Manual deixis in apes and humans

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Pointing by apes is near-ubiquitous in captivity, yet rare in their natural habitats. This has implications for understanding both the ontogeny and heritability of pointing, conceived as a behavioral phenotype. The data suggest that the cognitive capacity for manual deixis was possessed by the last common ancestor of humans and the great apes. In this review, nonverbal reference is distinguished from symbolic reference. An operational definition of intentional communication is delineated, citing published or forthcoming examples for each of the defining criteria from studies of manual gestures in apes. Claims that chimpanzees do not point amongst themselves or do not gesture declaratively are refuted with published examples. Links between pointing and cognitive milestones in other domains relating means to ends are discussed. Finally, an evolutionary scenario of pointing as an adaptation to changes in hominid development is briefly sketched.

Keywords: pointing, hominoidea, apes, communication, manual gestures, deixis, nonverbal reference

One of the most striking human developmental transitions is the dawn of manual deixis, or pointing, around the end of the first year of life (Bates, Camaioni, & Volterra, 1975; Butterworth, 2001; Carpenter, Nagell, & Tomasello, 1998; Franco & Butterworth, 1996). Deixis is the ability to locate, for an observer, a specific entity or location. Despite sporadic published reports of pointing by apes in captivity (reviewed by Leavens & Hopkins, 1999), until recently most developmental psychologists believed that pointing was a uniquely human behavior (e.g., Butterworth & Grover, 1988; Povinelli & Davis, 1994). Pointing is how one organism manipulates the visual attention of another to some distant entity; it is therefore a manifestly referential act, insofar as it co-ordinates the visual attention of two separate organisms (e.g., Bates, O'Connell, & Shore, 1987). At present, the evidence is as follows: (a) human infants in Western

Table 1. Phylogenetic patterns in manual deixis

	Characteristics of pointing	
	Imperative?	Declarative?
Humans		
Western civilization, Japan (*Homo sapiens*)[a]	Yes	Yes
Autism[b]	Yes	Rare
Great apes (captive, language-trained or home-reared)		
Chimpanzees (*Pan troglodytes*)[c]	Yes	Yes
Bonobos (*Pan paniscus*)[d]	Yes	Yes
Gorillas (*Gorilla gorilla*)[e]	Yes	Yes
Orangutans (*Pongo pygmaeus*)[f]	Yes	Yes
Great apes (captive, neither language-trained nor home-reared)		
Chimpanzees (*Pan troglodytes*)[g]	Yes	No
Bonobos (*Pan paniscus*)[h]	Yes	No
Gorillas (*Gorilla gorilla*)[i]	No	No
Orangutans (*Pongo pygmaeus*)[j]	Yes	N/A
Great apes (feral, in natural habitats)		
Chimpanzees (*Pan troglodytes*)[k]	N/A	N/A
Bonobos (*Pan paniscus*)[l]	N/A	Yes
Gorillas (*Gorilla gorilla*)	N/A	N/A
Orangutans (*Pongo pygmaeus*)	N/A	N/A
Monkeys (captive)		
Rhesus macaque (*Macaca mulatta*)[m]	Yes	N/A
Capuchin (*Cebus apella*)[n]	Yes	N/A
Monkeys (feral, in natural habitats):	No reports of pointing to date.	

Notes. N/A = insufficient data. Representative references: [a]Bates et al., 1987 [b]Baron-Cohen, Cox, Baird, Swettenham, Nightingale, Morgan, Drew, & Charman, 1996 [c]Gardner & Gardner, 1971; Kellogg & Kellogg, 1933; Savage-Rumbaugh, 1986 [d]Savage-Rumbaugh et al., 1998 [e]Bonvillian& Patterson, 1999 [f]Call & Tomasello, 1994; Furness, 1916; Miles, 1990 [g]Leavens & Hopkins, 1998; Leavens et al., 1996, 2004a; [h]Savage-Rumbaugh, Wilkerson, & Bakeman, 1977 [i]Pika, Liebal, & Tomasello, 2003; Tanner & Byrne, 1999 [j]Call & Tomasello, 1994 [k]Inoue-Nakamura & Matsuzawa, 1997 [l]Veá & Sabater-Pi, 1998 [m]Hess et al., 1993 [n]Mitchell & Anderson, 1997

societies commonly point to distant objects or events by the beginning of the second year of life, (b) apes in the wild only rarely point, (c) apes in captivity point very frequently, usually in the complete absence of explicit training, (d) monkeys in the wild have not been reported to point, and (e) monkeys in captivity only rarely point spontaneously, but they can be readily trained to point (Table 1).

