

Olive baboons communicate intentionally by pointing

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Abstract A pointing gesture creates a referential triangle that incorporates distant objects into the relationship between the signaller and the gesture's recipient. Pointing was long assumed to be specific to our species. However, recent reports have shown that pointing emerges spontaneously in captive chimpanzees and can be learned by monkeys. Studies have demonstrated that both human children and great apes use manual gestures (e.g. pointing), and visual and vocal signals, to communicate intentionally about out-of-reach objects. Our study looked at how monkeys understand and use their learned pointing behaviour, asking whether it is a conditioned, reinforcement-dependent response or whether monkeys understand it to be a mechanism for manipulating the attention of a partner (e.g. a human). We tested nine baboons that had been trained to exhibit pointing, using operant conditioning. More specifically, we investigated their ability to communicate intentionally about the location of an unreachable food reward in three contexts that differed according to the human partner's attentional state. In each context, we quantified the frequency of communicative behaviour (auditory and visual signals), including gestures and gaze alternations between the distal food and the human partner. We found that the baboons

were able to modulate their manual and visual communicative signals as a function of the experimenter's attentional state. These findings indicate that monkeys can intentionally produce pointing gestures and understand that a human recipient must be looking at the pointing gesture for them to perform their attention-directing actions. The referential and intentional nature of baboons' communicative signalling is discussed.

Keywords Gestural communication · Intentionality · Social cognition · Non-human primates · *Papio anubis*

Introduction

A pointing act creates a referential triangle that incorporates distant objects into the relationship between the signaller and the gesture's recipient (e.g. Butterworth 2003). In our species, pointing becomes an act of intentional communication at about 12 months of age (e.g. Bates et al. 1975; Butterworth 2001; Leung and Rheingold 1981) and is a developmental precursor to humans' acquisition of speech during infancy. It is regarded as having a key role in the development of cognitive abilities for understanding intentions, given that the use of pointing and gazing in a referential manner is one of the major expressions of this understanding, and pointing has thus been described as the 'royal road to language' (Butterworth 2003). More generally, researchers have suggested that the production of informative gestures plays an important part in the emergence of cooperation abilities, thus contributing significantly to the evolution of language (e.g. Bullinger et al. 2011). For these reasons, the ability to direct an observer's attention to a distal object has historically been viewed as uniquely human (Werner and Kaplan 1963).

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By administering object-choice tasks (i.e. tasks probing primates' ability to follow a human's gaze or gestures to find food hidden under one of several containers), researchers (e.g. Anderson et al. 1995; Byrmit 2004, 2009; Neiworth et al. 2002; Vick et al. 2001) have demonstrated that non-human primates are able to understand the referential meaning of gestures displayed by an experimenter. Furthermore, it has been shown that they are also able to use gestures such as pointing in a referential way. Pointing has been reported among great apes both in captivity (e.g. de Waal 1982; Savage-Rumbaugh 1986) and in the wild (Inoue-Nakamura and Matsuzawa 1997; Veà and Sabater-Pi 1998). Although pointing in captive conditions is mostly exhibited when great apes interact with humans (e.g. Call and Tomasello 1994; Krause and Fouts 1997; Leavens and Hopkins 1998; Leavens et al. 1996), most reports have described it as emerging spontaneously, without any explicit training (Call and Tomasello 1994). In spite of this spontaneous emergence, some authors have questioned whether great apes understand that pointing gestures influence the recipient's internal mental state (Povinelli et al. 2003). In addition, it has been argued that great apes do not actually point as such to distal objects, although they may exhibit 'reaches' for unreachable food (e.g. Povinelli and Davis 1994).

