

Chimpanzee (*Pan troglodytes*) Pointing: Hand Shapes, Accuracy, and the Role of Eye Gaze

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The manual pointing of 2 signing chimpanzees, Moja and Tatu, was examined in 2 experiments. Experiment 1 investigated eye-gaze direction, hand use, and hand shape while pointing. Both chimpanzees obtained the attention of a human before pointing toward an unreachable object. During 100 trials, the chimpanzees alternated their eye gaze between the object and the human while pointing. Moja's points were left-hand biased, and Tatu showed no lateral hand bias. Both indexical and whole hand points were recorded. Experiment 2 tested the chimpanzees' ability to point accurately toward objects in close proximity to each other. Humans were able to reliably determine the locations toward which the chimpanzees pointed. Both chimpanzees showed left-hand biases, and a higher proportion of indexical points were observed than in Experiment 1. These results are compared and contrasted with recent hypotheses pertaining to the topography of chimpanzee pointing and the role of eye gaze in deictic interactions.

Mutual eye gaze is necessary to establish and manipulate between conversation partners if pointing occurs during the interaction (Desrochers, Morissette, & Ricard, 1995; Leung & Rheingold, 1981; Lock, Young, Service, & Chandler, 1990). Pointing typically develops in human infants during the first year but does not become fully mature until 18 to 24 months of age (Bates, Camaioni, & Volterra, 1975; Desrochers et al., 1995; Dobrich & Scarborough, 1984). At this time infants start pointing as a means of directing the adult's attention toward an object, rather than exclusively to themselves, as evinced by the presence of eye-gaze alternation between the conversation partner and the referent in conjunction with pointing (Desrochers et al., 1995; Hannan & Fogel, 1987). Human infants comprehend the function of pointing before they are able to produce the gesture (Butterworth, 1995). Prior to the onset of pointing, infants also learn that gaze direction can be used to refer to something in the environment. Therefore, an understanding of the referential meaning of joint attention is a necessary condition for the

development of pointing. Butterworth (1995) notes that "joint attention is thought to pave the way in human development for deictic gestures, such as manual pointing, which draw attention to a particular object by locating it for another person" (p. 29).

Manual pointing has been reported in captive chimpanzees (Fouts, Hirsch, & Fouts, 1982; Gardner & Gardner, 1975; Leavens, Hopkins, & Bard, 1996), bonobos (Savage-Rumbaugh, McDonald, Sevcik, Hopkins, & Rupert, 1986), gorillas (Patterson, 1978), and orangutans (Call & Tomasello, 1994; Miles, 1980, 1990). The apes in these reports were reared in laboratory or home-like environments. Many of the captive apes for which there are published records of pointing were taught to use either American Sign Language (ASL) (Fouts et al., 1982; B. T. Gardner & Gardner, 1975, 1994; Miles, 1990; Patterson, 1978) or lexigram boards (Savage-Rumbaugh, 1986). However, Boysen, Berntson, Shreyer, and Hannan (1995), Call and Tomasello (1994), Leavens et al. (1996), and Povinelli, Nelson, and Boysen (1990), among others, report pointing in apes who have not received language training. Tomasello, Call, Nagell, Olguin, and Carpenter (1994) found that various chimpanzee gestures (including pointing) occurred in several contexts in which eye gaze was the medium in which the sender communicated his or her intentions. Manual pointing may not even be exclusive to humans and apes. Laboratory rhesus macaques (*Macaca mulatta*) pointed toward out-of-reach objects during experimental situations (Blaschke & Ettlinger, 1987; Hess, Novak, & Povinelli, 1993). Currently there are no published reports of pointing in feral chimpanzees.