Because pointing is rare in wild ape populations, yet commonplace in captive ape populations, in the complete absence of explicit training (e.g., Leavens & Hopkins, 1998; Leavens, Hopkins, & Bard, 1996; Leavens, Hopkins, & Thomas, 2004a), then this has clear implications for our understanding of the heritability of deixis. If pointing is the phenotype of interest, then variance in the expression of that phenotype (V_P) is

$$V_P = V_G + V_E + V_{GxE}$$

where V_G is variance attributable to genotype, V_E is variance attributable to the environment, and V_{GxE} is variance attributable to the interaction between the genotype and the environment. It is implausible that in the decades-long procurement of apes from the wild for display in zoos and for research and other purposes, hunters have somehow managed to select only those apes with 'pointing genes' or 'pointing gene complexes.' That is, apes in captivity are genotypically representative of apes in the wild. Therefore, V_G can be dropped from the equation and, with respect to pointing,

$$V_P = V_E + V_{GxE}$$

Thus, the heritability of pointing is nil; that is, the contribution of purely genetic variance to phenotypic variance is negligible. It follows that any account of the development of pointing in captive apes must invoke *exogenous* environmental factors. (See Danchin, Giraldeau, Valona, & Wagner, 2004, for an elaboration of the components of V_E.) Hence, if we are to understand the development of pointing in captive apes, we must understand which of the multitudinous environmental differences between wild and captive apes are most relevant. This is not a straightforward task, chiefly because, like humans, apes are extraordinarily long-lived and experience very long juvenile and adolescent epochs (Fragaszy & Bard, 1997; Tutin, 1994). This means that by the time researchers come to interact with or observe any particular ape, that ape may have experienced several decades of poorly-documented life experience. If we document pointing in, say, a 40-year-old chimpanzee, what can we say about how that chimpanzee might have acquired the behavior? In truth, very little.

However, it is still not universally accepted that apes point (cf. Baron-Cohen, 1999; Povinelli, Bering, & Giambrone, 2003a). Therefore, before turning to a consideration of a candidate explanation for the development of pointing in captive apes and its implications for understanding the evolution of manual deixis, considerable discussion is warranted on the question of what I mean when I assert that apes in captivity point.

Nonverbal reference defined

Because 'reference' is a term with both general and specialized meanings, a brief denotative digression is warranted. In symbolic reference, symbols are produced (e.g., "dog") which, by virtue of a shared lexicon between speaker and listener, co-ordinates the attention of the interactants to a conceptual entity. That is, no dog needs to be immediately present for reference to occur. Symbolic reference therefore allows communicators to transcend the immediate sensory environment (a property called 'displacement'). For some people, particularly linguists, 'reference' invokes a representational architecture in which a symbol 'stands for' a real or imaginary object, or 'referent.' For these researchers, who use the term 'reference' in this specialized sense, it is nonsensical to refer to pointing as 'referential' because in no meaningful sense does the gesture 'stand for' the event or object to which attention is being drawn. In the interest of clarity, therefore, it is important to emphasize that in the present paper, as in our previous articles (Leavens & Hopkins, 1998; Leavens et al., 1996, 2004a), I use the more general definition of reference, which means simply "to direct attention." Manual deixis, or pointing, is thus an act of nonverbal reference (Adamson, 1996; Bates et al., 1987; Leavens et al., 2004a). It should be obvious that this use of the term 'reference' differs also from that used in studies of nonhuman primate vocal communication, in which evidence for semantic reference is offered; i.e., different vocalizations seem to be emitted in response to different types of predators or threats (e.g., Cheney & Seyfarth, 1990).

What is intentional communication?

A second preliminary consideration concerns the definition of intentional communication. For the sake of brevity, in current usage there are essentially two ways to define it. In one camp, intentional communication is defined with reference to the exercise of will; a signaler *intends* to influence a social partner in a certain way. Intentional communication is, thus, defined with reference to the motivational state of signaler (which is unverifiable, in practice). The alternative definition emphasizes what we can objectively measure in a signaler or context. The operational definition of intentional communication that we use has been elaborated from that originally developed for the study of preverbal communication in human babies (e.g., Bates et al., 1975; Golinkoff, 1986; Sugarman, 1984; see Bard, 1992, for more extensive discussion, and see Rolfe,

