CHAPTER 9

The heterochronic origins of explicit reference

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Explicit reference is the communicative capacity to intentionally pick out a
specific object in the environment and make that object a manifest topic for
shared attention. Pointing is the quintessential example of non-verbal, explicit
reference. Chimpanzees, and other apes in captivity, spontaneously point
without overt training. Because wild apes almost never point, and because both
captive and wild apes are sampled from the same gene pool, this implies that,
for apes, hominoid genes interact with certain environments to elicit pointing.
We propose that changes in the patterns of hominid development interact with
ape-like cognitive capacities to produce features of explicit reference in human
infants, a capacity that emerges in our nearest living relatives when they experi-
ence similar circumstances.

1. Introduction

Despite a number of claims to the contrary (e.g., Butterworth and Grover 1988;
Petitto 1988; Povinelli, Bering and Giambrone 2003a) pointing is frequently dis-
played by captive apes (e.g., Leavens 2004; Leavens and Hopkins 1998, 1999). Captive
apes usually point in apparent requests for delivery of food, but they will also point
out the location of tools required to gain access to food (Call and Tomasello 1994;
Russell, Braccini, Buehler, Kachin, Schapiro and Hopkins 2005; Whiten 2000). One
chimpanzee, Clint, often pointed to experimenters' shoes, which he subsequently
manipulated with apparent satisfaction, upon presentation of said shoes (Leavens,
Hopkins and Bard 1996). Pointing is, manifestly, a referential act, directing the at-
tention, the movements or the actions of an observer to a specific locus.

It has been argued that nonhumans both do not and cannot point because
the psychological basis for their pointing-like behaviour differs from that of hu-
mans who point (e.g. Povinelli et al. 2003a; Tomasello 2006). We believe that the
psychological aspects of pointing and other communicative acts are distributed
between signaler and receiver, and that the psychological basis of pointing cannot
be correctly attributed to an individual, but to that individual, and any and all

observers, who form a communicative system. Thus, any appeal to unseen motivations or psychological bases of pointing individuals, specifically (and communicating entities, more generally), is as much an attribute of the psychology of the claimant as it is an attribute of the signaler (e.g. Johnson 2001).

It is common contemporary practice to analyze patterns of communicative behaviour for evidence of hidden mental processes. For example, if a human child points to an object and alternates her gaze between that distant object and a social partner, this is interpreted to mean that the child is attempting to manipulate the "mind" of their communicative partner and considered to be evidence by many researchers that the child must, therefore, have a conception of others as mental beings (e.g. Baron-Cohen 1999; Tomasello 1995). Because, for many years, it was often erroneously stated that apes did not point to distant entities whilst alternating their gaze between these distant entities and their communicative partners (e.g. Butterworth and Grover 1988; Petitto 1988), this was taken as evidence that apes do not have conceptions of others as mental beings. In fact, as we will argue below, pointing to distant entities with gaze alternation between those entities and an observer is as ambiguous with respect to the signaler's conceptions when that signaler is a human child as it is when an ape does the same thing. We will describe the human transition to intentional communication and describe a number of behavioural similarities between apes and young human children in their communicative signaling. Finally, we will outline an evolutionary scenario that might account for the near-ubiquity of pointing in human and captive ape populations, and the relative paucity of apparent pointing in wild apes. We turn, first to a brief consideration of how communication and cognition are instantiated in living systems.

2.   Communication is distributed, cognition is communicative

Communication is an interaction between transducing elements. Transduction is the codification of energy into information. Neither broadcast nor receipt of information constitutes a communicative act; communication is a distributed phenomenon, distributed across at least two transducing elements. Thus, cells of the same or different tissue composition within a body may communicate and organisms may communicate (transfer information) with organisms of the same or different species. If caught in an avalanche, the boulder that pins our leg may influence us, but it does not communicate with us, nor do we communicate with that boulder when we push it off our leg; communication requires at least two entities with transductive boundaries. As Gregory Bateson frequently noted (e.g. 1972a: 315), communication is about a "difference that makes a difference."