Although it is apparent that pointing is relatively common among captive apes, there is a paucity of literature dealing with the ways that eye gaze is used to manipulate the attention of others in deictic interactions (see Gomez, 1991; Russell, Bard, & Adamson, 1997). Also, much significance has been attached to the fact that humans extend their index

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fingers when pointing (see Butterworth, 1995; Povinelli & Davis, 1994). B. T. Gardner, Gardner, and Nichols (1989) and Leavens et al. (1996) report index finger extension in the pointing of several chimpanzees. However, the proportion of whole hand and indexical points are only reported in the latter study. Finally, the degree of precision or accuracy evinced by chimpanzees when pointing has received no attention.

Two experiments were conducted to address various questions relevant to referential pointing in apes. The first experiment examined the intentional components of pointing in 2 chimpanzees, namely, how they acquire the attention of a human and how they direct it toward a distal, out-of-reach object. We hypothesized that the chimpanzees would acquire the visual attention of a human before pointing toward an unreachable object, and, when pointing, would alternate their eye gaze direction between the human and object. Experiment 2 tested whether humans could reliably determine where the chimpanzees point when the side and height of an object are manipulated. On the basis of daily observations of pointing, we hypothesized that humans would be able to readily identify the specific locations toward which the chimpanzees point. Data on hand use and configuration were gathered during both experiments.

Experiment 1: Eye Gaze and Pointing

The purpose of Experiment 1 was to determine whether the chimpanzees' pointing was communicative. The presence of attention getting, mutual gaze, and concomitant gaze alternation between the referent and the recipient when pointing were taken as evidence for this. The methodology required that the chimpanzees initiate interactions with a human, and that subsequent gaze alternation by the chimpanzees remained uninfluenced by the gaze direction of the human. The attention-getting sounds with which the chimpanzees established mutual eye contact, gaze direction when pointing, and hand use and configuration were recorded for each trial.

Method

Subjects. The subjects were 2 adult female chimpanzees, Moja (23 years) and Tatu (21 years), who use the signs of ASL (B. T. Gardner & Gardner, 1994). Both chimpanzees were born in captivity and cross-fostered by humans (R. A. Gardner & Gardner, 1989). Moja and Tatu are socially housed in a large facility along with 3 other chimpanzees, Washoe, Dar, and Loulis. The chimpanzees have daily access to 2,133 m² of outdoor and indoor living space. Subject participation was optional. Washoe, Dar, and Loulis did not initiate any interactions.

Procedure. Data were gathered during the chimpanzees' meal times by an interactor and an experimenter. All trials were videotaped. At the beginning of each trial, the experimenter entered the chimpanzees' enclosure area and placed a food bowl (containing crackers or vegetables) within one of two randomly selected containers set 5.0 m apart and far enough beyond the enclosure fence to prevent reaching.

To eliminate the possibility of the experimenter cuing the interactor to the food location, the two did not have any contact.

The interactor remained in a waiting room while the experimenter placed the food bowl inside of a container. The experimenter showed the food bowl to the chimpanzees, placed it in the container, and knocked on the waiting room door before entering a separate, adjacent room. The interactor then entered the night enclosure area, started the video camera, and sat facing 180° away from the enclosure. The interactor could not see inside of the containers from where he sat.

Prior to the study we observed the chimpanzees producing a variety of sounds such as signing loudly, hitting the enclosure fence, "Bronx cheering," foot stomping, and hand clapping as attention-getting devices. When a chimpanzee made a sound, the interactor turned and faced her but did not exhibit any more interactive behaviors until the chimpanzee gestured. This procedure established whether or not the chimpanzees acquired the visual attention of the interactor before they pointed. The interactor kept his eye gaze fixed on the chimpanzee who initiated the interaction. This reduced the possibility that the chimpanzee's averted gaze was a response to the interactor's. If the chimpanzee signed what was in the container (e.g., CRACKER, CARROT, or COOKIE), the interactor repeated the sign back with a questioning look (raised brows, head tilted forward). Aside from facing the chimpanzee and reiterating their signs, the interactor remained noninteractive until the chimpanzees pointed for the first time. The end of the first point marked the end of each trial. After the chimpanzees pointed for the first time the interactor was free to sign and avert his gaze.