1996). The first criterion is that it is used socially; that is, that it requires an audience. This criterion has been met in studies of the gestural communication of orangutans (*Pongo pygmaeus*) and chimpanzees, in samples of from two to 101 subjects (Call & Tomasello, 1994; Hostetter, Cantero, & Hopkins, 2001; Leavens et al., 1996; Leavens et al., 2004a). The second criterion is that the visual orienting behavior of the signaler is under the stimulus control of the locations of the object or event of apparent interest and the social partner (i.e., that the signaler looks back-and-forth between the social partner and a distant event or object). This criterion has been met by virtually all reported studies of the gesture use of apes in captivity, including samples of from two to 115 apes (Call & Tomasello, 1994; Krause & Fouts, 1997; Leavens & Hopkins, 1998; Leavens et al., 1996; Leavens et al., 2004a). The third criterion is that the signaler exhibits putative attention-getting behavior when the social partner is not looking at the signaler. Again, this criterion has been met in studies of from two to 57 apes (Krause & Fouts, 1997; Hostetter et al., 2001; Leavens, Hostetter, Wesley, & Hopkins, 2004b; Pika, Liebal, & Tomasello, 2003; Tomasello, Call, Nagell, Olguin, & Carpenter, 1994). Finally, intentional communication is defined by persistence and elaboration in the face of apparently failed communicative bids. Small-scale studies have established this criterion in chimpanzees (e.g., Menzel, 1999; Leavens et al., 1996) and forthcoming work will establish the same finding in a larger sample of chimpanzees (Leavens, Russell, & Hopkins, in press). Hence, pointing by apes meets all the objective criteria for intentional communication originally defined with reference to the preverbal communication of human infants.

What is a point?

A third preliminary consideration concerns the structure of pointing. But Povinelli and Davis (1994) suggested that anatomical differences between apes and humans account for alleged species differences in the shape of the pointing gesture. But we know that chimpanzees who have received language training tend to point relatively frequently with the index finger (e.g., Krause & Fouts, 1997; Menzel, 1999; reviewed by Krause, 1997; Leavens & Hopkins, 1999). In contrast, non-language-trained apes tend to point to objects with the whole hand, with all fingers extended, though there are individual differences and some pointing with the index finger is exhibited by some language-naive chimpanzees in virtually all of our studies (e.g., Leavens & Hopkins, 1998; Leavens

et al., 1996, 2004a; see Call & Tomasello, 1994, for similar findings with orang-utans). Whether language-training directly or only incidentally influences the number of fingers extended while pointing is currently an open question (Call & Tomasello, 1994; Krause & Fouts, 1997; Leavens & Hopkins, 1999).

There is evidence that pointing with the whole hand serves a different function for young humans from pointing with the index finger: Butterworth (e.g., 2003; Franco & Butterworth, 1996) suggested that pointing with the whole hand serves to request objects or actions on objects, whereas pointing with the index finger serves to "comment" upon something in the world. In a cross-sectional study, Franco and Butterworth (1996) found that whole-hand-ed gestures did not change in relative frequency from 12 to 18 months of age, whereas the incidence of index-finger pointing increased dramatically over the same age range. Thus, in that study, only pointing with the index finger seemed subject to developmental change in frequency of use. Blake, O'Rourke, and Borzellino (1994) reported that no less than 87% of the gestures exhibited by one-year-old human infants to out-of-reach food comprised what they called 'reach-outs' (extension of all fingers of the hand), again suggesting a requesting function to whole-handed gestures. Iverson and Goldin-Meadow (1997, 2001) reported that when sighted children from 9 to 18 years of age were blindfolded and required to give verbal directions or re-tell a story, they exhibit strikingly less pointing with the index finger, compared to sighted children who are not blindfolded, and exhibit relatively more pointing with the whole hand. Wilkins (2003) has noted the cross-cultural variability with which people indicate distant objects. Taken together, these findings suggest that the form of pointing in humans is sensitive to contextual manipulations. Thus, if some apes (and humans) exhibit an overwhelming reliance on the index finger for pointing, and if others seem to prefer to indicate distant objects with their whole hands extended, then on what basis can anatomical differences between human and chimpanzee hands (and there are many such differences) be invoked to account for differences in the structure of pointing?

What does pointing do?