In response to these remarks, several researchers have investigated whether great apes use pointing as an attempt to reach for unreachable food (i.e. trying to grasp something for themselves) or whether these putative reaches might be better characterized as genuine referential gestures intended to communicate a request. Povinelli and Eddy (1996) examined the ability of chimpanzees to beg from one of two experimenters (one with open eyes, the other with various types of visual occlusion). In almost all cases, they found that the chimpanzees did not discriminate between the two experimenters on the basis of their ability to see. These authors concluded that chimpanzees' gaze-following abilities do not allow them to understand another's mental states from gaze cues: a conclusion which should, however, be viewed with caution, given that these experiments were performed with human partners and not with conspecifics. Moreover, many other studies have shown that great apes adjust their communicative gestures, including pointing, according to their recipient's attentional state (*Pongo pygmaeus*: Call and Tomasello 1994; *Pan troglodytes*: Hostetter et al. 2001; Leavens and Hopkins 1998; Leavens et al. 1996, 2004b, 2010; Tomasello et al. 1994), and Leavens and Hopkins (1999) reported that all the great ape species are capable of using whole hand pointing to communicate with humans about an out-of-reach object in their environment, with a view to gaining their help in attaining that object (a type of gesture defined as 'imperative', cf. Bates 1976; Pika 2008).

To our knowledge, very few studies have reported trained and spontaneous pointing by monkeys (Hess et al. 1993; Kumashiro et al. 2002; Mitchell and Anderson 1997). Although monkeys can be trained to exhibit pointing, using operant conditioning, little is yet known about their ability to use this learned pointing intentionally, as a referential gesture. More specifically, the ability of monkeys to take an experimenter's attentional state into account in order to communicate intentionally through pointing gestures has almost never been tested. The only three studies to have investigated this question were conducted with just two species, both New World monkeys. The first study, with three squirrel monkeys (Anderson et al. 2001, 2007, 2010), demonstrated that under certain circumstances, operant-trained pointing can be used flexibly and in association with recipient monitoring and gaze alternation. The second study, with tufted capuchin monkeys (Hattori et al. 2007), looked at whether the monkeys recognized human attentional states. Results indicated that the capuchins' pointing was sensitive to the experimenter's gaze direction, but not to the experimenter's attentional variations. In the third and final study, Hattori et al. (2010) used two experimental situations: in the first one, the capuchins simply had to attract the experimenter's attention, but in the second one, they were required both to attract the experimenter's attention and to direct it towards food on a table. In both conditions, the human partner displayed four different attentional states. Hattori et al. (2010) provided evidence of the capuchins understanding the experimenter's attentional variations, but only in the condition where they simply had to attract the experimenter's attention. The authors concluded that capuchin monkeys can understand variations in others' attentional states, but that this ability appears to be limited, compared with what is observed in humans.

In Old World monkeys, evidence on this issue is even scarcer. All we know is that three Olive baboons successfully learned to use a human experimenter's head orientation as a cue for obtaining a food item (Vick and Anderson 2003), although in this study, the baboons were not required to point. As far as we know, Old World monkeys have never been tested in an experimental setting that would allow researchers to say whether these species use learned pointing in their attempts to obtain unreachable food or whether they use it as a genuine referential gesture. Our study was therefore intended to fill this gap, by administering a pointing task to baboons in three situations that differed according to the attentional state of a human experimenter. Pointing was studied in an adaptation (see Meunier et al. 2011, 2012) of Bishop's Quantifying Hand Preference (QHP) test designed for use with human children (Bishop et al. 1996) to assess their degree of hand preference. In Bishop's original test, seven picture cards,

each 30° apart, were placed in a half circle around the child so that they were all within that child's reach. The child, standing in front of the template in the centre of the baseline, was required to pick up a specific, named card and to place it in a box located directly in front of him or her. The experimenter recorded the hand used to pick up each card. The card order was randomized, but the sequence of positions was the same for all participants. This test has the advantage of controlling for both spatial and postural factors. We therefore investigated the ability of baboons to communicate intentionally about the location of an unreachable food reward through (1) pointing gesture, (2) gaze orientation and (3) attention-getting behaviour as a function of the human experimenter's attentional state.

Methods

Data were collected between December 2009 and July 2010 at the Rousset-sur-Arc Primatology Centre in France. All the experiments were carried out in accordance with the principles of laboratory animal care set out in Centre National de Recherche Scientifique guidelines.

