containers override the subjects' ability to encode the experimenter's cue in the proximal method but not in the distal method in which the containers were not placed directly in front of the subjects and subjects initially only perceived the cue, not the containers. This hypothesis may explain why previous object-choice research in great apes has shown that the closer an experimenter's cue is to the baited container the more likely subjects will make a correct choice (see Miklósi & Soproni, 2006, for a review). Typically cues close to the containers (10 cm; Itakura & Tanaka, 1998; Peignot & Anderson, 1999) elicit more correct responses than cues 40 cm away, as used here and in other studies. If subjects are particularly attracted by the containers, they are more likely to pick up cues given in their proximity rather than more distal cues, especially when the containers and the cues compete against each other for the subject's attention.

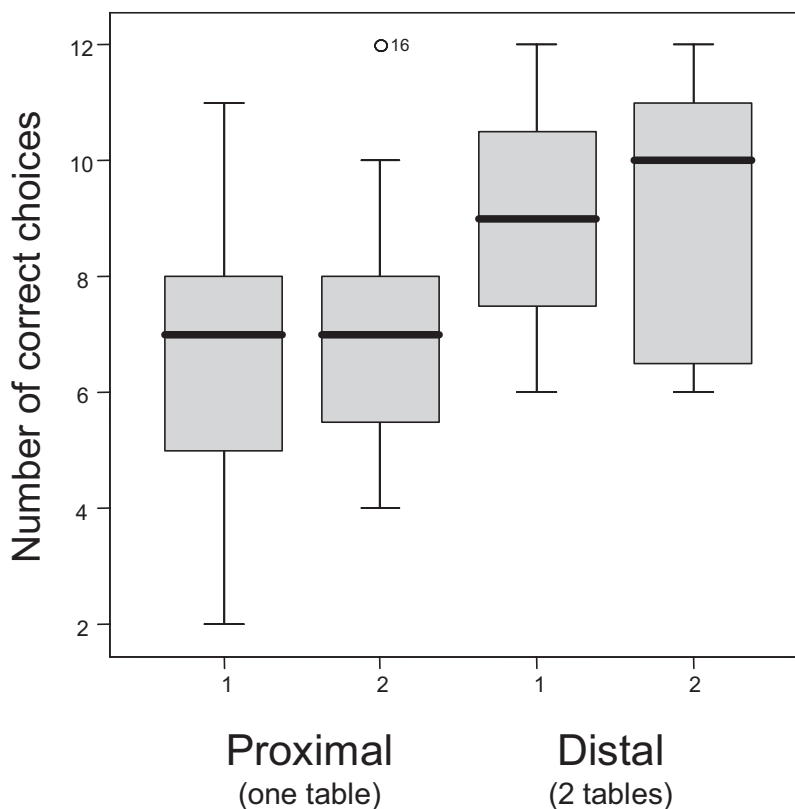


Figure 2. Median, interquartile range, and range of correct choices as a function of condition and session.

A second factor that may have affected performance is the position of the experimenter in relation to the containers and the subject. Although a greater proximity between the experimenter and the subjects may have enhanced the impact of the experimenter's cue, proximity alone cannot be the sole explanation for our results because the experimenter was even closer to the subject in the proximal condition in the current and other studies (e.g., Barth et al., 2005; Call, Hare, & Tomasello, 1998) and no enhancement was apparent. Instead, the position of the experimenter between the two containers resulted in cues that offered a maximum contrast. Another factor is the added cost of moving 165 cm toward a distal container to make a choice. In contrast, they only had to move their arm to make a choice in the proximal method. The increase in distance in the distal method may have prompted subjects to focus more on the experimenter to secure information about the reward's location thereby avoiding the added cost involved in making a wrong choice.

Contrasting our results to those of Povinelli and colleagues (Barth et al., 2005; Povinelli, Reaux, Bierschwale, Allain, & Simon, 1997) deserves a separate comment because of the singularity of their setup. Unlike other studies, their procedure entailed subjects entering the testing unit in every trial, receiving the corresponding treatment, and exiting the testing unit. This means that this procedure has some features of the proximal and distal setups. Like the distal setups, subjects moved toward one of the containers but both containers are within arms' reach once the subject arrives at the platform where the containers rest on. Povinelli and colleagues reported positive results not just with proximal pointing but also with head direction, even when the experimenter did not look directly at the container but above and behind it (Povinelli et al., 1999). Pointing and, especially, gaze direction cues are very powerful attractors of attention for chimpanzees (and other animals), and therefore it is conceivable that if those cues are the first thing that a chimpanzee sees right after she enters the testing unit, they capture her attention more so than the containers, which at that point are still far away from the subject. Once her attention is captured, the subject moves in the direction indicated by the gaze orientation which automatically sends her toward the baited container. Capturing the attention with the experimenter's cue (and away from the containers) at the outset (and before the containers' proximity plays a major role) represents a different, yet effective, way to the one that we used in the current study. In our case we accomplished the same result by not having the containers and the experimenter's cue in front of each other so that no competition occurred between the containers and the cues. In any case, our results show that entering the testing area in every trial is not necessary to elicit positive results as the distal condition of the current study has shown.

Although our distal setup was more effective than the proximal setup in leading subjects to locate a hidden reward, there was some statistical trend suggesting that subjects also benefited in the proximal setup because overall they found the reward in 58% of the trials (50% was chance) and three individual subjects performed above chance. Was this a coincidence? We do not think so because chimpanzees often score consistently above 50% as a group (e.g., Call, Agnetta, & Tomasello, 2000, Study 2: 61%; Call et al., 1998, Study 2: 57%; Hare et al., 2002, Study 1: 61%; Hare & Tomasello, 2004, Study 1: 54%, Study 3: 63%; Hermann & Tomasello, 2006, Study 1: 56%). So even though the effect is

weak, it does not mean that it is inexistent. Other studies have found even higher scores with enculturated apes (Itakura & Tanaka, 1998) or after extensive exposure to multiples cues (e.g., Peignot & Anderson, 1999).

Our current data do not allow us to assess the relative contribution of each factor to the subjects' successful performance. Similarly, our data cannot distinguish between the relative contribution of pointing and gaze direction in the subjects' responses. Future studies are needed to tease apart the factors and the specific cues involved in the subjects' improvement described here. Nevertheless this study documented that the proximal method with low contrast cues may underestimate the ability of the great apes to use experimenter-given cues to locate hidden food. This finding has important implications for comparative research because most primate studies have used the proximal method whereas most nonprimate studies have used the distal method (e.g., Call, 2004; Hare et al., 2002). It would be therefore of interest to test a variety of species in the two versions of the object-choice task used in the current study. In doing so, however, it is important to pay particular attention to the specific features of the task (e.g., cue saliency) not just the overall setup (distal vs. proximal). After all, some studies that used a distal setup found negative results (e.g., Hermann & Tomasello, 2006) and others that used the proximal setup found positive results (e.g., Itakura & Tanaka, 1998; Povinelli et al., 1997). We think that the key to resolve these inconsistencies lies on the specific features within these studies.

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