Because communication is distributed across boundaries of transduction and because networks of transduction exist at all levels of living systems, from cells to organisms and societies, and because cognition (the discrimination and use of information) is hence an inherently communicative act, therefore it is a category error to interpret communicative behaviour as an index to unseen cognitive processes. Because cognition implies communication (between neurons, between aggregates of neurons, between individuals), therefore it is also a category error to attribute cognitive processes to an individual element, because cognition is a manifestation of communicative processes; i.e, information is distributed across at least two transductive boundaries. It might be argued that networks of communication between neurons comprise functional cognitive systems, or modules, that are properties of individual brains, but because of the distributed nature of cognitive processes, because no cognitive activity can develop or be manifested in a sensorimotor vacuum, therefore all cognitive activity is co-constituted by organisms plus the physical consequences of action and sensation (e.g. Barrett and Henzi 2005; Bateson 1972b; Brinck 2007, this volume; Johnson 2001). We know, as an empirical fact, that organisms are not material objects with clear boundaries, or as William Bateson put it: "We commonly think of animals and plants as matter, but they are really systems through which matter is continually passing" (1906, in C. B. Bateson 1928: 209). The same general principle is true for communication and its special case: cognition. We are systems through which ideas (bits of information) are continually passing. The distributed nature of cognition across the transductive boundary of an individual can be masked by the sometimes deferred nature of environmental input and effects of action, due to memory processes influencing ongoing activity. But the fact that organisms can re-represent (as it were) environmental events only means that experience (or learning history) is important in understanding cognition; it does not mean that cognition can be isolated inside the skull. Gregory Bateson (1972c) expressed it this way:

> A priori it can be argued that all perception and all response, all behavior and all classes of behavior, all learning and all genetics, all neurophysiology and endocrinology, all organization and all evolution – one entire subject matter – must be regarded as communicational in nature, and therefore subject to the great generalizations or "laws" which apply to communicative phenomena.
>
> (1972c: 282–283)

In short, living systems are open systems at all levels of analysis. There are substantive implications for psychology, generally, and comparative psychology, in particular, of the multiscalar dependence of the systems we study, of which we wish to briefly note, here, the widespread dualistic assumption that individual brains constitute the loci for computations, the products of which then cause

overt behaviour. We note that the communicative phenomena we discuss, here (pointing and its accompaniments), are interactive, distributed phenomena that are usually not manifest except in particular social and physical contexts (e.g. Leavens et al. 1996; Leavens, Hopkins & Bard 2005a), which we describe below. As Johnson (2001) argued, social cognition is manifest in communicative interaction; this suggests that media (contexts), modes, and both individual and relationship histories are all vital components of particular communicative episodes. Communication (construed as manifest cognition, rather than an index to hidden mental processes) is simultaneously a preface and a denouement. Because cognition has been historically *defined* as the mental processes of an individual, there is a widespread contemporary misconception that cognition is a property of individuals. It is not and cannot be, and therefore a revolution in our traditional approaches to the acquisition, storage, retrieval and use of information is overdue (see e.g. Barrett and Henzi 2005; Bateson 1972c; King 2004; Shanker and King 2002). In what follows, we will occasionally write of individuals making discriminations and displaying evidence for having certain concepts; this is shorthand for describing what organisms do in particular social, cultural, historical, and experimental contexts.

3.   Intentional communication and intersubjectivity

When we speak of intentional communication, we are specifying a sub-class of communication that is manifest in its flexible accommodation to the behavioural state of a social partner (e.g. Bard 1992; Bates, Camaioni and Volterra 1975; Leavens, Russell and Hopkins 2005b; Pika, Liebal, Call and Tomasello 2005a; Sinha 2004; Sugarman 1984; Tomasello, Call, Nagell, Olguin and Carpenter 1994). Implicit within this definition is the idea that an organism who is intentionally communicating can perceive and respond to the independent agency of others and therefore intentional communication is manifest at higher than sub-organismal levels (e.g. Trevarthen 1998). There is a contemporary intellectual fashion towards re-defining intentional communication so as to limit it only to organisms who have concepts of others as mental agents (as contrasted with concepts of others as behavioural agents; e.g. Baron-Cohen 1999; cf. Povinelli, Bering and Giambrone 2000), but because we can perceive or attribute mentality only through manifest behaviour (see e.g. Brinck 2001; Mitchell 2000; Racine 2005), therefore all putative instances of mental state attribution reduce to either (a) behavioural analysis