A fourth preliminary consideration concerns the function of pointing. In human developmental research it has been well-established that human infants, after approximately one year of age, point with two distinctly different apparent goals. Sometimes, they point to objects in requestive contexts — this is

frequently referred to as *protoimperative* or *imperative* pointing (e.g., Bates et al., 1975; Baron-Cohen, 1999). Protoimperative gestures seem to function to request others to act on the world in some way, for example, to deliver otherwise unreachable food or toys. On other occasions, children seem to point as though merely sharing attention to some distant object or event with a social partner is the end in itself. This latter kind of gesture is typically referred to as *protodeclarative* or simply, *declarative* (e.g., Bates et al., 1975; Baron-Cohen, 1999). These terms were used by Bates and her colleagues to describe the preverbal communication of infants. Imperative speech serves to demand or request things of a social partner, hence Bates et al. (1975) termed apparent requests by preverbal humans "protoimperatives," suggesting continuity in humans between preverbal and later verbal requests. Correspondingly, declarative speech serves to comment upon the world, and preverbal communication with the same apparent goal was termed "protodeclarative," again implying continuity in preverbal and later verbal commenting. Because it is not coherent to write of "proto-" imperatives or declaratives in animals who will never exhibit symbolic communication (Leavens & Hopkins, 1998), I will refer to apparent nonverbal requests as "imperatives" and apparent bids to establish shared attention to some distant event or object as "declaratives."

More recently, these terms have been used in ways which imply that the distinction between imperative and declarative communication may mark a human developmental transition to a nascent theory of mind (e.g., Baron-Cohen, 1999; Legerstee & Barillas, 2003; Tomasello, 1999). According to this perspective, declarative communication implies that the signaler is attempting to manipulate another's state of mind, implying further that the signaler recognizes, at some level, that their social partners have perspectives and mental contents which differ from the signaler's. Imperative communication, on the other hand, implies only that the signaler is attempting to manipulate a social partner's behavior. It is empirically true that apparent preverbal requests, or imperative gestures, do seem to develop in humans prior to apparent declarative gestures (e.g., Bates et al., 1987). Hence, pointing to share attention, or declarative pointing, may index greater maturity and sophistication in the communication of developing infants near the end of the first year of life.

The implication which is typically drawn for comparative psychology is that because apes allegedly do not gesture declaratively, but only imperatively (e.g., Baron-Cohen, 1999; Butterworth, 2001; Povinelli, Theall, Reaux, & Dunphy-Leli, 2003b), therefore they do not recognize the mentality of their social partners. There are at least four grounds on which this generalization can

be questioned. First, there are several reports of apparent declarative pointing by apes. Savage-Rumbaugh, Shankar, & Taylor (1998) wrote of Matata, a female bonobo (mother of Kanzi, *Pan paniscus*): "when she heard unusual sounds in the forest, she would direct my [Savage-Rumbaugh's] attention toward them by looking and gesturing in that direction" (p. 11). Miles (1990) described several instances of apparent declarative pointing by a language-trained orangutan, Chantek. Ape language researchers report numerous allegedly declarative acts by apes using sign language or other non-vocal languages (e.g., Gardners & Gardner, 1971; Miles, 1990; Savage-Rumbaugh, 1986; Savage-Rumbaugh et al., 1998). Strikingly, the only published report of pointing by a wild bonobo appears to be a quintessentially declarative gesture: this bonobo pointed to the location of (not so very well) hidden observers and alternated his gaze between these human observers and the rest of his troop, following behind him (Veá & Sabater-Pi, 1998). With the exception of the report by Veá and Sabater-Pi (1998), what differentiates these particular apes from other apes in captivity is that they have experienced unusually close emotional bonding with human caregivers, usually (but not always) in the context of language training. Although reports of apparently declarative communication are relatively scarce, so are rearing histories in which captive apes experience intensely close emotional bonding with trained human observers. Thus, a substantial proportion of those few apes who experience these unusually intimate and emotionally rich relationships with human caregivers also exhibit declarative pointing. Hence, although the evidence for declarative pointing in apes is based on very small samples and relatively little systematic study; because these behaviors are so commonly reported in these special populations, I will tentatively accept the evidence at face value, acknowledging that future research in this domain is warranted.

The relevance of emotionality to understanding declarative gestures is highlighted by the second basis for doubting the human species-specificity of declarative gestural communication: humans who have experienced profound early social deprivation also exhibit deficits in communication at rates far above that seen in the general population (Rutter, Andersen-Wood, Beckett, Bredenkamp, Castle, Groothues et al., 1999; see also Hobson, 2002; Hobson & Bishop, 2003). What these findings suggest is that what we conceive of as normal human communicative development depends in no little part on the quality of babies' early emotional bonding. If deprivation can adversely influence communicative development in humans, then it is not implausible to suggest that the kinds of institutional rearing conditions experienced by most captive apes

would adversely influence their *motivation* to share attention with humans. It is at least plausible that the apparent paucity of observations of declarative gesturing by apes is attributable, in part, to a rearing history influence of deprivation on motivation rather than a primary cognitive deficit.