Subjects

The subjects were nine captive Olive baboons (*Papio anubis*) including eight adult males (7–12 years old, mean = 9.5, SE = 0.93) and one subadult male (4 years old). All the baboons lived in different social groups and were housed either in parks or in large cages, both with free access to an indoor shelter. The eight adult males were alpha males and were tested in their social group. The subadult male was tested in social isolation to avoid him being disturbed by dominant individuals during the experiments. The baboons were fed with commercial primate pellets twice a day, fresh fruit and vegetables once a day, and seeds three times a week. Water was available ad libitum.

Training

A training phase was necessary to ensure that each participant was able to point to one baited container with its whole hand. Whole-hand points involve arm extension towards the container, with the hand extended, fingers abducted (spread slightly apart) and the palm either held vertically or pronated to some degree (i.e. facing down, Leavens et al. 1996).

Each of the nine tested subjects was trained to produce pointing gestures as follows. First, a reachable raisin was presented to the subject on the experimental table (see

below) so that the subject was able to grasp it. Next, the raisin was gradually moved away until it was at an ambiguous distance. At this stage, the raisin was still almost reachable, and when the subject attempted to grasp it, the experimenter gave it directly to the animal. Finally, the raisin was placed 70 cm away from the subject (i.e. a distance beyond the subject's reach). Training was terminated when the subject was able to point to the out-of-reach raisin with one hand (left or right) without trying to grasp it. Pointing was thus defined as a manual gesture with arm, hand and/or finger extended towards one of the five containers, with no attempt to grasp it. We defined grasping as stretching out the arm so that the elbow was extended and protruding from the cage (pointing subjects kept their arm bent). No criterion of pointing gesture duration was considered. Random pointing at various places in succession seldom occurred. When it did, the trial was rejected and the subject was not rewarded.

Experimental procedure

The experimental procedure for testing the Olive baboons consisted of an adaptation of the QHP task, in which the cards (for testing human children; Bishop et al. 1996) were replaced by containers baited with a raisin. The Olive baboons sat in front of the set-up. Positions 1 and 7 of Bishop's QHP task were eliminated because they were too close to the subject. As a result, we retained five positions at successive 30° intervals. Positions 1 and 2 were on the subject's right, position 3 was the central one, and positions 4 and 5 were on the subject's left (see Fig. 1). Only one of the five containers was baited at a time. The sequence of positions was randomized, but the order was the same for all subjects. The distance between the baited container and the subject was 70 cm (about two arm's lengths).

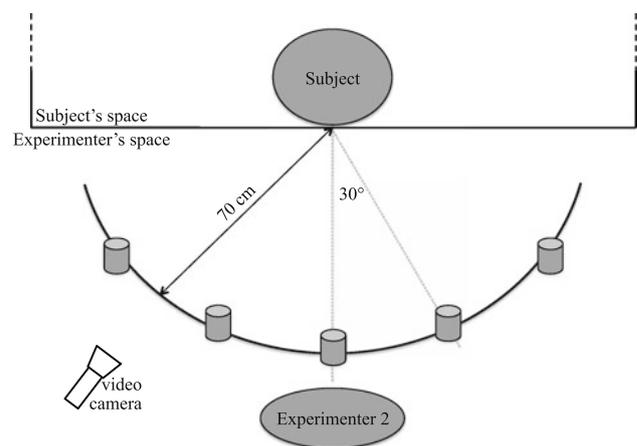


Fig. 1 Schema of the experimental set-up depicting Phase 3: Experimenter 2 is located in front of the experimental table and the subject. The food is hidden in one of the five containers

The experiment was set up outside the cage. A 10×60 cm hole in the wire mesh allowed the baboons to move their arms freely over the experimental table. To adjust the horizontal position of the subject, we placed a concrete block inside the cage, facing the mesh, 25 cm below the level of the table, aligned with the median plane of the table, so that when the subject sat down on the concrete block, it faced the set-up and the middle of the experimental table.