or (b) mental illness.[1] Suppose we tell you that there is an organism and ask you, "What does this organism desire/intend/believe, at this moment?" Is any statement about that organism's intentional or epistemic status rational in the absence of any more information than that the organism exists? Obviously not. We interpret this inescapable opacity of mental states to indicate simply that whatever publicly available information an observer uses to make attributions of mental states must partially constitute (and therefore define) those mental states. The fact that people, the world over, attribute complex motives and beliefs to their pets, other animals, other people, and mythical entities does not constitute evidence for the independent existence of these complex motives and beliefs, which are not available to the senses. Thus, no organism actually discriminates or attributes mentality to other organisms on a purely empirical or inductive basis; people learn, for example, to characterize behaviour of others in symbolic terms that are, by their very nature, distributed within a language-using community. This is not to say that organisms do not perceive regularities in the behaviour of others, nor is it to say that many behavioural regularities are not publicly available; to interpret behaviour in terms of hypothetical constructs such as "belief" or the notion that mental states are distinct from and, somehow, "cause" behaviour is to make a commitment to a currently fashionable, dualistic model of mental functioning that is historically situated in Western philosophy and its narrative structures (e.g., Gallagher and Hutto this volume; Susswein and Racine this volume). Commonsense models like these are acquired from our cultures, not from inductive observation (cf. Mitchell 2000).[2]

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1.   Are we really trying to assert that only crazy people attribute mental states? No. What we are asserting is that there is no essential difference between appeals to mental states as causes of behaviour and appeals to, for example, demons as causes of behaviour (e.g. "The Devil made me do it"; see also Mitchell 2000; Susswein and Racine this volume; Thompson 1994). We cannot see, hear, smell, taste, feel, or take photographs, spectrograms, temperatures, weights, volumes or any other measure of either demons or mental states. To attribute behavioural phenomena to either demonic influences or mental state influences is, in both cases, a culturally situated manner of speaking. It is no more or less crazy to appeal to mental states than it is to appeal to demonic possession in describing what organisms do, depending upon the cultural precepts of the individual attempting to account for the behaviour of others. What definitely *is* irrational is to make these appeals to unseen entities in the complete absence of any behavioural information whatsoever. Thus, if cognitive scientists wish to use concepts like epistemic states in models of psychological processes, then is it incumbent upon them to supply definitions of these hypothetical constructs in measurable terms.

2.   Are we advocating methodological behaviourism? Yes. The following quotation from the recent obituary of Gregory A. Kimble describes his position, with which we are in strong agreement:

The concept of intersubjectivity was predicated on Trevarthen's (e.g. 1977) observation that even very young babies act differently towards inert objects and animate agents, implying that the discrimination of independent agency occurs within two months of birth. According to Trevarthen, then, babies arrive more-or-less equipped to engage their worlds with two different motivations: a praxic mode for interaction with objects and a communicative mode for interaction with agents. In primary intersubjectivity (roughly 2–5 months of age), babies share emotional attitudes with their social partners, whereas in secondary intersubjectivity (after about 9 months of age) babies share emotional attitudes *about* events, objects and circumstances external to the dyad. In concrete terms, then, intentional communication is defined by the display of publicly observable behaviour which accommodates to the publicly observable behavioural correlates of intersubjective propensity (expressed emotion, orientation of gaze, etc.).

If intentional communication requires the concept of independent agency and if even very young babies manifest this concept as young as 2 months, then why do so many researchers speak of the human developmental transition to intentional communication much later, at 9 months of age? That young babies clearly do discriminate states of engagement in their social partners is demonstrated by the still-face procedure (e.g., Adamson and Frick 2003, for review); babies react to sudden lapses in engagement by their mothers in dyadic contexts and they make bids to re-engage with one or both parents in triadic contexts, long before the

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. . . Kimble believed that the so-called "cognitive revolution" had not in an Oedipal frenzy slain behaviorism, as was proclaimed by some cognitively oriented psychologists late in the 20th century. Instead, Kimble argued, cognitive psychology had not at all avoided the behaviorist requirement that intervening concepts and dependent variables be anchored to observables, in other words, to responses of some kind – be they overt muscular movements, verbal responses, or electrophysiological readings. Cognitive psychology, thus, could not escape its behavioristic roots.