Third, imperative communication about distant objects is a more behaviorally complex activity than is declarative communication, traditionally defined. The usual portrayal of a declarative act (e.g., "look at that") goes something like the following: a signaler captures the attention of a social partner and re-directs the partner's attention to some distant object or event. Imperative gestures (e.g., "give me that") require the further elaboration that the signaler expects the observer to manipulate the world in some way. In early human infancy and in chimpanzee communication, what action is expected is often signaled by context, in relation to the specific interactional histories of the individuals involved; that is, meaning seems to be co-constructed over a history of interactions between specific individuals (e.g., Shankar & King, 2002; Tomasello, 1999; Tomasello & Call, 1997; Tomasello et al., 1994). Hence, from a strictly behavioral perspective, imperative nonverbal communication subsumes the dynamic mechanics of declarative nonverbal communication and requires a bit more elaboration. If, on the other hand, signalers exhibit declarative communication with some expectation that there will be a response from the social partner over and above the mere contemplation of the distant object or event (e.g., Brinck, 2001; Liszkowski, Carpenter, Henning, Striano, & Tomasello, 2004), then both imperative and declarative acts reduce to the same level of behavioral complexity. Both are triadic and they differ only with respect to the putative ends ("give me that" vs. "engage with me"), with essentially no meaningful difference in the cognitive prerequisites for these two kinds of communicative act (Moore & Corkum, 1994).

Finally, as also noted by Povinelli et al. (2003a), we have no observational or experimental evidence that young human babies who point, apparently declaratively, also discriminate or recognize mental states in their social partners (cf. Moore & Corkum, 1994). Some writers argue that because declarative pointing is accompanied by gaze alternation between a social partner and a distant object or event of interest, that this implies the awareness on the part of the baby that others have attentional states which differ from their own (e.g., Franco & Butterworth, 1996; Tomasello, 1995). Adolescent and adult chimpanzees who gesture also exhibit concomitant gaze alternation between unreachable food and human experimenters during 80% to 100% of their gestures, which is a much higher rate than displayed by human infants before about two years of

age (Leavens & Hopkins, 1998; Leavens et al., 2004a; reviewed by Leavens & Hopkins, 1999). If visual monitoring of a social partner is a 'smoking gun' that implicates the awareness of the signaler that the social partner is a mental being, then either (a) chimpanzees also recognize mental states or (b) some compelling argument has to be made that gaze alternation implicates nascent mental state reasoning in human children, but not other animals (e.g., Povinelli et al., 2003a). Previously, we argued that gaze alternation implicated mental state reasoning in both humans and chimpanzees (Leavens et al., 1996). Since that time, we have come to the view that gaze alternation accompanying gestural behavior does not implicate mental state awareness in any species, including humans (Leavens et al., 2004a, although it is consistent with such an interpretation, e.g., Tomasello, 1995). We cannot directly measure the hypothetical motivational or volitional components of communicative behavior in any species, including humans, independently of their overt behavior (Bergmann, 1962; Leavens, 2002; Leavens et al., 2004b), including verbal behavior. Whether this is a mere technical limitation that will be overcome with advances in medical imaging technology (cf. Bergmann, 1962) or an indictment of the currently widespread assumption that folk psychologies accurately reflect psychological processes is an open question (Leavens, 2002; Leavens et al., 2004a,b; cf. Thompson, 1997). Hence, the empirical fact that both human infants and adolescent and adult chimpanzees frequently accompany their manual gestures with successive visual orienting between objects or events of apparent interest and their social partners, in both declarative and imperative contexts, does not uniquely implicate the possession by the signaler of abstract representations of their social partners' mental functioning (see also Brinck, 2001).

Environmental correlates of pointing in apes and humans

Which, among the many environmental factors that differ between wild and captive apes might account for the ubiquity of pointing in captive populations? We may be decades away from a truly inductive approach to this question. This is because we lack sufficient experimental control over the pre-experimental life histories of chimpanzees and to gain adequate experimental control will take extraordinary resources and time not heretofore deployed in the study of the development of manual gestures in apes. As noted above, there are striking differences in how language-trained apes and non-language-trained apes point, most obviously in the former's frequent use of the index finger and apparent declarative behavior. Hence, for these reasons, because at the current

level of empirical knowledge an inductive approach to this question is not fea-
sible, then a deductive approach is necessitated by the paucity of data.