Two experimenters took part in each trial. They were separated from the tested subject by the cage wire mesh. The first experimenter (experimenter 1) baited one of the five containers. The use of experimenter 1's right versus left hand to place a raisin under one of the five containers on the experimental table was randomized, with equal use of left and right hands. While the container was being baited, the second experimenter (experimenter 2) stood with her back to the subject and to experimenter 1. This meant that experimenter 2 did not know which container was baited (i.e. where the food was hidden) and relied on information from the baboon (via pointing) to know which container to lift in order to reward the baboon. Each trial comprised three experimental phases. Phase 1 (attentional state: 'experimenter is standing with her back to the subject') started just after experimenter 1 had baited one of the five containers and involved experimenter 1 going to stand next to experimenter 2, who had her back to the subject. By the end of Phase 1, therefore, both experimenters were standing with their backs to the subject and were out of range of the set-up (approximately 3 m). Phase 2 started when the subject was sitting in the correct position on the concrete block, that is, in front of the experimental table, with its sagittal median plane aligned with the central axis of the set-up, and when both hands were free and placed symmetrically on the table. Experimenter 2 then turned round and moved towards the set-up in a straight line. In this phase, the attentional state was: 'experimenter is facing the subject but cannot deliver the reward because she is still out of range of the setup'. Phase 3 (attentional state: 'experimenter is facing the subject and can reward it') started as soon as experimenter 2 was close enough to the set-up to touch the different containers. Phase 3 ended when experimenter 2 took the container pointed out by the subject. After Phase 3, if the subject had pointed to the correct container, it was rewarded with the food placed under the container. If the subject pointed to a different container, the food was removed and a new trial was started. Experimenter 1 waited for the subject to sit down again, in the position described above, before starting the next trial.

All trials were videotaped. For each of the five positions, ten trials (each including the three experimental phases described above) were performed by each of the nine

subjects. Subjects were free to stop the experiment whenever they wanted to do. Thus, the 50 trials per subject were collected over a number of sessions, depending each subject's motivation. Some subjects performed more than 20 trials in a single session, but others stopped after only a few trials and we therefore needed more sessions to complete the 50 trials. The number of sessions per subject ranged from two to seven (mean = 3.67; SE = 0.65). In total, 450 trials were videotaped.

Video analysis

In order to test intentionality through pointing gestures produced by baboons, we analysed the videos with the software The Observer XT 10.1.548. The different types of communicative behaviour (visual and auditory signals characteristic of intentional gestural communication) produced by the tested subjects were classified as follows: (a) whole-hand movements directed towards one of the five distal containers that had previously been baited with a raisin were coded as 'pointing' (no index-finger pointings were recorded); (b) hand slapping on the table and banging on the cage were coded as 'attention-getting behaviour' (as only four vocalizations were recorded in 450 trials, we decided not to take vocalizations into account in our analyses); (c) rapid (<0.75 s) alternating gazes between experimenter 2 and the baited container (and vice versa) were coded as 'gaze alternation'; (d) gazes at experimenter 2 were coded as 'looking at the experimenter'; (e) gazes at the baited container was coded as 'looking at the baited container'; (f) gazes in directions other than experimenter 2 or the baited container were coded 'other visual behaviour'.

The numbers of occurrences for pointing, gaze alternation and attention-getting behaviour, and the durations for looking at the experimenter, looking at the baited container and other visual behaviour were analysed as a function of the three experimental phases described above, in order to identify the main criteria of intentionality.

Data analysis

For each subject, we calculated the rates of pointing, gaze alternation and attention-getting behaviour as the mean number of occurrences per minute recorded over the 50 trials. We also calculated the duration (in seconds per minute) of looking at the experimenter, looking at the baited container and other visual attention for each subject over the 50 trials. A Friedman two-way analysis of variance by ranks was performed, followed where appropriate, by a post hoc analysis (Wilcoxon signed-rank test). When we analysed the subsets of data, probabilities were corrected by a sequential Bonferroni procedure (Hochberg 1988; Holm 1979). *P* values are reported before the

Bonferroni correction. If results did not remain significant at the 5 % level after the correction, they are indicated as P^* . All analyses were performed using StatXact 3.1 for Windows.

