

## COMPARATIVE PERSPECTIVES ON POINTING AND JOINT ATTENTION IN CHILDREN AND APES

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**ABSTRACT:** The comprehension and production of manual pointing and joint visual attention are already well developed when human infants reach their second year. These early developmental milestones mark the infant's transition into accelerated linguistic competence and shared experiences with others. The ability to draw another's attention toward distal objects or events facilitates the development of complex cognitive processes such as language acquisition. A comparative approach allows us to examine the evolution of these phenomena. Of recent interest is whether non-human primates also gesture and manipulate the eye gaze direction of others when communicating. However, all captive apes do not use referential gestures such as pointing, or appear to understand the meaning of shared attention. Those that show evidence of these abilities differ in their expression of them, and this may be closely related to rearing history. This paper reviews the literature on the topic of pointing and joint attention in non-human primates with the goal of identifying why these abilities develop in other species, and to examine the potential sources of the existing individual variation in their expression.

By the time they reach their second year, human children engage in social interactions that often include pointing and the establishment and manipulation of joint visual attention. The developmental course of pointing follows a relatively predictable pattern. In its earliest form, pointing is probably a self-orienting reflex or an alertness reaction, rather than an attempt to manipulate the attention of others (Bates, 1976; Hannan & Fogel, 1987; Lock, Young, Service, & Chandler, 1990; Trevarthen, 1977). The earliest form of visual orientation may be present as early as two months of age (Scaife & Bruner, 1975), with infants shifting their eye gaze in relation to an adult's gaze direction, though a specific referent is rarely the focus of the infant's attention

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(Butterworth & Cochran, 1980). At around 14 months, children point in a variety of contexts – from making requests, to calling the attention of others to objects or events. Infants who point while alternating their eye gaze between the partner of an interaction and the referent probably understand that pointing is only successful when the visual attention of another is held (Balwin, 1995). Thus an understanding that others are "intentional agents" coincides with an understanding that pointing can be used to direct the attention of others toward distal objects and events.

Comprehension of the social meaning of pointing normally precedes its production by human infants (Butterworth, 1991; Schaffer, 1984). Infants typically begin looking in the directions toward which others point at around 10-12 months of age (Leung & Rheingold, 1981; Murphy & Messer, 1977; Schaffer, 1984). Around this time, children comprehend pointing gestures and the referential nature of gaze direction as long as the referent is within their immediate visual field (Butterworth & Cochran, 1980). By eighteen months, children are capable of following the gaze direction and pointing of another toward objects that are outside of their initial visual field (Butterworth & Grover, 1988). At least three important components are involved in the production of referential pointing – the establishment of joint attention, extension of the hand and arm (typically with index finger extension) toward the object or event of interest, and concomitant eye gaze alternation between the referent and the partner in the interaction. Pointing is clearly of great importance to the development of human cognitive abilities, as pointing and joint visual attention are closely linked to, among other things, language acquisition (Bruner, 1983; Goldfield, 1990) and to developing a "theory of mind" (Baron-Cohen, 1991).

Pointing has been considered to be species-specific to humans by several authors (Povinelli & Davis, 1994; Werner & Kaplan, 1963). This is true insofar as the gesture does not appear to develop in feral non-human primates (but see Veá & Sabater-Pi, 1998, for a possible case in one wild pygmy chimpanzee, *Pan paniscus*). However, pointing and "pointing-like" gestures have been reported for all four great ape species and in some monkeys raised in various captive conditions. This suggests that, like many abilities that are revealed in laboratory studies of ape cognition, humans have a fairly pervasive influence on the animals with which they interact (see Call & Tomasello, 1996, for review). Based on the existing literature of ape pointing, there are differences in some topographical features of the gesture that may be attributable to rearing history. Captive ape conditions include

laboratory rearing in isolation or in social groups, nursery rearing where humans serve as surrogate parents for the apes' first few years, and cross-fostering, where a home-like setting and routine is provided. Most subjects of ape language studies were cross-fostered by humans (Gardner & Gardner, 1988; Miles, 1990; Patterson, 1978). The rationale for many of the early attempts to teach sign language to apes was based on the fact that they are adept at using their hands and often do so when communicating.