(Boneau and Wertheimer 2006: 632)

Although none of us would describe ourselves as philosophical behaviourists, we are unanimous in believing that all essential theoretical concepts in cognitive science must rest on patterns of publicly observable behaviour, as broadly defined in this quotation. From a methodological standpoint, cognitive scientists have not escaped the same rigorous requirements for grounding their hypothetical processes in observable behaviour under which behaviourists operate (cf. MacCorquodale and Meehl 1948: esp. 105–106). In short, we believe that scientifically useful concepts can be operationalized, at least in principle (see e.g. Brinck in press). Finally, we note that philosophers, theologians and other scholars are not necessarily subject to the same narrow requirements for public availability of core theoretical concepts to which scientists are required to adhere; we would not like to be construed as implying that only scientific endeavour is worthwhile.

traditional transition to intentional communication (see also Fivaz-Depeursinge and Corboz-Warnery 1999; Reddy 2003).

In contrast, most researchers evoke certain novel behavioural capacities that typically emerge at about 9 months of age as definitive of the transition to intentional communication, including pointing and use of other manual gestures to manipulate others to act on the world (e.g., Bates, Camaioni and Volterra 1975; Butterworth 2001, 2003) and, crucially, certain concomitants of manual gestures, such as visual monitoring of the social partner in explicitly triadic contexts (e.g., Bates, Benigni, Bretherton, Camaioni and Volterra 1977; Franco and Butterworth 1996; Tomasello 1995). Another behavioural capacity that emerges near the end of the first year of life is the ability to follow another's gaze or pointing gestures to increasingly specific loci in the environment (e.g. Butterworth and Grover 1988; Lock 2001).

Thus, the currently mainstream view of the transition to intentional communication can be characterized as a focus on the dawning of "attentionality"; the capacity to monitor, capture, and redirect the attention of a social partner. Because the discrimination or attribution of intentional behaviour and attentional behavior are both predicated on (a) the specific interactive histories of the organisms involved (the level of trust, the frequency of interaction, the amount of joy, etc.), (b) the ongoing motivational states of the interactants, (c) spatial relations obtaining between the interactants, and (d) specific manifestations of contextual markers (i.e., proxemic, behavioural, and physical correlates of routines; cf. Savage-Rumbaugh 1991), then the central difference between early intentional communication (in the first year of life) and late "attentional communication" (near the end of the first year of life and continuing into the second year) is the development of the capacity to integrate actions on objects with communicative acts directed toward people; this is the advent of Piaget's sensorimotor stage IV, or coordinated secondary circular reactions (cf. Sugarman 1984), or secondary intersubjectivity (Trevarthen and Hubley 1978).

Whether or not one cares to argue that intentionality characterizes babies' communication throughout the first year of life or that intentionality dawns later with the advent of triadic use and responses to deictic gestures, virtually all researchers agree that there is a developmental elaboration of communicative behaviours in humans, near the end of the first year of life. Despite much debate over whether this pattern is better characterized as a primary discontinuity in cognitive development (e.g. Baron-Cohen 1995; Lock 2001) or the product of continuous processes manifest in a developing organism of maturing motoric capabilities (cf. Moore and Corkum 1994; Reddy 2001, 2003), it is empirically true that, in many cultures, at the end of the 20th Century, babies begin to point to distant events, agents, and objects with gaze alternation between these elements and their