Following each trial the interactor offered the food to all of the chimpanzees, placed the food bowl in front of the room where the experimenter waited, and knocked on the door. The interactor then returned to the waiting room. The experimenter entered the night enclosure area, refilled the food bowl if necessary, and placed it in the next randomly assigned location to begin the next trial.

Fifty trials were collected for each chimpanzee with an equal number of trials for both locations. A maximum of five trials for each chimpanzee was collected during each data session. Data sessions were collected over a 37-day period with a maximum of two sessions per day that were separated by a 3-hr interval.

Analysis. The trials were analyzed from the video tapes. Only the first point in each trial was analyzed for eye-gaze direction. Scoring for gaze behavior began 2 s prior to full extension of the arm and ended 2 s after full arm extension. The direction of the chimpanzee's gaze was recorded during this interval. The gaze-direction categories included alternating eye gaze between the interactor and the container, fixing eye gaze on either one or the other, or toward neither. Attention-getting behaviors, hand use, and hand configuration (index extended or whole hand) were also recorded.

Reliability. Two observers independently viewed all of the trials to determine if the interactor averted his gaze before the chimpanzees pointed. Trials were discarded if both observers agreed that the interactor averted his eye gaze before the chimpanzee completed her first point. This eliminated the trials in which the human may have influenced the chimpanzees' gaze direction. If the observers disagreed, the trial was viewed by a third observer and was either kept or discarded on the basis of the agreement between two of the three observers. Discarded trials were later reexecuted.

Two observers separately viewed the 100 trials from video and recorded the chimpanzees' eye-gaze direction and attention-getting behaviors. Interobserver agreement for eye-gaze coding was 95.1% (Cohen's $\kappa = .74$) and for attention-getting behaviors reached 93% (Cohen's $\kappa = .90$). Twenty-five percent of the trials were scored for hand use and configuration. Interobserver agreement levels on hand use and configuration (combined for both experiments) were 99% (Cohen's $\kappa = .97$) and 100% (Cohen's $\kappa = 1.0$), respectively.

Table 1

Frequency of Each Attention-Getting Behavior With Which Moja and Tatu Successfully Initiated Interactions

Subject	Behavior									
	bc	hc	hf	dfs	sn	sn + hf	bc + hf	bc + sn	sn + hc	hf + bc + sn
Moja (<i>n</i> = 50)	4	0	28	1	7	6	2	1	0	1
Tatu (<i>n</i> = 49)	0	10	0	0	38	0	0	0	1	0
Total	4	10	28	1	45	6	2	1	1	1

Note. One of Tatu's attention-getting behaviors was not visible. bc = "Bronx cheer" or "raspberry," hc = hand clap, hf = hit on fence, dfs = foot stomp, sn = sign.

Results

Table 1 shows the frequencies for the various attention-getting sounds with which Moja and Tatu initiated interactions. Both chimpanzees always initiated interactions shortly after the interactor sat down. The two never attempted to initiate an interaction simultaneously.

Individual differences in attention-getting behaviors were found. Tatu typically signed loudly (78%) or hand clapped (20%) when initiating interactions. Moja typically hit the fence to obtain the interactor's attention (56%), and she combined many attention-getting behaviors either simultaneously or in immediate succession. Attention-getting behaviors always preceded pointing toward the containers. Presumably if the chimpanzees extended their hands toward the containers without first establishing eye contact, one could reasonably argue that they were reaching rather than pointing. This was not the case since only one point was emitted (by Tatu) before mutual gaze was established (binomial test, $p < .0001$), and an attention-getting behavior still preceded the point.

Either Moja or Tatu pointed during every trial. Their gaze directions for the 100 trials are shown in Table 2. Both chimpanzees alternated their eye gaze between the interactor and the container during a statistically significant portion of the trials: Moja, $\chi^2(3, N = 50) = 124.7, p < .0001$; Tatu, $\chi^2(3, N = 50) = 131.6, p < .0001$. Moja always made eye contact with the interactor within the 2-s interval prior to full arm extension. With one exception, Tatu did the same. With few exceptions the chimpanzees made use of attention-getting behaviors, pointed only after mutual eye gaze was established, and alternated their gaze between the referent and interactor in conjunction with pointing. This demonstrates that the chimpanzees' pointing is communicative.

