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Intentional Communication by Chimpanzees: A Cross-Sectional Study of the Use of Referential Gestures¹

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Abstract

This study describes the use of referential gestures with concomitant gaze orienting behavior to both distal food objects and communicative interactants by 115 chimpanzees, ranging from 3 to 56 years of age. Gaze alternation between a banana and an experimenter was significantly associated with vocal and gestural communication. Pointing was the most common gesture elicited; 47 subjects pointed with the whole hand, whereas 6 subjects pointed with index fingers. Thus, communicative pointing is commonly used by laboratory chimpanzees, without explicit training to point, language training, or home rearing. Juveniles exhibited striking decrements in their propensity to communicate with adult male experimenters compared with older chimpanzees. Significantly fewer mother-reared chimpanzees exhibited gaze alternation compared with nursery-reared chimpanzees.

Pointing in humans becomes an intentionally communicative gesture at about 12 months of age (e.g., Bates, Camaioni, & Volterra, 1975; Blake, O'Rourke, & Borzellino, 1994; Bruner, 1975; Franco & Butterworth, 1996; Leung & Rheingold, 1981). *Intentional*, mature use of pointing is defined as pointing with reference to the attentional status of an observer; this is measured by the gaze behavior of pointing individuals. One measure of gaze behavior used to identify intentional communication in humans is *gaze alternation*, in which the signaler alternates his or her gaze between a distal object or location and the face of the recipient of a gesture (e.g., Harding & Golinkoff, 1979; Tomasello, 1995).

Recent work examining intentional communication and social referencing in apes in a variety of free-ranging and laboratory settings also relies on measures of visual orienting behavior to establish that communication by these close relatives of humans is "about" specific objects in the environment (e.g., Bard, 1990, 1992; Gómez, Sarriá, & Tamarit, 1993; Leavens, Hopkins, & Bard, 1996; Miles, 1990; Russell, Bard, & Adamson, 1997; Tomasello, George, Kruger, Farrar, & Evans, 1985; de Waal, 1982). For example, Tomasello et al. (1985) reported that only the 2 oldest of their sample of 5 juvenile chimpanzees exhibited gaze alternation while gesturing. More recently, Russell et al. (1997), in their study of social referencing, found that each of 17 infant and juvenile chimpanzees exhibited referential glancing (gaze alternation) between a novel object and the faces of their primary caregivers. Russell et al. also reported that the rate of referential glancing significantly increased with age. The present study seeks to establish whether gaze alternation between a communicative interactant and a desirable food

¹*Referential*, in the present context, means that gestures are demonstrably about objects in the environment and is not meant to imply symbolic reference or representation.

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object is associated with vocal or gestural communication throughout the life span of chimpanzees (*Pan troglodytes*).

Pointing has been characterized as a species-specific human gesture (e.g., Butterworth & Grover, 1988; Werner & Kaplan, 1963, p. 78); however, recent work in several laboratories has established that great apes of all species—bonobos (*Pan paniscus*), chimpanzees (*Pan troglodytes*), a gorilla (*Gorilla*), and orangutans (*Pongo pygmaeus*)—use pointing gestures to communicate about objects and events in their environments with both humans (e.g., Krause & Fouts, 1997; Leavens et al., 1996; Miles, 1990; Patterson, 1978; Povinelli, Nelson, & Boysen, 1990; Savage-Rumbaugh, 1984; Woodruff & Premack, 1979) and with conspecifics (Fouts, Hirsch, & Fouts, 1982; de Waal, 1982; Savage-Rumbaugh, 1986; Tomasello et al., 1985). To date, at least 24 individual chimpanzees have been reported to point; of these, 12 have received training in linguistic communication, usually involving sign language or geometric lexigram symbols arranged on a panel, which may specifically shape pointing behavior to involve the index or other single finger (Table 1; cf. Call & Tomasello, 1994). However, pointing has never, to our knowledge, been reported in wild populations of chimpanzees (see Leavens et al., 1996, for more extensive discussion of the effects of captivity on pointing by chimpanzees).

Recently, Leavens et al. (1996) established that use of both the whole hand and the index finger in communicative pointing by a chimpanzee subject exhibited all of the hallmarks of intentional, communicative pointing in humans, including gaze alternation between the object of the point and a human observer and attention-getting behaviors associated with the pointing gesture. However, because Leavens et al. measured gaze behavior in only 1 subject, the claim by Petitto (1988) that “apes ... do not point to a referent while moving eye gaze to and fro between the referent and the caretaker to establish joint visual regard” (pp. 216–217) remains only weakly refuted. The present study was designed to directly test this claim and to extend previous research on pointing behavior by laboratory chimpanzees to a large sample of 115 subjects, thus overcoming the limitations of previous research on very small samples (1 to 5 individuals per study).