## THE ETHOLOGY OF COMMUNICATIVE GESTURES

Feral chimpanzees have rich vocal and gestural communicative repertoires (Goodall, 1968; Marler & Tenaza, 1977; Plooi, 1978). Plooi (1978) found that some aspects of wild chimpanzee communication resemble human pre-linguistic behavior. Bates (1976) considers the use of an object to obtain someone's attention to be one type of proto-declarative communication. Human infants, for example, may repeatedly strike the ground with a toy in order to get an adult's attention. Bates, Camaioni, and Volterra (1975) define proto-declarative communication as "...a preverbal effort to direct the adult's attention to some event or object in the world" (p. 208). Proto-declarative acts eventually accompany declaratives, which can be simple forms of verbal output produced by human children for the purposes of giving or showing (Bates et al., 1975).

Plooi (1978) found examples of proto-declarative communication in feral chimpanzees. For example, chimpanzees pick leaves and manipulate them when in the presence of conspecifics. This behavior usually leads other chimpanzees to approach and observe this "leaf-grooming". The putative goal of this behavior appears to have less to do with grooming leaves, and more to do with initiating play, social grooming, or sexual interactions (Nishida, 1980). A similar example noted by Plooi (1978) involved play solicitation where a chimpanzee would grab an object (often a fairly abundant, non-valuable one such as a twig) and run away with it while looking back toward another chimpanzee. During respites in their daily ranging, Goodall (1986) observed leaders in chimpanzee groups looking toward other group members before moving to other areas, or shaking branches to initiate consortships or group movements.

Looking at the mother's face while interacting is an important development in human infant communication (Bates et al., 1975;

Butterworth, 1991; Corkum & Moore, 1995). Eye gaze direction can be used to specify the referent of an interaction and the location of an object or event. Human infants understand that the adult is an agent of an interaction when they begin looking toward their mother's face while communicating (Bates et al.). In comparison, chimpanzee infants initially grab food from their mothers when begging, but eventually communicate their wishes through indirect means such as touching the mother's mouth and looking at her face (Plooij, 1978). However, aside from Veá and Sabater-Pi's (1998) observations, pointing has not been reported in feral apes.

## THE COMPARATIVE PSYCHOLOGY OF COMMUNICATIVE GESTURES

With few exceptions, reports of non-human primate pointing involve laboratory or home-reared subjects. Some laboratory rhesus macaques (*Macaca mulatta*) pointed toward objects that they were not able to reach during experimental situations. Blaschke and Ettlinger (1987) observed whole-hand pointing by four monkeys, and Hess, Novak, and Povinelli (1993) describe one monkey's gesture as "pointing-like". Rhesus monkeys also follow the eye gaze of conspecifics toward objects (Emery, et al., 1997), and Capuchin monkeys (*Cebus apella*) have shown evidence for deceptive pointing under experimental conditions (Mitchell & Anderson, 1997). In comparison to these reports, however, the pointing that has been reported for great apes appears, in many cases, to be more similar to that of human children (e.g., hand shapes used, audience effects, shared attention). However, some of the similarities bare close resemblance to non-pointing gestures used by feral apes. Thus a close evaluation of the topographical features of the pointing gesture is necessary. Also, some important contextual differences that elicit pointing in apes and children remain given the current state of knowledge. Captive apes normally point toward objects to request them. Human children do this as well, but also point for other reasons and incorporate gesture with speech. The work reviewed below compares the pointing reported for captive apes across rearing environments, and highlights some of the similarities and notable differences between ape and human pointing.

*Pointing in laboratory reared, non-language trained apes*

There are several reports of pointing in laboratory apes. Among the earliest is Wolfgang Kohler's discovery that chimpanzees could be trained to point toward a box containing food (cited in Yerkes & Yerkes, 1929). The majority of instances of pointing in chimpanzees are of laboratory-reared individuals (see Leavens & Hopkins, 1998, for brief historical review). During their attempts to test the abilities of chimpanzees to deceive and recognize intentions, Woodruff and Premack (1979) required four chimpanzees to communicate the location of out of reach objects to humans. The chimpanzees involved in this experiment were wild-caught and had no formal training in any mode of human-based communication. Three of the chimpanzees developed manual pointing without any explicit training from the experimenters, and one chimpanzee "pointed" with her foot. However, these four chimpanzees did not point outside of the testing situations (Premack & Premack, 1983).