Results

Pointing gestures

The pointing rate (Fig. 2) was significantly influenced by the experimenter's attentional state (Friedman test: $\chi^2 = 14.22$, $P < 0.001$). Subjects pointed significantly more in Phase 3, where experimenter 2 was facing them and could reward them, than in Phase 2, where experimenter 2 was facing them but could not reward them (Wilcoxon test: $P = 0.027$, $T = 4$), or Phase 1, where experimenter 2 was standing with her back to them (Wilcoxon test: $P = 0.004$, $T = 0$). The baboons also pointed more when the experimenter was facing them but could not reward them than when the experimenter was standing with her back to them (Wilcoxon test: $P = 0.012$, $T = 2$).

Visual behaviour

The rate of gaze alternation (Fig. 3) was significantly influenced by experimental phase (Friedman test: $\chi^2 = 6.22$, $P = 0.048$). Subjects produced significantly more gaze alternations when the experimenter was facing them and could reward them, than when she was standing with her back to them (Wilcoxon test: $P = 0.012$, $T = 2$). Baboons also tended to produce more gaze alternations when the experimenter was facing them but could not reward them than when the experimenter was standing with her back to them (Wilcoxon test: $P^* = 0.027$, $T = 4$).

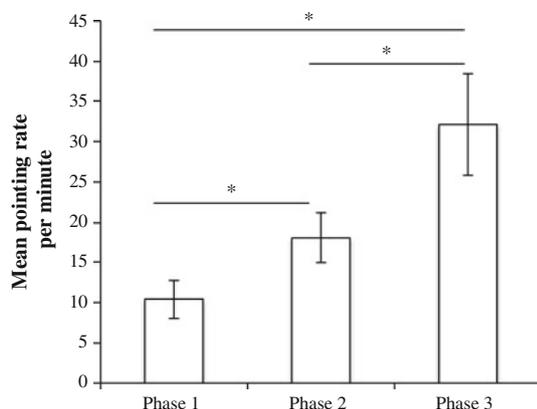


Fig. 2 Mean 'pointing' rates (\pm standard error) for the three experimental phases (*indicates $P < 0.05$)

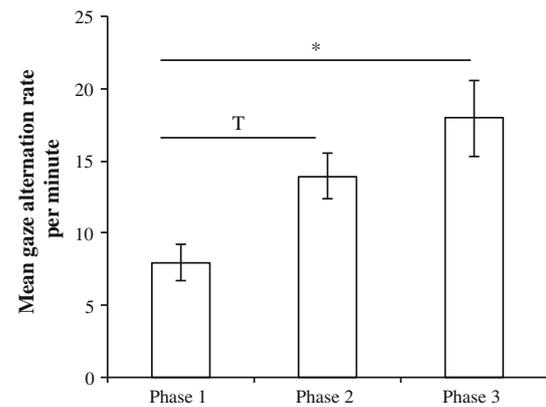


Fig. 3 Mean 'gaze alternation' rates (\pm standard error) for the three experimental phases (*indicates $P < 0.05$; T indicates $P < 0.06$)

There was no difference in gaze alternation between the two conditions where the experimenter was facing the subject (Phases 2 and 3).

The duration of looking at the experimenter (Fig. 4) was also significantly influenced by the experimenter's attentional state (Friedman test: $\chi^2 = 8.22$, $P = 0.006$). Post hoc analysis revealed that subjects looked at the experimenter for longer when she was facing them but was not able to reward them than when she was standing with her back to them (Wilcoxon test: $P = 0.008$, $T = 1$) or was facing them and could reward them (Wilcoxon test: $P = 0.008$, $T = 1$).