It has long been established that chimpanzees typically point with all fingers extended (*whole-hand points*) toward objects or events of interest (de Waal, 1982; Fouts et al., 1982; cf. Leavens et al., 1996). Apparent exceptions are those chimpanzees who have received sign language training, in which index-finger extensions are explicitly shaped over many years; indexical points serve pronominal and locative functions in sign languages. Hence, when communicative pointing is studied in sign-language-trained chimpanzees, relatively high incidences of pointing with the index finger alone is observed (Krause & Fouts, 1997). Because points emitted with the whole hand superficially resemble acts of prehension (reaches), invariably, it is suggested that these finger extensions are not communicative but are direct attempts to reach for desirable stimuli, usually food items. These two hypotheses, the *reaching hypothesis* and the *communication hypothesis*, make testable predictions about the use of whole-hand finger extensions in the presence of out-of-reach food.

The communication hypothesis predicts that whole-hand points will be emitted only in the presence of a communicative interactant and out-of-reach objects, whereas the reaching hypothesis predicts that *reaches*, or attempts to grasp distal objects, should be emitted in the presence of desirable food, irrespective of the presence or absence of an observer. Every extant study of pointing by chimpanzees that has looked for audience effects has found that the emission of both index-finger pointing and whole-hand pointing to distal food items are dependent on the presence or the visual attention of a human (Krause & Fouts, 1997; Leavens et al., 1996). Similar results were obtained by Call and Tomasello (1994) for two orangutans; they found that a language-naïve orangutan pointed with the whole hand, whereas a sign-

language-trained orangutan pointed with the index finger (cf. Miles, 1990), and both subjects waited for the presence of an experimenter before pointing to a hidden food location. Thus, whole-hand pointing by chimpanzees and an orangutan was unambiguously communicative in previous experimental studies. In other words, if ape subjects who extend all fingers toward obviously out-of-reach food items are attempting to reach for these items, why do they fail to reach for these same food items when no human is present?

The present study pits the reaching hypothesis against the communication hypothesis by comparing the incidence of gaze alternation concomitant with whole-hand pointing to the incidence concomitant with chimpanzee species-typical food-begging gestures and other gestures. The communication hypothesis absolutely requires that individuals who exhibit intentionally communicative gestures also exhibit higher levels of concomitant visual orienting behaviors (gaze alternation between an experimenter and highly desired food items) while gesturing than do those individuals who do not gesture. The reaching hypothesis makes no strong claim about the incidence of visual orienting behavior concomitant with whole-hand finger extensions toward these same food items.

In addition, because previous studies of reaching have demonstrated that chimpanzees, like humans, reach toward food items presented on their peripheries (i.e., to their left or their right) with the hand that is ipsilateral to the food stimulus (Welles, 1976), the reaching hypothesis predicts that if the whole-hand finger extensions observed in the present study are reaches, then they should be emitted with the hand that is ipsilateral to (hence, closest to) the food stimulus. The communication hypothesis makes no strong prediction about positional effects on hand use because either hand is equally effective in redirecting the attention of a communicative interactant to a distal object.

During the course of data analysis in the present study, we became aware of a recent attempt to clarify the effects of social rearing histories on the sociocognitive and communicative skills of apes (Call & Tomasello, 1996). With respect to pointing behavior, Call and Tomasello concluded that “referential pointing and more elaborate forms of imperative communication ... have been observed only in home-raised apes” (p. 391), by which they mean apes raised in richly cultural contexts (i.e., “enculturated” apes). Thus, the results of the present study, which derive from observations of laboratory chimpanzees who have generally not been raised in richly cultural contexts, are highly germane to this claim.

In sum, the experiment reported here (a) investigates the relationship between visual orienting behavior and vocal and gestural communication in chimpanzees, (b) directly tests Petitto’s (1988) claim that gaze alternation and pointing do not develop in apes, (c) compares whole-hand pointing against the predictions of a reaching hypothesis and a communication hypothesis, and (d) tests Call and Tomasello’s claim that a humanlike cultural environment is requisite to the development of referential pointing in apes. Because this sample comprises 115 laboratory chimpanzees, the question of whether communicative pointing in laboratory chimpanzees is limited to a few, uncharacteristic individual chimpanzees (Table 1) or is instead a more widespread, if previously underreported, phenomenon can be answered with considerable confidence. Finally, the effects of age and sex on communicative and visual orienting behaviors were assessed. Hand preference and gesture use from the present data set are reported elsewhere (Hopkins & Leavens, 1998).