Povinelli, Nelson, and Boysen (1992) report pointing by four chimpanzees during an experiment on social attribution. A contingency was arranged that required the chimpanzees to direct the attention of experimenters, who had different apparent knowledge states, toward a specific location in order to receive a reward. Pointing was among the gestures described, but the authors found that some of these gestures were akin to food begging gestures seen in wild chimpanzees (Goodall, 1968), or variations of gestures that may have resembled pointing in at least some ways. The four subjects of this study showed spontaneous comprehension of human pointing (the authors do note that the chimpanzees had previous experience with similar testing situations). Two of the subjects (Sarah and Darrell) pointed from the outset of the experiments while the others (Sheba and Kermit) eventually developed a gesture that at least resembled pointing. Of these subjects, Sarah was the only one who had received language training, and her pointing was previously reported (Premack & Woodruff, 1978).

The first experimental study of pointing in chimpanzees was that of Leavens, Hopkins, and Bard (1996). Clint, a fourteen year old, nursery-reared subject, pointed toward out of reach food with both whole-hand and indexical points. Notably, Clint also alternated his eye gaze between the food and an experimenter during the majority of the trials. Two other subjects, Flora and Anna (nursery-reared, and possibly wild caught, respectively), also pointed indexically and whole-handedly, but eye gaze direction was not measured for these two. To date, the study

with the largest sample is Leavens and Hopkins (1998), who report pointing in 53 of 115 chimpanzees tested at the Yerkes Regional Primate Center. The majority of the subjects pointed whole-handedly (88.7%), while the other 11.3% pointed indexically. Also, chimpanzees that were reared in a nursery alternated their eye gaze between an experimenter and a referent much more than mother-reared chimpanzees. Mother-reared chimpanzees did, however, look toward the experimenter while pointing. Interestingly, Leavens and Hopkins (1998) found no significant differences in pointing frequencies between nursery and mother-reared chimpanzees. Gaze alternation during social referencing also occurs among nursery-reared chimpanzees (Russell, Bard, & Adamson, 1997), with incidences of this increasing with age. There is also evidence for social referencing between chimpanzee mother-infant pairs (Evans & Tomasello, 1986; Itakura, 1995).

Call and Tomasello (1994) report pointing in a laboratory reared orangutan (Puti) and a cross-fostered, language-trained orangutan (Chantek). Comparisons between the two were made in the production and comprehension of pointing and tests for sensitivity to varying levels of experimenter visual attention were done as well. Puti's ability to use and comprehend pointing was more limited in comparison to Chantek. Also, Puti pointed regardless of whether the experimenter had his eyes open or closed, thus he did not appear to understand the meaning of visual perception or the bi-directional nature of pointing. Chantek, however, was much more likely to point when the experimenter was looking toward him. Miles' (1990) longitudinal observations of Chantek's pointing supports the notion that human exposure facilitates the development of increasingly complex sociocognitive abilities in great apes (see below). Although there are fewer reports of pointing in orangutans than for chimpanzees, additional examples have been noted in the former while performing various cognitive tasks (e.g., Call & Rochat, 1997).

To my knowledge there are no published reports of pointing in non language-trained gorillas. Gomez (1991) reports intentional communication, as measured by eye gaze alternation in a problem solving situation, but no pointing, in a young, hand-reared gorilla. Also, Tanner and Byrne (1996) found that several gestures used by a captive gorilla appeared to be iconically representative of action or movement.