The interactor was free to sign with the chimpanzees without any restrictions after the first point occurred in each

trial. A total of 288 points were recorded during all of the interactions. These are included in the data presented in Table 3, which reports hand use and configuration.

Moja pointed with her left hand on 87 of 135 (64%) single-hand points and with her right hand on the remaining 48 (36%; binomial test, $p < .001$). Moja pointed across her body with her left hand 11 times but never pointed across her body with her right hand. Tatu normally pointed toward the object with the ipsilateral hand (73 left-hand and 64 right-hand points). She pointed across her body once (with the left hand) and showed no lateral bias for hand use (binomial test, $p = .14, ns$). Hand configuration appeared to be closely related to hand use for both subjects. Therefore, hand use and configuration data were analyzed with chi-square tests for each chimpanzee. Whole-hand points were most prevalent when the chimpanzees pointed with their left hands: Moja, $\chi^2(3, N = 135) = 67.4, p < .0001$; Tatu, $\chi^2(3, N = 147) = 66.2, p < .0001$. Leavens et al. (1996) also reported a bias toward left whole-hand points by their subjects. Indexical points were more frequent than whole-hand points: Moja, 111 indexical, 24 whole hand; Tatu, 119 indexical, 28 whole hand. All of the two-handed points included extended index fingers. The hand use distributions for single-hand indexical points were fairly even for both chimpanzees: Moja, 66 left handed (60%) and 45 right handed (41%); Tatu, 56 left handed (47%) and 63 right handed (53%).

Experiment 2: Communicating Object Locations

That the chimpanzees referentially indicate location was clearly demonstrated in Experiment 1. With one exception, Moja and Tatu always pointed toward the container that held

Table 2

Frequency of Each Eye-Gaze Direction for Moja and Tatu

Subject	Alternate	Object	Interactor	Neither ^a
Moja	48	0	2	0
Tatu	49	1	0	0
Total	97	1	2	0

Note. Moja: $\chi^2(3, N = 50) = 124.7, p < .0001$; Tatu: $\chi^2(3, N = 50) = 131.6, p < .0001$.

^aRefers to points in which gaze direction was not oriented toward the object or the interactor.

Table 3

Hand Use by Configuration Frequencies for Moja and Tatu Recorded During Experiment 1

Subject	Left hand		Right hand		Both ^a
	Index	Whole	Index	Whole	
Moja (<i>n</i> = 141)	66	21	45	3	6
Tatu (<i>n</i> = 147)	56	27	63	1	0
Total	122	48	108	4	6

Note. Moja: $\chi^2(3, N = 135) = 67.4, p < .0001$; Tatu: $\chi^2(3, N = 147) = 66.2, p < .0001$. All two-handed points were with extended index fingers.

^aNot included in the test statistics.

the food. However, the substantial distance between the containers (5 m) provided only a gross indication as to how accurately the chimpanzees point. By adding locations along the dimensions of height and side relative to the chimpanzee, it was possible that determining where they point would be more difficult. This was tested in a second experiment. Additional data on hand use and configuration were also gathered.

Method

Subjects. The subjects of Experiment 2 were Moja and Tatu. As in Experiment 1, subject participation was optional. Washoe, Dar, and Loulis did not initiate any interactions.

Procedure. Four 7.5-L containers were placed on their sides 1.5 m in front of an enclosure so that their contents were visible to the chimpanzees. The containers were placed beyond the chimpanzees' reach. Two of the containers were positioned on the ground 1.2 m apart, and the other two were placed 1.2 m directly above each of these. The trials were recorded with a video camera mounted on a tripod 1.2 m above ground.