Method

Subjects

Subjects were 115 chimpanzees (*Pan troglodytes*) housed at the Yerkes Regional Primate Research Center (YRPRC) in Atlanta, Georgia (Table 2). There were 50 males and 65 females,

ranging in age from 3 to 56 years ($M = 18$ years 10 months, $SD = 11$ years 8 months). None of the subjects have been language trained. Three of the subjects have been previously reported to point (Anna and Clint, Leavens et al., 1996; Kipper, Tomasello et al., 1985). In terms of rearing histories, 71 subjects were nursery reared, 24 were mother reared, and 20 had unknown rearing histories (see Bard & Gardner, 1996, for discussion of nursery-rearing practices at YRPRC).

Procedure

Two experimenters participated in each trial. Experimenter 1 (E1) walked to the outside section of each subject's home cage and placed one half of one banana on the ground, out of the subject's ability to reach, approximately 1 m from the cage mesh, in line with either the left or the right walls of the subject's cage. The position of the banana was randomized by side across subjects. Experimenter 1 then departed, whereupon Experimenter 2 (E2) approached the subject and engaged him or her with eye contact and verbal greetings but ignored the banana (i.e., E2 did not look at the banana). If the subjects (a) alternated their gaze between the banana and the experimenter while either vocalizing or gesturing or both, (b) vocalized while emitting a gesture, or (c) gestured, they were immediately rewarded with the banana. If none of these responses was observed within 30 s of the arrival of E2, the subject was given the banana. Each subject received only one 30-s trial to minimize the effects of learning within the context of this study. Assignment of the researchers to E1 or E2 was determined by their relative familiarity with each subject; both researchers were familiar to the chimpanzees because the apes have been subjects in several colonywide studies of behavioral laterality (e.g., Hopkins, 1994, 1995).

Behavioral Coding

Specific behaviors recorded by E2 are presented in Table 3. Vocalizations were recorded as either present or absent during each trial. Gestures were coded as being *food begs*, *whole-hand points*, *indexical points*, or *other gestures*. Food begs involve extended arms directed toward E2 with the fingers and palm of the hand supinated (facing up) and maintained in a "cupped" posture (van Lawick-Goodall, 1968; Plooi, 1978, pp. 120–121). Whole-hand points involve arm extension, usually toward the object of the point (though infrequently directed at E2), with the hand extended, fingers abducted (spread apart slightly), and the palm either held vertically or pronated to some degree (i.e., facing down; Leavens et al., 1996). The indexical point is similar to the whole-hand point except that only the index finger (the finger next to the thumb) is extended and the other fingers, including the thumb, are curled in toward the pronated palm (see Figure 1). According to Leavens et al., pointing gestures can be emitted with single digits other than the index finger, but this was not observed in the present study. Occasionally, a subject pointed with two or three fingers extended—these were recorded here as whole-hand points. Other gestures recorded from 9 individuals were (a) a tickle solicit (Plooi, 1978), (b) three apparent attempts to exchange or trade a corn cob, a cucumber, and a peanut shell, respectively, for the banana, (c) two cage-banging responses, (d) a lip pout (van Lawick-Goodall, 1968), (e) a rump present (a species-typical posture signaling either sexual invitation or submission; see van Lawick-Goodall, 1968), and (f) one repeated biting of the right hand while looking back and forth between the banana and E2.

Gaze behavior was recorded as (a) subject *gazes alternately* between E2 and the fruit, (b) subject looks at E2 only, (c) subject looks at only the fruit, and (d) subject does not look at the experimenter or the fruit. We counted *gaze alternation* as having occurred when the subject looked successively at the experimenter and the banana or vice versa (see Leavens et al., 1996; Russell et al., 1997). No subject in this study looked at the banana without also looking at E2.

Analyses

Chi-square analyses were used to evaluate hypotheses. For 2×2 contingency tables, following the guidelines of Thomas (1986). Yates' correction for continuity was used when the smallest expected cell frequency was between 5 and 10 and Fisher's exact test was used where the smallest cell frequency was less than 5. When larger contingency tables were analyzed (row or column > 2), we required the lowest expected cell frequency to be at least 2; where expected cell frequencies fell below 2, data were regrouped for analysis as required. Alpha was set at $p < .05$ for all tests.

Age classes for our youngest chimpanzee subjects were adapted from the age categories of Fragaszy and Bard (1997). At YRPRC, chimpanzee mothers wean their infants at between 3 and 4 years of age; thus, our youngest subject, Agatha (3 years 7 months), is at the demarcation of the infant–juvenile boundary. Because the mean age at first birth for captive chimpanzees is 8 years 5 months (Tutin, 1994), we defined the juvenile–adolescent boundary as 8 years for the purposes of the present study. The age classes of “young adult,” “mature adult,” and “elderly” are more arbitrary but roughly follow those of Goodall (1986). The particular postadolescent age boundaries presented here were selected to approximately equalize the number of subjects in each age class. Thus, assignment to age class was as follows (Table 2): juveniles (3–7 years), adolescents (8–12 years), young adults (13–20 years), mature adults (21–35 years), and elderly (36–56 years).