#### *Pointing in Cross-fostered and language trained apes*

Published accounts of pointing exist for nearly every ape that has

been home-reared and/or received language training. These include anecdotal reports (e.g., Hayes & Hayes, 1954; Kellogg & Kellogg, 1933; Savage-Rumbaugh, 1984), descriptions of American Sign Language (ASL) hand shapes (Fouts, Hirsch, & Fouts, 1982; Gardner, Gardner, & Nichols, 1989), experimental studies (Krause & Fouts, 1997), and developmental accounts (Miles, 1990). Pointing is also reported as a mode of communication used by cross-fostered and language-trained chimpanzees while solving various problems (Boysen & Bernston, 1989; Premack & Woodruff, 1978). Unfortunately, little developmental data on pointing exist for language-trained chimpanzees. To date, the only developmental information available for chimpanzees (a cross-sectional study) is for laboratory and nursery-reared subjects (Leavens & Hopkins, 1998).

Kellogg and Kellogg (1967) raised the chimpanzee Gua in their home in order to compare her development with their son. Without any assistance from her caregivers, Gua pointed with an extended index finger shortly after the Kelloggs began their project. The Kelloggs note that "Perhaps the best indicator of 'seeing' or 'observing' on her part is the reaction of pointing with the index finger to objects which attract her attention" (p. 89). Donald, the Kelloggs' son whose development was compared with Gua's, did not begin pointing until after Gua developed the gesture. However, Gua only pointed toward objects within her reach. For example, the Kelloggs observed Gua following bugs while pointing toward them. Hayes and Hayes (1954) raised the chimpanzee Viki in their home and noted that she too pointed, but only to objects that were within her reach (such as objects that she was forbidden to touch). Unfortunately, due to a lack of descriptive information, these early reports are difficult to evaluate.

Gardner et al. (1989) provided information on the order in which ASL signs were used reliably by Washoe, Moja, Tatu, and Dar. Pointing signs were among the earliest to be used reliably by the four chimpanzees. The first sign used reliably by Tatu was GO, and Washoe's 28th reliable sign was ME. (See Gardner et al. for criteria of reliable usage), the latter of which was the latest that any pointing sign was incorporated into the sign vocabularies of the four (of around 150 to 200 signs each). Gardner et al. described the chimpanzees' hand configurations for the sign THAT/THERE as "Index extended" for Tatu and Dar, and as "Index extended from open hand or open hand" (p. 157) for Washoe and Moja. Fouts, Fouts, and VanCantfort (1989) describe Loulis' THAT/THERE sign as "Tip of index contacts or points toward object or location" (p. 289). Notably, Loulis learned some signs from

other chimpanzees (Fouts, Hirsch, & Fouts, 1982). It should be noted that the above descriptions are of the appearance of signs as they are normally used. The goals of each of these studies were not to estimate the relative frequencies of any variations in the place, hand configuration, or movement of the signs. Krause and Fouts (1997), however, provide relative frequencies of index and whole-hand pointing in Moja and Tatu during two experiments – taken together, index finger extension was scored for 364 of 416 (87.5%) points, and the remaining 12.5% of points were whole-handed.

The indexical signs (e.g., THAT/THERE) of language-trained chimpanzees are consistently used in a structured order (Gardner & Gardner, 1975, 1994). Moja, Tatu, and Dar used the THAT/THERE sign prior to noun signs when producing nominative phrases (e.g., THAT BRUSH) in reply to the question WHAT THAT? In response to locative queries (e.g., WHERE BRUSH?), the three typically followed the noun with the indexical sign (e.g., BRUSH THERE) (Gardner & Gardner, 1975, 1994).

Terrace (1987) also described the hand configurations of his language-trained chimpanzee Nim, who used the indexical signs YOU, ME, THAT/THERE, and GO. Terrace later combined these into a single "point" sign. Nim's first reliable pointing sign was GO (his 14th overall), which Terrace (1987) described as "flat hand, palm down; sometimes index finger extended from loosely cupped hand". Nim's second reliable pointing sign was ME (28th overall), which took the form of a flat hand in its original form, and at the termination of the project was described as "index finger extended from closed fist". Nim's 43rd reliable sign was YOU and his 49th sign was THAT/THERE. The hand shapes for both of these were described as "index finger extended from closed fist", with "palm in various orientations" added to the hand shape description of the latter. Nim used signs that involved index finger extension before his first pointing sign was acquired (e.g., LISTEN). That Nim's first pointing signs were whole-handed, and his later ones indexical, suggests that indexical pointing may have developed from whole-hand pointing (which is not the case for human infants). Laura Pettito, a former teacher of Nim, maintained 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" (1988, p. 216-217). At the time this quote was published, there was no experimental evidence that could address this assertion. Therefore, based on Pettito's observations, it appears that Nim did not point communicatively. Terrace and his colleagues never published any

experimental evidence to support or refute the claim.