Call and Tomasello (1996) outlined a hierarchy of 'enculturation' in which
captive apes can be categorized according to their degree of intimacy with their
human caregivers. Some captive apes, particularly those raised in biomedical
research institutions, might experience as little as four minutes per day of posi-
tive face-to-face interaction with humans (Bard, unpublished data) whereas
others, particularly language-trained and home-reared apes, experience many
frequent daily, intense, affect-laden interactions with humans (e.g., Kellogg &
Kellog, 1933). Thus, in terms of rearing histories, it is naive to characterize any
particular captive ape population as being representative either of all captive
apes or, worse, all apes of that species. Examples are legion in which research-
ers, having studied a chimpanzee, or a handful of chimpanzees, subsequently
expound upon the behavior of 'The Chimpanzee'; as though their particular
subjects, with their particular rearing histories, were meaningfully representa-
tive of the species.

However, because apes subject to the entire range of possible rearing his-
tories in captivity exhibit pointing in the absence of explicit training, it is not
unreasonable to consider possible similarities across the range of captive rear-
ing conditions for clues to the advent of pointing. As a first approximation, I
will consider three factors or dimensions of life experience: *barriers*, *history
of delivery*, and *emotional responsiveness* (see Table 2). The term *barriers* re-
fers to obstacles to free movement; these can be exogenous barriers, such as
cage mesh, or endogenous barriers, such as locomotor immaturity (Leavens
et al., 1996). The effect of these endogenous and exogenous barriers on com-

Table 2. Pointing in apes and humans with respect to three environmental variables

	Barrier?	History of delivery?	Emotional responsivity?	Imperative pointing?	Declarative pointing?
Apes					
Wild	No	No	Yes	Rare	Rare
Captive (institutional)	Yes	Yes	No	Yes	Rare
Captive (home-reared)	Yes	Yes	Yes	Yes	Yes[a]
Humans (6–15 months)					
Impoverished	Yes	Yes	No	Yes	Rare
Typical Western	Yes	Yes	Yes	Yes	Yes

[a]Although there are relatively few observations of home-reared or language-trained apes exhibiting
protodeclarative behaviors, weight is given here to the fact that these few observations constitute a
very large fraction of the relatively few apes who have experienced these unusual rearing histories.

municative development is that, in the presence of desirable, but unreachable objects, organisms are put into a problem space that is not characteristic of the natural habitats of wild apes. Chimpanzees, for example, exhibit independent quadrupedal locomotion by 4 to 5 months of age (van Lawick-Goodall, 1968). In captivity, but not in the wild, apes face a frequent problem in which desirable objects are visible, but unreachable, due to intervening cage mesh or bars. Human children, who do not develop mature bipedal locomotion until a year of age, and who are frequently restrained in high chairs, cribs, and the like, face a very similar problem space with both endogenous and exogenous factors constraining them from directly attaining objects of interest. When captive apes and humans face these barriers, they also frequently experience circumstances in which caregivers deliver items to them. To the degree that delivery is contingent on the signaling behavior of the ape or human infant, then a means becomes established, through interaction, or ontogenetic ritualization (see, e.g., Tomasello, 1999; Tomasello & Call, 1997).

If barriers coupled with histories of delivery can account for the development of pointing, then why don't human infants tend to start pointing earlier than the 10–12-month average age of pointing onset? In Piagetian terms, this would be explained by the pattern of development of coordinated secondary circular reactions (Stage 4 in the sensorimotor period), the ability to relate means (caregiver) to specific ends (unreachable objects), which develops from 8 to 12 months of age (cf. Sugarman, 1984). Harding and Golinkoff (1979) found relationships between intentional vocalizations and Stage 5 sensorimotor intelligence, but 31% of the children adjudged to be Stage 4 with respect to the object concept and 36% of the children adjudged to be transitional between Stage 4 and Stage 5 in terms of their understanding of physical causality also exhibited intentional vocalizations. Harding and Golinkoff therefore argued that "attainment of a specific level of development of the object concept does not appear either to be necessary or sufficient for the transition into [intentional communication]" (1979, p. 37). Sugarman (1984) reported that children in Stage 4 began to exhibit "coordinated person-object interaction" at 8–10 months of age. Bates, Thal, & Marchman (1991) noted that tool use, causal understanding, and deictic gestures all development in roughly the same epoch, the 9 to 10 month period (see their Table 2.1). Hence, across a variety of human developmental studies relating communication to sensorimotor cognition, there is striking temporal congruity between the age at onset of intentional communication and display of late Stage 4/early Stage 5 sensorimotor intelligence.