A total of 40 trials were collected for each chimpanzee (80 trials total). Three humans collected the data: an experimenter and two interactors. Each interactor collected 40 trials (20 per chimpanzee). Data sessions took place during meal times. The experimenter placed a food bowl holding crackers or vegetables into a randomly selected container to begin each trial. Similar to Experiment 1, the procedure for avoiding contact between the interactor and experimenter was used. The interactors were unaware of the food location during each trial.

The interactor sat facing the enclosure and made eye contact with any chimpanzee that approached. The interactor looked inside of the first container toward which the chimpanzee pointed. If the container held the food bowl, the interactor offered the contents to all of the chimpanzees. If the container did not hold the food bowl, the interactor removed the bowl from the correct container and did not offer the contents to the chimpanzees until a successful trial was completed or the data session ended.

After each trial, the interactor placed a slip of paper in the food bowl that indicated the location toward which the chimpanzee pointed. The interactor then knocked on the door before returning to the waiting room. The experimenter retrieved the food bowl and recorded the information from the slip of paper on a cumulative data sheet that included a randomized list of the food locations and the corresponding result from each trial. The experimenter then refilled the food bowl if necessary and placed it in the next randomly assigned location for the next trial. A maximum of two sessions per day of up to five trials for each chimpanzee were collected over a 34-day period.

Chance expectancy. The food locations for the entire 80 trials were randomized with an equal number of trials collected per location for both Moja and Tatu. Chance expectancy was estimated using the formula from Patterson, Gardner, and Gardner (1986). The interactors knew the number of trials they would collect and the number of possible food locations. Therefore, guessing on the part of the interactors must be accounted for when determining chance level performances. Assuming perfect memory, the interactors' chances of correctly guessing the loaded container would have improved over the course of the experiment based on trial-by-trial feedback alone. Using the formula from Patterson et al. (1986), we determined that 29.2% of the trials could have been scored as correct by chance alone. This is slightly higher than the 25.0% chance level that only accounts for guessing on the part of the chimpanzee.

Reliability. Interobserver agreement on the locations that the chimpanzees pointed toward was compared between the interactors and two observers. The first observer viewed the first 40 trials from the video recordings and the second observer viewed the remaining 40 trials.

The observers separately viewed the trials on a video monitor while a VCR operator (VO) controlled the video playback and watched the trials from a second monitor. A blind separated the observer and the VO. After viewing each trial, the observer wrote down the location that the chimpanzee pointed toward on a piece of paper and slipped it through a slot in the blind. The VO recorded this information and told the observer where the food was placed. This procedure provided the observers with the same trial-by-trial feedback that the interactors had during the trials. Interobserver agreement for the locations that the chimpanzees pointed toward was 86% (Cohen's $\kappa = .83$).

Results

The chimpanzees directed their points spatially to one of four locations with a high level of accuracy. Table 4 shows the number of trials scored as correct for Moja and Tatu by the interactors and the observers. The data reported in Table 4 show that humans were able to reliably determine where the chimpanzees pointed. Moja and Tatu pointed to the correct location in a significantly high proportion of the 80 trials. The interactors scored the fewest points as correct for either chimpanzee: Tatu, 30 correct out of 40 (75%). The interactors also scored the most points correct for either chimpanzee: Moja, 37 correct out of 40 (93%). The observers scored 34 out of 40 (85%) points as correct for both Moja and Tatu. The expected percentage is the proportion of trials that either the interactors or the observers could have scored as correct using trial-by-trial feedback alone. Clearly, the number of correct points produced by both chimpanzees is appreciably higher than the expected value.

The number of trials scored as errors by the interactors and the observers are reported in Table 5. The food was placed in the high locations on 20 trials and in the ground level locations on 20 trials for each chimpanzee. Errors that were made along the dimension of height are combined in Table 5, irrespective of the side on which the food was placed. Also, 20 trials were collected per side for each chimpanzee. Table 5 also shows the number of errors in which the chimpanzees pointed to the wrong side, irrespective of height. The chimpanzees never pointed to the wrong side and height. The most frequent error was along the

Table 4
Percentage of Points Scored as Correct for Moja and Tatu by the Interactors and the Observers

Subject	No. of trials	Expected %	Points (%) scored correct by	
			Interactors	Observers
Moja	40	29.2	92.5	85.0
Tatu	40	29.2	75.0	85.0

Note. Expected percentage is the proportion of the total trials that the interactors and the observers could score as correct by chance alone.