Boysen, Berntson, Shreyer, and Hannan (1995) described various "indicating acts" used by Sheba during experimental tests of numerical competence. Sheba was cross-fostered for her first 2.5 years, and had extensive direct contact with human caregivers. Pointing was among the gestures used by Sheba (at nine years of age) in Boysen et al., and her use of pointing prior to this had been noted (Povinelli, Nelson, & Boysen, 1992). Figure 3 in Boysen and Berntson (1989) shows Sheba "motor tagging" objects in an array, which is a gesture that is akin to pointing and is typically used by Sheba during tests of numerical competence.

Miles (1990) reports the development of referential communication in the orangutan Chantek. Miles (1980) taught Chantek to use ASL while rearing him in a home-like environment. Chantek acquired 140 signs over the course of the project, some of which were pointing signs (Miles, 1990). Chantek pointed to refer to himself at 13 months of age, and by 29 months pointed to indicate the direction of locations. Chantek also alternated his eye gaze between the referent and his conversation partner when pointing (Miles, 1990). Pointing signs were also reported for Princess, a home reared/free ranging, language-trained orangutan (Shapiro, 1982), but information on eye gaze and hand shapes were not provided.

## BUT IS IT POINTING?

The similarities between the natural food-begging gestures of feral chimpanzees and the pointing of captive chimpanzees deserve attention, especially since the majority of studies where pointing is reported included food that could not be obtained without the assistance of a caregiver. Goodall (1968, 1986) and Plooiij (1978) noted that while food begging the palm faces upward and is held out toward the mouth of the possessor of the food. Thus it is possible that chimpanzees reared in captivity are simply using some variation of this gesture, rather than pointing. In terms of hand shape, both food begging and pointing differ in at least two important ways. First of all, food-begging gestures are often prolonged, where the supinated hand remains in the proximity of the mouth or hands of the possessor. Secondly, when pointing the palm is normally oriented either toward the ground, or at a right angle to the ground. All digits are normally extended when food begging, which can be true for pointing as well (although indexical pointing is more

common among humans). A conservative distinction between pointing and non-pointing can be made wherein pointing that occurs when no putative goal is present is not food begging (or begging of any other sort). When food is present, however, a close examination of hand shape is necessary in order to distinguish points from food begs.

Feral chimpanzees that food beg are typically in very close proximity to the possessor of the food. It is possible (although not always probable) that a begging chimpanzee could easily grab food from its possessor. Barriers such as cage mesh or plexiglas often prevent captive chimpanzees from obtaining food themselves, which is a situation that most chimpanzees for which there are reports of pointing encounter. This by itself does not preclude the possibility that gestures are food begs rather than points. However, food-begging gestures can resemble manual reaching. In humans, pointing does not appear to develop out of failed attempts to grasp objects, yet it has been hypothesized as ontogenetically rooted in reaching for the purpose of touching, rather than grabbing (Werner & Kaplan, 1963). Vygotsky (1926/1962) viewed pointing as exclusively instrumental, serving to connect the infant with the physical world and is thus simply a modified form of reaching. In contrast to this, Franco and Butterworth (1996) recently found concomitant development of reaching and declarative pointing. Regardless of its developmental course in humans, we can not simply assume that any of these findings hold true for the development of pointing in great apes, especially since it does not appear to occur naturally (but see Veá & Sabater-Pi, 1998).

Presumably, if chimpanzees are motivated enough to reach for food, it would be consumed immediately should the possibility to obtain it without assistance arise. Since many of the pointing gestures used by chimpanzees are whole-handed, audience effects can also be used as a criterion to distinguish reaching from pointing. If gestures or directed hand and arm movements of any kind orient toward out of reach food (in the absence of caregivers), we might conclude that the gestures are attempts to reach the food. However, this occurred only twice out of 256 points among the three chimpanzees observed in Leavens et al. (1996). In Krause and Fouts (1997), the two chimpanzees waited for a human to face them directly before pointing in 99% of their trials. Pointing toward out of reach food without the visual attention of a caregiver could also reflect an inability to comprehend the importance of shared attention, even if the gesture itself appears more pointing-like than reaching-like. Thus shared attention and pointing or "pointing-like" (non-reaching) gestures together serve to distinguish

intentional, communicative acts from non-communicative reaching or grasping.