In feral apes, retrieval of distant objects by caregivers is obviated by infant apes' ability to independently locomote to within reach of objects of interest, and this locomotor independence precedes the cognitive milestone of coordinated secondary circular reactions in apes (e.g., Gibson, 1996; Parker, 1999; Potì & Spinozzi, 1994). In the case of human infants, the precipitating condition of prolonged confinement extends through the latter half of the first year of life, when the ability to co-ordinate actions on objects with actions on social agents first develops. Hence, heterochrony, or changes in the timing of development, in humans creates a problem space for humans which wild apes do not experience, or experience rarely. As noted above, captive apes experience this problem space frequently (e.g., Leavens et al., 1996).

Two observations of pointing by captive apes for other apes illustrate these points (and, further, serve to refute incorrect claims that apes do not point amongst themselves, e.g., Butterworth, 2001; 2003; Povinelli et al., 2003a). Savage-Rumbaugh (1986) reported 37 instances in which Sherman and Austin, two language-trained chimpanzees, pointed in communication between themselves. What distinguishes Sherman and Austin from most other captive apes is that they were explicitly raised in a food-sharing culture; that is, they were trained to share and to take turns from an early age. Hence, they were often placed in experimental circumstances in which their training required them to await the actions of the other. In these circumstances, they frequently pointed, apparently to draw the attention of the other to the correct response, or to items of fallen food. Both the inhibition to act directly (barrier) and history of delivery (food-sharing) were explicitly trained. The second observation, by de Waal (1982) at the Arnhem Zoo, can be summarized as follows: two chimpanzee juveniles were playing together, when the play descended into an angry brawl. One mother, Tepel, prodded the matriarch of the group, Mama, who was napping nearby, and then pointed in the direction of the fighting juveniles. Mama subsequently waded between the antagonists and separated them. De Waal's interpretation of this event was that because Tepel feared reprisal from the mother of the other juvenile, a female named Jimmie, her fear of reprisal (barrier) prevented her from directly intervening in the fight, so she enlisted Mama's assistance (Mama being the dominant female, hence not subject to negative consequences). Tepel thus experienced the problem space in which a desired outcome required the capture and re-direction of the attention of an ally.

According to this argument, then, imperative pointing develops in the context of barriers to direct retrieval of desirable objects given histories of delivery

by caregivers. Why, then, don't captive monkeys, who experience similar problem spaces, also point? In fact, some monkeys apparently do spontaneously point (Hess, Novak, & Povinelli, 1993; Mitchell & Anderson, 1997), but it seems to be much rarer than pointing by apes. Because the impact of barriers on the efficacy of humans, apes, and monkeys to act on their environments are similar, more research into the communicative interactions between captive monkeys and their human caregivers is warranted. A number of studies that explicitly trained pointing in monkeys have noted that this training seems to lead to some generalized facility in other domains of social cognition, including comprehension of pointing, the production of declarative pointing, and imitation (Blaschke & Ettlinger, 1987; Kumashiro, Ishibashi, Itakura, & Iriki, 2002; Kumashiro, Ishibashi, Uchiyama, Itakura, Murata, & Iriki, 2003). Thus, on the one hand it would be premature, given the paucity of data on the subject, to conclude that there is a fundamental difference between apes and monkeys in their capacities for manual deixis, whereas, on the other hand, there are very few reports of spontaneous pointing by monkeys (two, to my knowledge: Hess et al., 1993; Mitchell & Anderson, 1997). The evidence tentatively suggests that once monkeys have a certain competence in following and manipulating attention in humans, then this may facilitate performance in other domains of social cognition. This may also be true for both apes and humans.