social partners by about one year of age (Bates et al. 1975, 1977; Blake, O'Rourke and Borzellino 1994; Franco and Butterworth 1996; Leung and Rheingold 1981; see Butterworth 2001 and Lock 2001, for reviews). In these populations, during the second year of life, additional changes occur in how babies deploy their manual gestures and visual orienting behaviour: they become sensitive to whether their social partners are attending to themselves or to distant loci; in other words, there is a well-documented behavioural transition characterized by sensitivity to the behavioural correlates of visual attention in others, or "attentionality" (e.g. Bakeman and Adamson 1986; Franco and Gagliano 2001; O'Neill 1996). By 18 months of age, human babies in the cultures studied, to date, exhibit a robust capability to monitor, capture, and direct the attention of their social partners, through pointing; this is the capacity for explicit reference. In accordance with the introductory remarks, our position is that reporting on the capacity to monitor, capture, and direct attention is to describe typical behavioural development in particular cultural contexts; moreover, organisms can exhibit these capabilities in the absence of any explicit theory of mental functioning (see e.g. Brinck 2003; Doherty 2006; Mitchell 2000).

4.   The phylogeny of explicit reference

4.1   Pointing

Having briefly summarized the ontogeny, or development of explicit reference, we turn now to the phylogeny, or evolutionary history of this capacity. Humankind's nearest living relatives are the African great apes: gorillas (*Gorilla gorilla gorilla*), chimpanzees (*Pan troglodytes*), and bonobos (*Pan paniscus*). We shared a common ancestor approximately seven million years ago (e.g. Hacia 2001). Orang-utans (*Pongo pygmaeus*) are Asian apes with which we shared a common ancestor approximately 15 million years ago (Hacia 2001). Apes and humans are a group of close relatives that are relatively distantly related to monkeys: monkeys and apes shared a common ancestor approximately 30 million years ago (Steiper, Young and Sukarna 2004). Thus, humans and chimpanzees have approximately 23 million years of shared evolutionary history between the time at which we shared a common ancestor with monkeys and the time at which humans and chimpanzees diverged. To put this another way, the lineage of the last common ancestor of chimpanzees and humans existed for more than 75% of the length of the modern human lineage since the split with monkeys. In general, any strong claim that a species-specific cognitive or behavioural capacity (of which speech is the most salient example) evolved *de novo* in humans must therefore also claim (a) that

the selective contexts in which these traits appeared are strictly limited to recent times (from slightly before the Miocene/Pliocene boundary to the present), (b) that the selective contexts pre-dating the Miocene/Pliocene boundary are irrelevant to understanding both the evolution and the development of those traits, and therefore (c) the study of our nearest living relatives, the Asian and African great apes, will not produce data relevant to understanding the development in humans of the traits in question.

To date, there is only one unambiguous published report of pointing by any wild ape, a bonobo (Veà and Sabater-Pi 1998). In this episode, a male bonobo pointed repeatedly (with outstretched arm and "ring" and "index" fingers; presumably the 2nd and 4th rays) towards the location of several human observers who were partially hidden behind some shrubbery, whilst looking back-and-forth between these observers and the rest of his troop. Wild apes do extend their hands towards each other, in various contexts (e.g. van Lawick-Goodall 1968), but it is the triadic use of the outstretched arm and hand that seems to be exceedingly rare. Recently, Pika and Mitani (2006) reported that wild chimpanzees use a characteristic, directed scratching behaviour to elicit grooming at that part of the body from their grooming partners. Thus, although manual pointing by wild apes appears to be extremely rare, the report by Pika and Mitani (2006) suggests that the capacity for explicit reference may be expressed more commonly through different kinds of behaviours.

In strong contrast to the rarity of pointing by wild apes, captive apes commonly and spontaneously point in the complete absence of overt training (e.g. Call and Tomasello 1994; Krause and Fouts 1997; Leavens and Hopkins 1998; Leavens et al. 2005a, b; Leavens, Hopkins, and Thomas 2004a; Menzel 1999; Miles 1990; de Waal 1982; Whiten 2000; reviewed by Leavens 2004; Leavens and Hopkins 1999; de Waal 2001). By far the most common context in which captive apes use pointing gestures is one in which they point to desirable, but unreachable food, in the presence of a human observer.