In its most basic form, communicative pointing requires an understanding that certain sensory stimuli are encoded via the visual modality in both the sender and the recipient of the gesture. Many language and non-language trained apes appear to understand this, as pointing is less likely to occur when there is no mutual eye contact. Recently, however, Povinelli and Eddy (1996) discovered a failure to spontaneously recognize that "seeing is knowing" in seven young (4 to 6 years old), laboratory-reared chimpanzees. In other words, the chimpanzees showed no automatic preference to food beg from an experimenter that was looking toward the chimpanzee, versus one with his or her vision obstructed to varying degrees (although performance increased over time). This contradicts what has been discovered in the studies of audience effects and pointing reviewed above. Call and Tomasello (1994) manipulated the attention levels of the experimenters and found comprehension by their language-trained subject. Krause and Fouts (1997) and Leavens et al. (1996) figured audience effects into their designs but did not vary the levels of the experimenter's visual attention when present. Regardless, the chimpanzees from these two studies rarely pointed unless a human was present and looking toward them. Tomasello, Call, and Hare (1998) recently discovered conspecific gaze following in five monkey and apes species, which further demonstrates that nonhuman primates use the gaze direction of others to obtain information.

That certain apes do not understand the link between seeing and knowing does not preclude investigations of pointing and shared attention in non-human primates, nor does it negate any previous findings demonstrating positive results. Manipulating experimenter attention levels is a necessary procedure for establishing whether chimpanzees and other apes communicate intentionally. Furthermore, careful analyses of hand shapes serve to determine whether gestures are points, food begs, or reaches.

## HAND MORPHOLOGY: IMPLICATIONS FOR POINTING

Povinelli and Davis (1994) contend that "...chimpanzees ... do not develop a pointing gesture with the index finger and rarely point by gesturing with hands or arms" (p. 134). This certainly is not true for all captive chimpanzees. Povinelli and Davis' (1994) explanation for the

purported lack of pointing in chimpanzees is based on the resting state of the hand. At a resting state (wrist pronated and fingers relaxed), the index finger of the human hand normally protrudes slightly above the remaining fingers, whereas the chimpanzee hand curves with all digits (besides the thumb) positioned parallel to each other. Povinelli and Davis (1994) consider this a possible explanation that supports their position that chimpanzees do not point, and "...suspect that the species differences ... obtained are due to differential tenodesis action of the extensor digitorum in the index finger of humans and chimpanzees..." (p. 138). The authors go on to state that "...in the present context the exact nature of the morphological difference is secondary to its behavioral expression" (p. 138). Actually, the morphological difference may be of primary importance as an explanation for the relatively low incidences of indexical pointing in chimpanzees. Evidence for behavioral expression has existed for quite some time now.

Treating the shape of the pointing hand with such primacy may undermine the actual importance of the gesture, which are its functional properties. This has been noted with regard to human infant pointing (Blake, O'Rourke, & Borzellino, 1994). Information is not necessarily lost when the whole hand is used for pointing -- the intentions of the gesturer are still communicated. On the other hand, if gaze following or audience effects were absent, there would be a significant breakdown in communication. Still, in considering hand configuration alone, the pointing of many language-trained chimpanzees is more similar to that of humans than of non-language trained chimpanzees. This may be because their hands are physically molded into the appropriate hand shape while they are learning the gesture (Fouts, 1972), or because direct observation is encouraged as a means to acquire signs. The teaching and use of non-pointing signs that include index finger extension may also serve to facilitate the development of indexical pointing.