Results

Visual Orienting and Communication

There were significant relationships between gaze alternation and both vocalizations, $\chi^2(1, N = 115) = 8.72, p < .01$, and gestures, $\chi^2(1, N = 115) = 19.76, p < .001$; that is, relatively more individuals who vocalized or gestured also exhibited gaze alternation between E2 and the banana than among those individuals who did not vocalize or gesture. However, vocal and gestural communication were not significantly related, $\chi^2(1, N = 115) = 2.00, ns$. Thus, gaze alternation is a functional component of communication in both the auditory and the visual domains, but these domains are functionally distinct.

Because communication in the auditory and visual domains were independent (randomly distributed with respect to each other in this sample), it is possible to classify individuals on the basis of whether they (a) vocalized and gestured ($n = 27$), (b) gestured only ($n = 51$), (c) vocalized only ($n = 8$), or (d) neither vocalized nor gestured ($n = 29$). Gaze alternation was exhibited significantly more often by individuals who attempted to communicate than by those who did not attempt to communicate, $\chi^2(3, N = 115) = 27.11, p < .001$. Fully 100% of the 27 chimpanzees who both vocalized and gestured also exhibited concomitant gaze alternation, whereas only 12 (41%) of 29 subjects who did not attempt to communicate exhibited this concomitant gaze alternation. Of the 51 chimpanzees who only gestured, 41 (80%) exhibited gaze alternation; of the 8 subjects who only vocalized, 6 (75%) exhibited gaze alternation.

Gesture Type

The specific gestures exhibited are listed in Table 3. The most common gesture exhibited was whole-hand pointing, with 37% of the subjects ($n = 42$) exhibiting this gesture. Indexical points were exhibited by 6 subjects (5% of the sample). Another 14% of this sample ($n = 16$) exhibited species-typical food begs. Five subjects, or 4% of the sample, exhibited both food begs and whole-hand points. Nine subjects (8% of the sample) emitted a variety of other gestures (listed in the Method section). Finally, 32% of this sample ($n = 37$) exhibited no gestures.

Gaze Alternation and Gesture Type

The co-occurrence of each type of gesture with gaze alternation is displayed in Figure 2 (see also Table 3). Clearly, all gesture types are associated with a relatively increased incidence of gaze alternation between E2 and the banana. From 80% (food beg plus point) to 100% (index-finger points) of those who gestured exhibited gaze alternation, whereas only 49% of those subjects who did not gesture exhibited gaze alternation. Because of low cell frequencies in the number of subjects who pointed without gaze alternation, statistical analysis considered all subjects who pointed as a single category (whole-hand points, $n = 42$; index-finger points, $n = 6$; and food begs plus points, $n = 5$; see Table 3). Thus, the four categories used in this analysis were (a) food begs, (b) points, (c) other gestures, and (d) no gesture. The relationship between gestures and gaze alternation was not random, $\chi^2(3, N = 115) = 20.13, p < .001$. Thus, gestures are not only associated with gaze alternation but each type of gesture is also individually associated with a high incidence of concomitant gaze alternation ($\geq 80\%$; see Figure 2).

Positional Effects on Hand Use During Pointing With the Whole Hand

Of the 47 subjects who exhibited whole-hand points, 3 pointed with both hands. The remaining 44 subjects, who emitted whole-hand points with a single hand, exhibited no bias in hand use as a function of the side of stimulus presentation, $\chi^2(1, N = 44) = 0.32, ns$. In other words, subjects who exhibited unimanual whole-hand points were as likely to use the hand contralateral to the food stimulus as the hand ipsilateral to the food.

Age

No juvenile vocalized in this study, and relatively fewer juveniles engaged in gaze alternation than did older chimpanzees (see Figure 3). There were statistically significant relationships between age and the number of subjects who vocalized, $\chi^2(4, N = 115) = 14.13, p < .01$, and between age and the number of subjects who exhibited gaze alternation, $\chi^2(4, N = 115) = 13.61, p < .01$. The relationship between age and the number of subjects who exhibited communication in the visual domain (i.e., gestures) bordered on statistical significance, $\chi^2(4, N = 115) = 9.31, p = .054$.