The duration of looking at the baited container (Fig. 4) was also significantly influenced by the experimenter's attentional state (Friedman test: $\chi^2 = 14.22$, $P < 0.001$). Subjects looked at the baited container for longer when the experimenter was facing them and was able to reward them than when she was facing them but could not reward them (Wilcoxon test: $P = 0.004$, $T = 0$) or was standing with

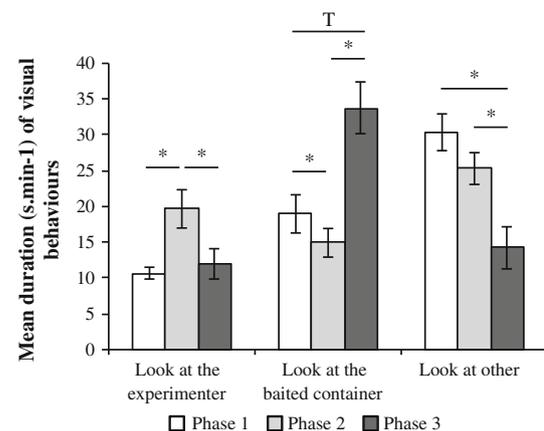


Fig. 4 Mean durations (in seconds per minute) of the three types of visual behaviours (\pm standard error) for the three experimental phases (*indicates $P < 0.05$; T indicates $P < 0.06$)

her back to them (Wilcoxon test: $P^* = 0.027$, $T = 4$). However, subjects looked at the baited container for longer when the experimenter was standing with her back to them than when she was facing them but could not reward them (Wilcoxon test: $P = 0.039$, $T = 5$).

Finally, the duration of other visual behaviour (Fig. 4) was significantly influenced by the experimenter's attentional state (Friedman test: $\chi^2 = 8.66$, $P = 0.0303$). The baboons looked in directions other than that of the experimenter or the baited container for significantly less time when the experimenter was facing them and could reward them than in the other two experimental conditions (Phase 1 vs. Phase 3, Wilcoxon test: $P = 0.019$, $T = 3$; Phase 2 vs. Phase 3, Wilcoxon test: $P = 0.004$, $T = 0$).

Attention-getting behaviour

The rate of attention-getting behaviour was not significantly dependent upon the experimenter's attentional state (Friedman test: $\chi^2 = 4$, $P = 0.143$).

Discussion

The aim of the present study was to investigate the ability of baboons to communicate intentionally about the location of an unreachable food reward, depending on the observer's degree of visual attention. To our knowledge, this is the first study to have assessed the communicative role of pointing in Olive baboons. Concerning intentionality, studies of human communicative development have considered the following criteria for defining children's ability to attract other people's visual attention and influence others to act upon the environment (e.g. Bard 1992; Bates et al. 1975, 1979; Rolfe 1999; Sugarman 1984): (1) requirement of an audience for the display of signals (Franco and Butterworth 1996); (2) influence of the observer's attentional state on gesture production (Bakeman and Adamson 1986; Franco and Butterworth 1996; O'Neill 1996); (3) gaze alternation between social partners and distant objects or events (Bates et al. 1975; Franco and Butterworth 1996; Tomasello 1995, 1999); (4) production of attention-getting behaviour such as vocalizations (Bates et al. 1975; Lock 2001); and (5) persistence in and (6) display of communicative behaviour when initial attempts to communicate fail (Bates et al. 1975; Golinkoff 1986, 1993; Lock 2001). In the present study, we examined the first four criteria.

The results of the current study showed that the baboons produced different types of communication behaviour as a function of experimental phase, that is, as a function of the experimenter's attentional states. They pointed more when they could see the experimenter's face than when they