Table 5
Error Frequencies for Height and Side Scored by the Interactors and Observers

Subject	Moja		Tatu	
	Height	Side	Height	Side
Interactors	2	1	10	0
Observers	6	0	6	0

dimension of height. With one exception, all of these errors occurred when the higher location was loaded and the point oriented toward the container below it. Tatu made this type of error most frequently. Table 5 reflects the difficulty in discriminating Tatu's points to the higher locations from her points to the lower locations.

Overall, the observers and the interactors were able to identify Moja's points to the higher locations more readily than Tatu's. The data reported above are restricted to the first point in each trial. However, on four trials Tatu corrected herself by pointing higher than she previously had after the interactor looked into the lower (empty) container. These points were still scored as errors. Similar to Experiment 1, additional points were recorded after the trials ended. These points were included in the hand use and configuration analyses.

Table 6 shows the distributions for hand use and configuration for all of Moja and Tatu's points ($n = 128$) recorded during Experiment 2. Left-hand points were more frequent than right-hand points (83% for both chimpanzees; binomial tests, $p < .0001$). The hand use and configuration distributions from Experiments 1 and 2 clearly differ. The majority of the points observed in Experiment 2 were left-hand indexical: Moja, $\chi^2(3, N = 66) = 117.5, p < .0001$; Tatu, $\chi^2(3, N = 60) = 106.3, p < .0001$, and no whole-hand points were observed. Trends in hand use, configuration, and the interaction between the two found in both experiments resembled those reported for other chimpanzees (see Leavens et al., 1996).

Discussion

Experiment 1 confirms that the chimpanzees point referentially toward objects in their environment. With one exception, Moja and Tatu waited for the human to face them

Table 6
Hand Use by Configuration Frequencies for Moja and Tatu Recorded During Experiment 2

Subject	Left hand		Right hand		Both ^a
	Index	Whole	Index	Whole	
Moja ($n = 67$)	55	0	11	0	1
Tatu ($n = 61$)	50	0	10	0	1
Total	105	0	21	0	2

Note. Moja: $\chi^2(3, N = 66) = 117.5, p < .0001$; Tatu: $\chi^2(3, N = 60) = 106.3, p < .0001$. All two-handed points were with extended index fingers.

^aNot included in the test statistics.

before pointing, and they maintained eye contact and alternated their eye gaze between the referent and recipient while pointing. Index-finger extension was the most common hand configuration used, although whole-hand points occurred. The pointing observed should not be confused with reaching. If the chimpanzees were reaching, then acquiring the human's attention before doing so would be of little use.

Some noteworthy differences in hand use and configuration were found between the two experiments. The differences observed could be a function of the distance between the chimpanzees and the object. The chimpanzees situated themselves 5 m from the object during Experiment 1, and roughly 1.5 m from the object during Experiment 2. A correct solution in Experiment 2 required a greater degree of precision when pointing than Experiment 1. This could explain why the chimpanzees were more inclined to point indexically when the objects were closer together and at different levels. The reduction in distance from the object may also explain the greater hand bias seen in Experiment 2. Tatu's switch from ambidextrous to left-hand pointing from Experiments 1 and 2 may have been distance related. The same types of food were used in both experiments, which reduced the possibility that different motivation levels influenced these data. However, further work is needed in order to determine whether it is the distance from the object or the number of locations that influences hand use and shape.