As is evident from Figure 3, the effects reported here were driven by the behavior of individuals in the juvenile category: Adolescents and adults did not differ among themselves in vocal behavior, $\chi^2(3, N = 93) = 2.01, ns$, gaze behavior, $\chi^2(3, N = 93) = 1.52, ns$, or gestural behavior, $\chi^2(3, N = 93) = 0.321, ns$. Juveniles, however, differed significantly from all older individuals combined in all three behaviors: vocal, $\chi^2(1, N = 115) = 10.19, p < .01$, gaze alternation, $\chi^2(1, N = 115) = 12.41, p < .01$, and gesture, $\chi^2(1, N = 115) = 7.57, p < .01$. Thus, fewer juveniles than adolescents or adults exhibited vocalizations, gaze alternation, or gestures.

Sex

There were no differences in communicative behavior exhibited by our subjects as a function of sex: vocal behavior, $\chi^2(1, N = 115) = 0.00, ns$, gestural behavior, $\chi^2(1, N = 115) = 0.71, ns$, or gaze alternation, $\chi^2(1, N = 115) = 0.49, ns$. Thus, sex was not a factor in the propensity to communicate with the experimenter.

Rearing History

Rearing history was known for 95 of the 115 subjects in this study. Because it is extremely difficult to interpret any effects of an unknown rearing history, analyses of rearing history included 71 nursery-reared and 24 mother-reared chimpanzees; the 20 chimpanzees for whom rearing histories were unknown were excluded from this analysis. Rearing history was not significantly related to vocal behavior, $\chi^2(1, N = 95) = 0.73, ns$ or gestural behavior, $\chi^2(1, N = 95) = 0.59, ns$. However, rearing history was related to the incidence of gaze alternation, $\chi^2(1,$

$N = 95$) = 6.31, $p = .012$. Only 54% of mother-reared chimpanzees exhibited gaze alternation, whereas 80% of the nursery-reared chimpanzees exhibited gaze alternation.

Closer analysis revealed that whereas 8% of both nursery-reared and mother-reared chimpanzees failed to look at both the experimenter and the banana, relatively more mother-reared chimpanzees looked at only the experimenter and not at the fruit compared with nursery-reared chimpanzees. Thus, the difference is attributable to a greater propensity to exhibit gaze alternation by nursery-reared chimpanzees and not to a reduced propensity by mother-reared chimpanzees to visually engage the experimenters. The difference does not appear to be attributable to an interaction with age because the proportion of juveniles in each group is virtually identical (25% for the mother-reared group, 23% for the nursery-reared group).

Discussion

The present study demonstrates that gaze alternation between a distal object and a communicative interactant is significantly associated with communication in both vocal and visual domains in laboratory chimpanzees. This visual orienting behavior is a crucial defining feature of intentional communication (e.g., Bard, 1992; Bates et al., 1975; Harding & Golinkoff, 1979; Tomasello, 1995). Thus, earlier reports of associations of gaze alternation with communication by chimpanzees from studies with relatively small sample sizes (1 to 5 subjects: e.g., Krause & Fouts, 1997; Leavens et al., 1996; Tomasello et al., 1985) have been convincingly replicated here with a much larger sample.

As to the putative “species-specificity” of index-finger pointing among humans, a typical chimpanzee index-finger point is depicted in Figure 1, a photograph taken of Merv (a male, nursery-reared young adult) pointing to a bottle of juice placed on the ground just out of camera range; note, in particular, the absence of straining against the cage mesh and the relaxed posture. It has been suggested that index-finger points are caused by the constraints of the cage mesh; but, because all points reported here—those with index fingers and those with all fingers extended—involved extensions of these fingers through the cage mesh, there is no differential effect of the cage mesh on the number of fingers extended while pointing.

Considerable debate hinges around interpretation of whole-hand finger extensions by chimpanzees to distal food objects as attempts to reach for these food items. The data reported here are not at all consistent with the reaching hypothesis and are fully consistent with the communication hypothesis. First, those chimpanzees who emitted whole-hand finger extensions were associated with high incidences of concomitant gaze alternation, like those who emitted food begs and other unambiguously communicative gestures, and they differed, in this regard, from individuals who did not communicate (Figure 2). Second, previous research on the reaching of chimpanzees and humans has demonstrated that individuals of both species reach for peripherally presented objects with the hand that is ipsilateral to (closest to) the side of stimulus presentation (e.g., Welles, 1976). In contrast, subjects in the present study were as likely to use the hand contralateral to the food as the hand ipsilateral to the food. From a communication perspective, either hand is equally effective in redirecting the attention of a communicative interactant to distal objects. In sum, these whole-hand finger extensions are attempts to communicate; by a variety of measures in several laboratories (Call & Tomasello, 1994; Krause & Fouts, 1997; Leavens et al., 1996; the present study), these whole-hand finger extensions are incompatible with a reaching interpretation.