Butterworth (1991) hypothesizes that "The specialized function of the index finger in relation to shared attention may be innate" (p. 230). He also suggests that the relationship between the human thumb and index finger is a specialized adaptation, perhaps relating to precision gripping and tool manufacture. The opposability of the human thumb and index finger, which allows one to form a pincer grip, may have implications for pointing. Butterworth (1998) takes the position that "Perhaps the question whether chimpanzees point should no longer be expressed simply in terms of whether the ability is present or absent. The more appropriate question is why index-finger pointing is

relatively infrequent and very difficult to observe in chimpanzees" (p. 179). Butterworth (1998) hypothesizes that the pincer grip co-evolved with pointing, although with different respective functions. Human infants use pincer grips by 15 months of age and do so consistently from the time of onset (Butterworth, Verweij, & Hopkins, 1997). Chimpanzees also use the pincer grip, but it develops much later and occurs less frequently (Butterworth & Itakura, in press; Jones-Engel & Bard, 1996).

According to the Butterworth (1998), pointing is the motor antithesis of the pincer grip, and the two hand configurations serve antithetical functions. The pincer grip involves the fine manipulation and control of tools or objects, while pointing involves the manipulation of the outward attention of another (Butterworth, 1998). Thus, the precision afforded by index-thumb opposability may explain some of the differences between ape and human pointing. Another explanation for the predominance of indexical pointing in language-trained apes may be found if the development of pincer grips are described for these subjects. Evidence from Christel (1995) suggests that manual precision among primates relate to species capacities for shared attention. This relationship could be further evaluated by examining the effects of rearing environment (e.g., language versus non-language training) on the concomitant development of manual gripping and pointing. Comparisons with tool-using, feral chimpanzees would be quite valuable.

## SOCIAL CONTEXT AND POINTING

Using criteria set forth by researchers of child development, the descriptions of captive ape pointing suggest that the gestures are intentional. The majority of studies of pointing and shared attention in primates show strong evidence of "imperative" pointing, the function of which is to draw the attention of another toward him or herself, and, to redirect the recipient's attention toward something desired. Declarative pointing, on the other hand, functions to redirect the attention of another toward something for the purposes of sharing or showing (Franco & Butterworth, 1996; Tomasello & Camaioni, 1997). This implies that the organism recognizes that the recipient has states of knowledge, emotion, and/or belief, which there is some evidence for in chimpanzees (Premack & Woodruff, 1978; but see Heyes, 1998).

There are some examples of declarative communication and

pointing in non-human primates (Gardner & Gardner, 1975; Miles, 1990; Patterson, 1978; Russell, et al., 1997; Savage-Rumbaugh, 1986, 1988). Most of these instances come from subjects who were language trained and thus had extensive exposure to human pointing. However, apes that point appear to primarily do so in imperative contexts. In every systematic study of ape pointing published to date, an object of some kind (food or a tool used to obtain food) was placed out of the subject's reach. Declarative pointing is probably rare among apes, even those raised by humans in socially enriched environments. This may simply be because apes rarely need to show things to others in these situations, or only do so when verbal or signed questions (e.g., WHAT THAT?) posed by humans, precede the pointing (e.g., Van Cantfort, Gardner, & Gardner, 1989).

One type of pointing that clearly is not imperative has been reported for language-trained chimpanzees. Language-trained chimpanzees sign to themselves when no humans are present (Bodamer, Fouts, Fouts, & Jensvold, 1994). Furrow's (1984) categories of private speech were used to score chimpanzee private signing in 56 hours of videotape reported in Bodamer et al. Among these categories was "referential", which was defined as "an utterance (that) refers to a present object or a present event that does not involve the child" (Furrow, 1984, p. 358). Pointing is a referential act that typically takes place in a social context. Defining it otherwise runs counterintuitive to what has become a broadly accepted definition of referential pointing; but in the interest of comparing private with social speech, a common definition is needed. The chimpanzees in Bodamer et al. often pointed while private signing. While this is not referential (or declarative) in the standard usage of the term which implies outward social communication, it is another interesting context in which, at least, pointing that is not imperative occurs.