Evidence from the present investigation demonstrates that captive chimpanzees use referential pointing with extended index fingers. This ability develops in both laboratory- and home-reared apes. Language training is not necessary for the development of pointing (see Boysen et al., 1995; Leavens et al., 1996). Despite their rich communicative repertoires, pointing has not been reported in wild chimpanzees. Plooi (1978) states that "searching for examples of pointing in chimpanzees is not very fruitful" (p. 126). Most likely, Plooi's comment is in reference to feral chimpanzees. Plooi (1978) has shown that feral chimpanzees gesture and establish mutual eye gaze when food begging. This indicates that certain behavioral requisites for referential pointing occur naturally. Menzel (1973), who studied vocal and nonverbal communication in a group of captive chimpanzees, states that chimpanzees use posture as a means of indicating direction and therefore do not need pointing. Chimpanzees primarily stand and locomote quadrupedally when on the ground. Quadrupedalism could make pointing inconvenient because of the postural adjustments that it would necessitate.

Eibl-Eibesfeldt (1989) claims that indexical pointing occurs universally among human cultures. However, other evidence suggests that cultural customs dictate whether or not indexical pointing is used (Jakobsen, 1990). Several investigators include index-finger extension in their definitions of pointing (e.g., Butterworth, 1995; Dobrich & Scarborough, 1984; Lock et al., 1990; Povinelli & Davis, 1994). The functional utility of pointing is overlooked by regarding a single aspect with such primacy. The meaning of the gesture is not necessarily changed according to the

number of digits extended. Therefore, a truly useful definition of referential pointing emphasizes its functional properties rather than its structural appearance.

The most important aspect of pointing is that it draws the attention of the recipient toward something. This can be done with a variety of bodily regions including the head, shoulders, and chin. Pointing requires visual attention between conversation partners. Thus a variety of directional gestures, accompanied by mutual eye contact, are what make the exchange of referential information possible. Povinelli and Davis (1994) hypothesize that the presence of pointing in humans and its apparent absence in chimpanzees are due to species differences in hand morphology and social attribution abilities. The results from the present experiments offer alternative evidence to both of these positions. Captive chimpanzees raised under various conditions do in fact use indexical pointing (e.g., Fouts et al., 1982; Hayes & Hayes, 1954; Kellogg & Kellogg, 1967; Leavens et al., 1996; B. T. Gardner & Gardner, 1975; B. T. Gardner et al., 1989).

Food was used as an incentive in this investigation. It was not necessarily an incentive to point. The chimpanzees could have attempted to direct the interactor's attention to the food in other ways, but pointing happened to be the most consistent strategy used from the beginning of the experiments. The chimpanzees also point to nonfood objects during a variety of activities. Clearly, when the chimpanzees sign YOU or ME, they are not pointing toward food items. When private signing, the chimpanzees look at picture books and magazines, point to objects on the pages, and use signs that match the stimuli present (Bodamer, Fouts, Fouts, & Jensvold, 1994).

These findings relate to a broader issue concerning the type of information conveyed through pointing. The two experiments reported here show how pointing is used to direct another's attention toward a desired object. Referential pointing is also used to name and show objects to another. The distinction between pointing as a means of naming or showing versus requesting has received considerable emphasis in the child development literature (see Bates et al., 1975; Franco & Butterworth, 1996). Evidence such as that in Bodamer et al. (1994), B. T. Gardner and Gardner (1994), and Miles (1990) demonstrate that apes point toward and name objects in both social and nonsocial contexts. Additional experimental research could further examine how pointing is incorporated into signed utterances that serve to name or show objects as well as request them. This could also be tested in apes who have not received language training.

A replication of these experiments using a larger sample and subjects with various rearing histories would be favorable. The types of stimuli that motivate chimpanzees to point could also be identified by using a variety of food and nonfood objects. Finally, given that pointing develops early in captive chimpanzees (see B. T. Gardner et al., 1989), comparative developmental studies between chimpanzees and children of similar ages could be done. Data on developmental rates, the establishment of mutual eye gaze, the topography of the gesture, and the environmental conditions that

influence the development of pointing would prove useful to comparative studies in chimpanzee and human cognition.

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