It follows that chimpanzees in captivity, without any explicit training whatsoever, commonly adopt a pointing gesture in face-to-face communicative interactions with humans, and we found no evidence that age, sex, or rearing history had any differential impact on the propensity to point by these subjects. That these chimpanzees appear to point more with the whole hand than with the index finger might therefore reflect only the lack of response-shaping in this population

compared with chimpanzees who have undergone language training and other intensive exposure to human cultural behavior (cf. Call & Tomasello, 1994, 1996; Krause & Fouts, 1997). The use of the whole hand in pointing also suggests that these chimpanzees have not acquired the gesture through imitation of humans (cf. Tomasello, Davis-Dasilva, Camak, & Bard, 1987) but may have “invented” the gesture as part of a problem-solving tactic involving the instrumental manipulation of a social agent (e.g., Bard, 1990, 1992; Gómez, 1990; see Leavens et al., 1996, for an elaboration of the systemic parallels in the circumstances in which captive chimpanzees and human infants point).

Juveniles differed strikingly from adolescent and older chimpanzees in their propensity to emit communicative behaviors in face-to-face interactions with adult, male experimenters (Figure 3). It is possible that juveniles are simply less competent than older chimpanzees in contexts requiring the instrumental use of others to obtain food. Alternatively, juveniles may be more intimidated by adult, male, human experimenters than are older chimpanzees. We favor the latter interpretation for two reasons. First, juvenile chimpanzees have been shown to be fully competent in exhibiting intentional communication with other chimpanzees, especially in play contexts (Tomasello et al., 1985). Second, although juveniles in the present study were less likely to gesture than were older chimpanzees, those juveniles who did gesture did not differ in the types of gestures they emitted compared with older chimpanzees. These considerations suggest that a lack of competence in the juvenile period is an unlikely explanation for the decrements in communicative behaviors reported here. Although it is not clear from the present study why this age difference obtains, it is clear that juvenile chimpanzees are not representative of the species in face-to-face interactions with adult, male, human communicative interactants. This finding strongly suggests that where juvenile chimpanzees are compared with juvenile humans in face-to-face interactions with humans (e.g., Povinelli & Eddy, 1996), differences that emerge between similar-age representatives of the two species may reflect task factors irrelevant to the cognitive capacities ostensibly under scrutiny (e.g., Leavens, 1998).

Sex was not an apparent factor in any of the dependent variables studied here; male and female chimpanzees did not differ in their propensity to vocalize, gesture, or exhibit gaze alternation between an experimenter and a desirable fruit. In contrast, relatively fewer mother-reared chimpanzees exhibited gaze alternation between E2 and the fruit than did nursery-reared chimpanzees. Mother-reared chimpanzees were as likely as nursery-reared chimpanzees to look at the face of E2; the difference was that mother-reared chimpanzees were less likely to exhibit concomitant looks at the banana. This result is congruent with that reported by Carpenter, Tomasello, and Savage-Rumbaugh (1995). Carpenter et al. defined joint attentional episodes as gaze alternation occurring between objects and humans and measured the proportion of time spent in joint attentional episodes and the durations of joint attentional episodes by 6 human infants, 3 “enculturated” chimpanzees (i.e., raised in intimate association with humans), and 3 mother-reared chimpanzees. As in the present study, the chimpanzees most familiar with humans seemed to exhibit relatively more gaze alternation than did the mother-reared chimpanzees. If gaze alternation reflects greater sophistication in cognitive processes integrating communication about a distal object with instrumental use of another being—that is, if gaze alternation in this context reflects an increased understanding of others as social agents (Bard, 1990; Butterworth, 1991, 1995; Franco & Butterworth, 1996), an understanding that attention follows gaze (Gómez et al., 1993), or an understanding of others as intentional agents (Call & Tomasello, 1996)—then these putative cognitive differences may be induced by increased familiarity with humans, as argued by Call and Tomasello (1994, 1996; but see Leavens, 1998). Replication of this finding is needed in other large, captive populations of chimpanzees and other apes with known rearing histories.