could not see it. Pointing has been characterized as a referential activity, where humans and great apes use their outstretched arms and fingers to indicate distant objects (or events), referring to specific entities (Hopkins and Leavens 1998; Leavens and Hopkins 1998; Leavens et al. 1996, 2004b). Because the baboons used pointing gestures in a triadic context to draw the experimenter's attention to the unattainable food reward, these gestures can also be characterized as referential gestures. According to Tomasello (1996), the tested subjects could have learned this novel gesture via an individual learning process. This author called the process by which an action turns into a communicative signal as a result of the partner's reaction *ontogenetic ritualization*. Therefore, the use of such gestures should involve some understanding of how they act upon the recipient's behaviour. Had the subjects not understood the function of pointing gestures (i.e. had these gestures lacked a communicative role), this behaviour would have been randomly expressed, independently of the experimenter's attentional state. Consequently, our results are in agreement with those reported in the human literature (e.g. Bakeman and Adamson 1986; Franco and Butterworth 1996; Liszkowski et al. 2004), which show that children point more when their adult partners are attentive to them than when they are inattentive. Our results are also in agreement with several studies in chimpanzees (Hostetter et al. 2001, 2007; Kaminski et al. 2004; Krause and Fouts 1997; Leavens et al. 2004a; Liebal et al. 2004; Tomasello et al. 1994; see also Call and Tomasello 1994, for related findings with two orangutans) reporting an *audience effect* on pointing behaviour: great apes do not point (or point much less frequently) when an observer is absent or looking away from the pointing individual. Similar audience effects have been reported for capuchin monkeys (Mitchell and Anderson 1997) and rhesus monkeys (Blaschke and Ettliger 1987). More specifically, recent studies in chimpanzees suggest that their requesting gestures vary not only with the experimenter's body posture, orientation and bodily gestures (Hostetter et al. 2001; Leavens et al. 2004a; Povinelli et al. 2003), but also with his or her visual attention (e.g. eyes opened or closed; see Hostetter et al. 2007). However, this last conclusion concerning the experimenter's attention is not shared by Povinelli and Eddy (1996), who found that chimpanzees did not differentiate between two experimenters on the basis of their ability to see.

Another criterion for identifying intentional communication is gaze alternation. Gaze-following in non-human animals was first investigated by Povinelli and Eddy (1996) in a group of young chimpanzees. In great apes, gaze alternation between a human communicative partner and out-of-reach food has been described as complementing gestural communication (Leavens and Hopkins 1998;

Leavens et al. 1996, 2004b). In the wild, it has been reported that a bonobo that had previously been pointing at human observers to communicate about their presence to its conspecifics used gaze alternation between these observers and the other bonobos (Veà and Sabater-Pi 1998). Anderson et al. (2001, 2007, 2010) have also shown that squirrel monkeys are able to produce operant-trained pointing in association with gaze alternation. In human infants, many studies (e.g. Bates et al. 1975; Butterworth 2001; Franco and Butterworth 1996; Tomasello 1995, 1999) have reported successive visual orienting behaviours between social partners and distant objects or events. Interestingly, this visual orienting behaviour has been shown to be more frequent in great apes than in human infants (Leavens and Hopkins 1999). Our results revealed that the Olive baboons' display of gaze alternation between the experimenter and the baited container differed according to the experimenter's attentional state. The baboons produced more gaze alternation when the experimenter was facing them (Phases 2 and 3) than when she was standing with her back to them (Phase 1). Consequently, our results followed the patterns reported in studies with great apes and humans. Moreover, our results indicated that the direction (i.e. experimenter, food or other) in which the baboons looked was also influenced by the experimenter's attentional state. It is worth noting that the subjects spent the most time looking in directions other than that of the experimenter or the baited container when the experimenter had her back to them and was thus was not attending to their gestures. Therefore, we can hypothesize that the subjects understood the key role played by the human partner in obtaining the food reward, and indicated their lack of interest in both the experimenter and the baited container by looking in other directions during Phase 1. Conversely, when the experimenter attended to the subjects' gestures, other visual behaviour tended to decrease, being replaced by looking at the experimenter (mostly in Phase 2) and looking at the baited container (mostly in Phase 3). This change in the baboons' behaviour between Phases 2 and 3 suggests that they realized the difference between the two phases and understood that the experimenter was not able to reward them when the container was out of her reach. The fact that the baboons mostly directed their gaze towards the baited container during Phase 3 seems to indicate that they wanted to communicate about the location of the container with the desired food to their human partner through their gaze orientation. Given the absence of reports of pointing in wild monkeys, we adhere to the hypothesis (see Leavens et al. 1996; Menzel 1973) that monkeys naturally/instinctively indicate their interest in a distal desired object by turning their face, as well as their body, in its direction—even those that can use operant-trained pointing to

communicate. Our study supports this hypothesis insofar as the baboons used gaze alternation simultaneously with their gestural communication.