A brief digression is warranted about what constitutes pointing behaviour. When human infants point with their whole hands (outstretched arms and most or all fingers extended), researchers have long termed this "reaching" (Blake et al. 1994; Leung and Rheingold 1981; Murphy and Messer 1977; see Leavens and Hopkins 1999, for review). The term "reach" has two primary meanings: (a) to attempt to grasp something and (b) to extend the arm and hand. Neither meaning captures the communicative significance of these gestures, which has been noted by many infancy researchers (e.g., Murphy and Messer 1977; Leung and Rheingold 1981). Franco and Butterworth (e.g. 1996) have employed the term "indicate" or "indicative" for these whole-handed gestures, but this implies the same function as the term "pointing." For these reasons, we refer to these as

"whole-hand points." (Recently, at a public science lecture, a member of the audience asked, sardonically, if we stayed up nights developing this terminology). In this usage, we join, for example, Kendon and Versante (2003), Haviland (2003), and Wilkins (2003) in recognizing that adult humans in diverse cultures do, indeed, point with their whole hands in naturalistic contexts (see photographs and drawings in these sources). Pointing has an attention-directing function, and people can and do point with their eyes, with their lips (Enfield 2001; Wilkins 2003), with their whole hands (Wilkins 2003), and with their index fingers. Some researchers argue that pointing with the index finger has a special status as a human species-specific biological adaptation for definite reference (see, esp., Butterworth 2003), implying that the gesture is derived from our species-specific adaptations for language and speech, but because (a) apes point with their index fingers (see below) and (b) some humans do not point with their index fingers (Wilkins 2003), we believe that both the claim for the species-specificity of pointing and the alleged adaptive derivation of the gesture from adaptations for speech are challenged, at our present state of knowledge.

Most captive apes who point, point with their whole hands (Call and Tomasello 1994; Leavens and Hopkins 1998, 1999; Leavens et al. 2004a; de Waal 1982). That these are communicative signals and not attempts to reach for obviously unreachable food is demonstrated by the necessity of an audience for the display of these gestures (Call and Tomasello 1994; Hostetter, Cantero and Hopkins 2001; Leavens et al. 1996; Leavens et al. 2004a; see Table 1). Thus, apes in captivity do not point to obviously unreachable items, with either their index fingers or with all fingers

Table 1. Apes require an audience to display points and other manual gestures in the presence of unreachable food: Summary of experimental studies.

Study	Species	N (subjects)	% Presence[a]
Call and Tomasello (1994)	Orangutans	2	95[b]
Leavens, Hopkins, and Bard (1996)	Chimpanzees	3	99
Hostetter, Cantero, and Hopkins (2001)	Chimpanzees	49	97
Leavens, Hopkins, and Thomas (2004a)	Chimpanzees		
– Visible Banana Condition		101	98
– Hidden Banana Condition		101	98
– Experiment 2		35	100

Notes. [a]This is the percent of trials in which subjects pointed (Call and Tomasello 1994), percent of gestures, some of which were points (Leavens et al. 1996; Hostetter et al. 2001), or percent of subjects who gestured, including those who pointed (Leavens et al. 2004a) in the presence, as compared to the absence of human observers.
[b]In 48 of the total of 96 experimental trials in this study, the human observer, although present, either had his eyes closed or was facing away from the subjects.

extended, in the absence of a human observer; these are communicative signals, not abbreviated reaches for obviously unreachable food.