In comparison with data from studies of pointing and other intentional communication in human infants, chimpanzees seem to be markedly less vocal. For example, Leung and

Rheingold (1981) and Franco and Butterworth (1996) reported that 87% and 76%, respectively, of the infants' points that they reported were accompanied by vocalizations. By way of comparison, in the present study, of the 78 chimpanzees who gestured, only 35% also vocalized (see Table 3). In the study reported by Leavens et al. (1996), Clint, a 14-year-old male chimpanzee, vocalized during 24% of his points. Despite the differences in dependent measures (gestures accompanied by vocalizations compared with gesturing individuals who vocalize), it seems that chimpanzees may be markedly less vocal than human infants older than about 12 months in age in similar experimental contexts, and this is consistent with the species difference in vocal-auditory communication inasmuch as human infants who point communicatively are also beginning to produce speech (e.g., Bates et al., 1975). However, inasmuch as vocalizations might serve an attention-getting function for chimpanzees (e.g., Krause & Fouts, 1997; Tomasello et al., 1985), then factors inherent to the present experimental design might have influenced the vocal behavior of these subjects, to wit: E2 was oriented in a face-to-face posture with the subjects after calling the subjects' names, thus reducing the need for emitting attention-getting signals. (In contrast, human infants are typically tested while sitting beside their caregivers.)

This study presents evidence that chimpanzees exhibit high levels of what has been variously termed "gaze alternation" (e.g., Leavens et al., 1996), "referential glancing" (Russell et al., 1997), and "visual checking" (Franco & Butterworth, 1996) concomitant with the emission of indicative gestures. Every chimpanzee who both vocalized and gestured, without exception, also exhibited this visual orienting behavior between a banana and an experimenter, implying a relationship between gaze alternation and either the number of communicatory systems (e.g., vocal and gestural) invoked in these communicative episodes or, possibly, the degree of motivation involved in communicating about the banana. This gesturing or vocalizing while alternating the gaze between the communicative interactant and the object of interest cardinally represents what has been called in both the human developmental literature (e.g., Bates et al., 1975; Harding & Golinkoff, 1979) and the literature pertaining to communication in apes (e.g., Bard, 1992; Plooij, 1978), *intentional communication*. Intentional communication is "the ability to coordinate sequences of behavior involving objects with sequences of behavior involving social agents" in goal-directed activities (Bard, 1992, p. 1187; see also Gómez et al., 1993; Sugarman, 1984). It is important to emphasize that intentional communication among apes is not limited to captive populations or dependent on human interaction (e.g., Bard, 1992; Plooij, 1978). Thus, the cognitive capacity for " 'coordinated person-object' interactions" (Sugarman, 1984, p. 28) is distributed widely among great ape species.

However, a distinction has been made specifically with respect to the cognitive significance of pointing in different functional contexts (Bates et al., 1975; Baron-Cohen, 1989; Tomasello, 1996). This distinction contrasts *protoimperative* with *protodeclarative* pointing (Bates et al., 1975; Baron-Cohen, 1989). Protoimperative pointing in humans serves a requestive function; a social agent is instrumentally manipulated to achieve some goal involving an object or location, and this is held to constitute a manipulation of another's *behavior*. In contrast, protodeclarative pointing establishes a state of joint attention, and this is generally construed as an attempt to manipulate another's *mental state* or "to comment or remark on the world to another person" (Baron-Cohen, 1989, p. 118). Given that imperatives and declaratives are linguistic devices, it is not at all clear that nonlinguistic organisms, such as the subjects in the present study, can exhibit protoimperatives or protodeclaratives. The pointing and other gestural behaviors reported here, while certainly requestive in function, are therefore not diagnostic of whether these chimpanzees are attempting to manipulate mental states in others. However, it should be noted that quintessentially protodeclarative behaviors, such as exhibiting of self and showing objects, have been reported for non-language-trained chimpanzees (Russell et al., 1997; Tomasello et al., 1985), and these behaviors along with protodeclarative pointing have been reported for a language-trained orangutan, Chantek (Miles, 1990).

A particular strength of the research design used in the present study is the ease with which it can be implemented in other ape colonies and with other ape species to test the replicability of the findings reported here. Several pertinent questions remain. Given that these chimpanzees pointed relatively rarely with the index finger, what are the historical, morphological, and contextual factors influencing this difference between the species? It appears that chimpanzees and an orangutan trained in sign language do point relatively more with the index finger than do chimpanzees or an orangutan that have not received training in sign language (e.g., Call & Tomasello, 1994; Krause & Fouts, 1997; Miles, 1990), but the distance of the objects of interest and the relative salience of the objects may also influence the specific fingers used to indicate distal objects in both language-trained apes (Krause & Fouts, 1997) and in language-naïve apes (Leavens et al., 1996). These factors need to be systematically manipulated in future research. Furthermore, as noted by Povinelli and Davis (1994), human and chimpanzee hands differ in the resting state of the index finger, in relaxed and anesthetized human and chimpanzee subjects, and this may have implications for the specific forms of pointing in apes and humans. Finally, whether this behavior is acquired through imitation, incidental operant conditioning, or some other learning process remains unclear; longitudinal studies will be required for clarification of this question.