In the wild, gorillas, bonobos and chimpanzees have also been seen to express attention-getting behaviour with respect to the visual state of conspecifics (Pika et al. 2003; Tomasello et al. 1994, 1997). Krause and Fouts (1997) provided observational evidence that their two sign-language-trained chimpanzees generated a variety of sounds (i.e. foot stomping, cage banging, vocalizations and clapping) to attract the attention of the human experimenter before pointing to unreachable food. However, caution needs to be exercised regarding the conclusions of these observational studies. Many authors (Itakura and Tanaka 1998; Neiworth et al. 2002; Peignot and Anderson 1999) have drawn attention to the fact that great apes, because of their involvement in a number of object-choice experiments, have a history of 'enculturation' (Call and Tomasello 1996). Call and Tomasello (1996) reviewed experimental data on great apes' performance on cognitive tasks and found that individuals that had been raised in intimate and extensive contact with humans and human culture unanimously displayed more complex levels of cognition than naïve subjects. It is worthwhile pointing out that our baboons, apart from being rather rapidly trained to point, were in no way 'enculturated', as they were living their 'baboon's life' in their respective social groups. This factor reinforces our findings regarding this species' mastery of intentionality. In our study, the baboons' use of attention-getting behaviour (i.e. hand slapping on the table and banging on the cage) did not differ as a function of the human partner's attentional state. Hostetter et al. (2001) and Leavens et al. (2004a), on the other hand, have produced experimental evidence that captive chimpanzees produce more of this type of behaviour when a human observer is not looking at the communicating chimpanzee. It is interesting to note that in the current study, the desired distal object was a food reward—the object that is most often used in studies of manual gestures in great apes (e.g. Bard 1992; Call and Tomasello 1994; Leavens and Hopkins 1999). As argued by Leavens and Hopkins (1999), as well as by Russell et al. (2005), the frustration and excitement generated by the presence of unreachable food may influence the expression of this 'noisy' behaviour. Accordingly, this behaviour may be expressed not only to attract the experimenter's attention but also as a result of emotional factors. These two aspects may have interacted during the three experimental phases, regardless of the experimenter's orientation (facing towards or away from the subject), and may thus explain our results. To address the observer effect on the production of attention-getting behaviour in baboons, the food could be replaced with a non-food item, as used in previous studies with great apes

(Call and Tomasello 1994; Russell et al. 2005), the downside being that it might reduce the baboons' motivation to take part in the experiments.

To summarize, we have demonstrated that baboons recognize the need to get the human experimenter's attention before pointing to the location of out-of reach food. We have also demonstrated our baboons' capacity for non-verbal reference, the latter being defined as the ability to direct the attention of a social partner to some specific entity without language (e.g. Adamson 1996; Bates et al. 1987). Furthermore, our study indicates that baboons accompany gestures with gaze alternation between the experimenter and the distal food, which they adjust according to the situation (human attentional state), reinforcing our assertion that our subjects' gestural communication was about a specific item. In conclusion, the present findings support the evidence that, like great apes and human infants, baboons are able to discriminate between the visual attentional states of a human partner and to communicate the location of an unreachable food reward to the latter through pointing gestures associated with gaze alternation. The signals produced by the tested subjects met the criteria for intentional gestural communication defined in both the human and the ape literature. By modulating their manual and visual communicative signals as a function of the human's attentional state, baboons that had previously been trained to exhibit pointing, using operant conditioning, also displayed a cognitive ability to communicate intentionally.

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