Perusal of Table 2 reveals that captive apes who exhibit apparently declarative pointing are distinguished by rearing histories of close emotional bonding with and emotional responsiveness by human caregivers. Examples of humans who experience profound early social deprivation are rare, but Rutter et al. (1999) described profound communicative deficits in their sample of 111 orphans raised in such deprived circumstances (see Hobson, 2002; Hobson & Bishop, 2003 for extended discussions of the impact of social factors on communicative development in humans). The suggestion put forward here is that unless apes or human infants experience rearing histories in which the affective exchange that accompanies shared attention to distant objects (gleeful vocalizations, smiling, hugs, etc.) become reinforcing, through experience, the motivational basis for exhibiting declarative gestures is undermined. Thus, I hypothesize that gesturing imperatively may provide a foundation for later generalization of pointing in declarative contexts; that is, gesturing to get somebody to act on objects provides a behavioral template for later gesturing to get somebody to engage in positive, shared emotional states. Because wild apes virtually never experience a problem space conducive to the development

of imperative pointing, this obviates its later generalization to contexts eliciting emotional engagement.

The 'driving force' for the development of declarative communication being offered here is the motivational basis for sharing attention and this is seen as being subject to the emotional consequences of sharing attention to distant objects or events with another. According to this view, naming behavior, which is a frequent activity in the lives of human infants and language-trained apes, and which involves shared attention to distant objects, is accompanied by high rates of positive affective signaling on the part of the caregiver. Joint attention is thus socialized and the reinforcing effects of caregivers' smiles, gleeful vocalizations, etc., are manifested in no little part on a foundation of emotional exchanges. Or in other words, for apes and humans in these social circumstances, affective exchange becomes desirable as an end in itself (see, e.g., Adamson, 1996; Adamson & Bakeman, 1985; Gómez, 1998; Moore & Corkum, 1994).

Implications for the evolution of manual deixis

Given that similar problem-solving capabilities, particularly the ability to use an object to obtain otherwise unreachable items, develop in most humans and both wild and captive apes (see, e.g., Bard, 1990; Parker & Gibson, 1977), then manual deixis can be seen as a problem-solving behavioral adaptation to the ubiquitous problem space posed for hominids once the development of independent locomotion became so protracted that it extended into stages of infancy in which agent-object coordinative skills were simultaneously developing. Hence, manual deixis became a human epigenetic consequence of the adaptation to bipedalism. When, in hominid evolution, bipedalism became an obligate, rather than facultative, mode of locomotion is subject to considerable current debate, with controversial claims for the first origins of bipedal locomotion in excess of 6 million years ago (Senut, Pickford, Gommery, Mein, Cheboi, & Coppens, 2001).

From the standpoint of human linguistic evolution, because joint attention is foundational to such early precursors of language use as naming of objects (cf. Butterworth, 2003; Baldwin, 1995), then the following evolutionary scenario assumes some plausibility under a loosely recapitulationist view. First, the period of locomotor immaturity extended, sometime between 6 and 4 million years ago, into later stages of cognitive development, particularly coordinated secondary circular reactions and tertiary circular reactions. Infants dur-

ing this time would have increasingly been forced to tactics of manipulation of their caregivers by their inherent inability to retrieve objects for themselves. Then, between 4 and 2.5 million years ago, as the hominid ontogenetic environment became ever more rich in artifacts, basic lexicons developed. The assumption here is that there is a rubicon of artifactual complexity above which efficient communication becomes subject to selection (see, e.g., Tomasello, 1999). (I.e., some means of communicating "No, not the chopper, the spear lying next to the chopper" becomes selected for as the complexity of material culture increases beyond some, currently ill-defined, minimum). As hypothesized by Corballis (2002), this may have been initially in the visual domain, through iconic gestures. However, in part because chimpanzees in captivity use vocal signals tactically in attention-getting functional contexts (Hostetter et al., 2001; Leavens et al., 2004b), I have argued that the emergence of language was probably multimodal (visual and vocal) from its inception, involving simultaneous use of vocal and gestural components (Leavens, 2003; see also Gibson, 1996; Lock, 1983). It is manual deixis, the ability to capture and redirect the visual attention of a social partner to some specific entity through manual gestures, that is shared by humans and their nearest living relatives, *given certain commonalities in their social environments*, including exposure to the problem space in which manipulation of others is the only viable solution to the problem (as in the retrieval of otherwise unreachable objects).

To summarize, because apes point in captivity, and because they don't require explicit training to do this, pointing is not necessarily derived from the neurobiological or cognitive adaptations for symbolic communication in the human lineage. The epigenetic scenario sketched here, speculative though it is, does account for the near-ubiquity of pointing in captive apes and in humans (but see Wilkins, 2003), as well as its apparent scarcity in wild ape populations.

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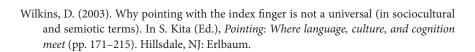
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