In sum, laboratory chimpanzees without special training use parallel activation of visual orienting behaviors and communication in both vocal and gestural domains. Chimpanzees do point to referents while alternating their gaze between a communicative interactant and a distal object of interest, though specialized training (particularly language training) may be necessary for the development of a heavy reliance on the index finger specifically. Juvenile chimpanzees exhibited a reduced propensity to communicate in face-to-face interactions with adult male experimenters, compared with older chimpanzees, and therefore are not representative of the species in these contexts. Subjects' sex did not influence communication in this study. Mother-reared chimpanzees were less likely than nursery-reared chimpanzees to exhibit gaze alternation between a food item and an experimenter, revealing an influence of rearing history on gaze orienting behavior.

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Figure 1. Merv, a male, nursery-reared, young adult chimpanzee, points to a bottle of juice placed on the ground just out of camera range. The protruded lower lip is a captivity-induced facial gesture generally glossed as “juice-me.”

Figure 2.

Percentage of subjects in each of six categories of gestural behavior who exhibited concomitant gaze alternation between Experimenter 2 and a banana (see Table 3 for sample sizes). For statistical analysis, subjects who emitted whole-hand points, index-finger points, and whole-hand points with concomitant food begs were combined into a single category because of low cell frequencies, $\chi^2(3, N = 115) = 20.13, p < .001$.

Figure 3.

Percentage of subjects in each age class exhibiting vocalizations, gestures, and gaze alternation (see Table 2 for sample sizes per age class). For vocalizations, $\chi^2(4, N = 115) = 14.13, p < .01$; for gestures, $\chi^2(4, N = 115) = 9.31, p = .054$; and for gaze alternation, $\chi^2(4, N = 115) = 13.61, p < .01$. Yrs. = years.

Table 1**Chimpanzees Previously Reported to Point**

Subject	Source	Language trained?
Unnamed	Furness, 1916	Yes
Gua	Kellogg & Kellogg, 1933	Yes
Viki	Hayes & Hayes, 1954	Yes
Washoe	Gardner & Gardner, 1971	Yes
Nim	Terrace, 1979	Yes
Bert	Woodruff & Premack, 1979	No
Sadie	Woodruff & Premack, 1979	No
Luvie	Woodruff & Premack, 1979	No
Jesse	Woodruff & Premack, 1979	No
Loulis	Fouts, Hirsch, & Fouts, 1982	Yes
Tepel	de Waal, 1982	No
Kipper ^a	Tomasello, George, Kruger, Farrar, & Evans, 1985	No
Sherman	Savage-Rumbaugh, 1986	Yes
Austin	Savage-Rumbaugh, 1986	Yes
Sheba	Boysen & Berntson, 1989	No
Sarah	Povinelli, Nelson, & Boysen, 1990	Yes
Kermit	Povinelli et al., 1990	No
Darrell	Povinelli et al., 1990	No
Anna ^a	Leavens, Hopkins, & Bard, 1996	No
Clint ^a	Leavens et al., 1996	No
Flora	Leavens et al., 1996	No
Moja	Krause & Fouts, 1997	Yes
Tatu	Krause & Fouts, 1997	Yes
Panzee	Whiten, in press	Yes

^a Also subjects in the present study.

Table 2

Sample Characteristics

Sex and rearing history	Age class				Total
	Juvenile (3-7 yrs.)	Adolescent (8-12 yrs.)	Young adult (13-20 yrs.)	Mature adult (21-35 yrs.)	
Male					
Mother	1	3	7	0	11
Nursery	6	12	13	3	34
Unknown	0	0	0	4	5
Subtotal	7	15	20	7	50
Female					
Mother	5	2	2	4	13
Nursery	10	7	5	7	37
Unknown	0	0	0	8	15
Subtotal	15	9	7	19	65
Grand total	22	24	27	26	115

Note. N = 115. Yrs. = years.

Table 3

Behaviors Recorded and Their Frequencies

Gaze and vocal behavior	Gestural behavior					No gesture
	Food beg	Whole-hand point	Index-finger point	Food beg + point	Other gesture	
Gaze alternation						
With vocalization(s)	8	17	2	0	0	6
Without vocalization(s)	5	20	4 ^a	4	8	12
Look at experimenter only ^b						
With vocalization(s)	0	0	0	0	0	2
Without vocalization(s)	3	5	0	0	1	7
Did not look at experimenter or fruit						
With vocalization(s)	0	0	0	0	0	0
Without vocalization(s)	0	0	0	1	0	10
Total	16	42	6	5	9	37

Note. N = 115.

^aOne subject pointed with her whole hand to the banana and then to her mouth with her index finger.

^bNo subject looked at only the fruit.