## CONCLUSION

The development of both human and ape social cognition begins early. Given this, comparative studies of social cognition ought to treat rearing conditions as a set of variables that are inextricably linked to performance. The development of chimpanzee muscle tone and social responses are affected by their early rearing environments, with differences becoming evident even within the first month of life (Bard & Gardner, 1996). Rearing environment appears to have a greater effect

on temperament than on cognition in one-year old chimpanzees (Bard & Gardner, 1996). However, cognitive skills in chimpanzees and other apes may develop more slowly than in humans, and the effects of cultural influences on the expression of ape cognition may be delayed in comparison to human infants. Therefore, the effects of rearing environment on social cognition may not be apparent until late infancy, adolescence, or adulthood.

Issues in need of attention in research on pointing in non-human primates include the topographies of the gestures used, gaze direction, and the social contexts in which it occurs. The first two have received considerable attention in the experimental work reviewed above. The third, social context, has received less attention largely because it is difficult to distinguish such phenomena in non-linguistic species, and because it may occur only rarely. Imperative pointing appears to be fairly common among captive apes reared under various conditions, which makes it especially important that pointing be distinguished from food begging or reaching. The convergence of this behavior among captive apes may stem from a context that is common to most captive environments. Human caregivers typically control resources such as food and other objects that captive apes are known to request. This is a partial explanation as to why many captive chimpanzees point imperatively. However, contexts that do not involve such situations exist as well, especially among cross-fostered and language-trained apes. Still, declarative pointing for these subjects is probably rare; which could be due to either cognitive differences between humans and apes, or because an appropriate eliciting context has not yet been provided in a systematic way.

Why don't feral chimpanzees point? Menzel (1973) suggests that they simply do not have the need to because they point with body posture. Similarly, Goodall (1986) notes that body orientation is used to communicate direction of travel. Also, it may be that left to their own devices, feral chimpanzees do not utilize the gesture because of cognitive limitations. Human "enculturated" apes show some cognitive capabilities that have few observed counterparts in feral populations (for further discussion see Call & Tomasello, 1996, and Tomasello & Call, 1997). However, as previously discussed, Plooij (1978) showed that some of the requisite abilities for pointing exist in feral chimpanzees, and make their appearance early in development. Thus the pointing of captive chimpanzees is superimposed upon an already existing propensity for intentional communication.

As Povinelli and Eddy (1996) point out, older chimpanzees (greater

than five years of age) may be capable of understanding the relationship between seeing and knowing, and some evidence for this appeared in a follow up study. Whether apes can or can not understand what "seeing" is may depend upon the social experiences of the individuals tested. Povinelli and Eddy (1996) researched nursery-reared chimpanzees. The social richness of chimpanzee nursery environments surely are not the same as those of human mother-infant pairs. Yet in a comparative psychological study such as this, attempts to replicate the rearing histories of the subjects ought to be made. Throughout their monograph, Povinelli and Eddy (1996) contrast mentalist hypotheses of seeing with behaviorist hypotheses, the latter of which best explains their data. Yet with no comparative data on children encountering their first contingencies of the exact type arranged in their study, we can in no way conclude that children do not learn that "seeing is knowing", as opposed to executing this knowledge spontaneously via complex mental processes. A suitable comparative base might come from cross-fostered chimpanzees. Future work in this area will hopefully be conducted.

Most studies of human pointing are from a developmental perspective. Unfortunately, few longitudinal studies of pointing exist for non-human primates. A comparative developmental base would prove invaluable for research on this topic. The relative contributions of molding and observational learning necessary to shape predominantly indexical pointing in language-trained apes are of definite interest. The developmental relationship between production and comprehension of pointing should be investigated as well. Also, surfaces such as cage mesh should be altogether removed from experimental situations. This would make tests for contrasting hypotheses (e.g., pointing vs. reaching or food begging) easier to execute and would be feasible with young subjects. Systematic observations and descriptions of other gestures used by young chimpanzees should be made as well. Among other reasons, this would allow investigators to determine if pointing is a ritualized variant of some other gesture. Also, since pointing does not occur in feral apes, we can not assume that its developmental course is similar to that of humans. Specifically, it would be worth determining if pointing develops from reaching, grasping, or touching. These hypotheses have been considered for human infants (Vygotsky, 1926/1962; Werner & Kaplan, 1963), and should be tested on non-human primates as well.

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