However, there is considerable diversity in the preferred form of point-ing across captive groups of apes: language-trained apes point overwhelmingly with their index fingers (Figure 1). As Figure 1 shows, language-trained chim-panzees point preferentially with their index fingers. Similar observations were reported for two orangutans, Puti (not language-trained) and Chantek (language-trained) by Call and Tomasello (1994). There are numerous observations of lan-guage-trained apes that support the generalization that they point primarily, or at least very frequently, with their index fingers (Bodamer and Gardner 2002 Call and Tomasello 1994; Krause and Fouts 1997; Menzel 1999; Miles 1990; Savage-Rumbaugh 1986; Whiten 2000). It is not clear which aspects of language-training result in this group difference between different populations of captive apes, but it is clear that apes who have more prolonged and direct interactions with hu-mans point more frequently with their index fingers than do apes who are raised
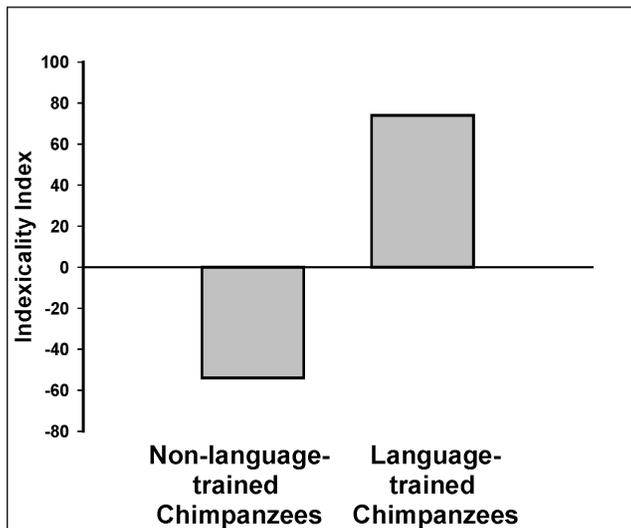

Figure 1. Indexicality index of pointing in captive chimpanzees: Differences in percent-ages of index-finger to whole-hand extensions to objects distal to both chimpanzees and their human observers. Negative numbers reflect a majority of whole-hand extensions, whereas positive numbers reflect a preponderance of index-finger extensions. Sources: *Language-naive chimpanzees* – Leavens et al. 1996, and a re-analysis of data reported in Leavens and Hopkins 1998; *Language-trained chimpanzees* – data from Kause and Fouts 1997, Experiments 1 and 2 combined. Figure and caption adapted from Leavens and Hopkins (1999, their Figure 1).

with less human contact. Thus, for captive apes, the preferred form of pointing is attributable to differential *environmental* influences on communicative development; the form of pointing is attributable to epigenetic (i.e., other than exclusively genetic) processes (see Leavens 2004 and Leavens et al. 2005b, for elaboration of this specific point, and Sinha 2004, for more general considerations of epigenetic effects on human communicative development).

4.2   Gaze alternation

In humans, alternation of gaze while gesturing in triadic contexts is a defining behavioural criterion for the development of mature intentional communication in the second year of life (e.g. Bates et al. 1975, 1977; Franco and Butterworth 1996; Leung and Rheingold 1981). That human infants do alternate their gaze between distant entities and their human caregivers while pointing is well-established, but what it might signify for the infants, themselves, is really quite unclear. A rich interpretation of this behaviour was offered by Tomasello (1995) who argued that gaze alternation while pointing signifies "that the child understands that the adult is a separate person who has intentions and attention that may differ from its own" (p. 109), largely because he claims that babies direct affectively laden facial expressions toward adults, but not the objects to which they point. Empirically, this turns out not to be the case: babies frequently smile while pointing to distant entities before they turn to look at their social partners (e.g. Jones and Hong 2001; Leavens and Todd unpublished raw data). In an earlier paper (Leavens et al. 1996), we also suggested that this gaze alternation implied an awareness by the signaler that the recipient of the gesture had a distinct visual perspective, in accordance with Tomasello's (1995) claim. Since that time, we have rejected this interpretation (e.g. Leavens 2004). A more cautious interpretation of this visual orienting behaviour is that babies are monitoring the effect of their gestures, implying that they have some expectations that their communicative bids will have social or instrumental consequences.

In our studies of captive apes, housed in a research facility, we find that between 85% and 100% of individuals who gesture in the context of unreachable food also display gaze alternation between the food and the social partner (Table 2).

As Table 2 illustrates, it takes human infants two years to reach the same levels of accompanying gaze alternation displayed by chimpanzees; unfortunately, there are no relevant data, to our knowledge, on the early development of gaze alternation in chimpanzees. Nevertheless, it is clear that chimpanzees raised in what may be considered to be impoverished conditions, nevertheless acquire this pattern of visual orientation in the absence of any explicit training to do so, just as people do.

Table 2. Comparison between chimpanzees and human infants of the percent of subjects displaying gestures accompanied by gaze alternation.

Species	Study[a]	N (Subjects)	% Subjects w/GA[b]
Chimpanzees	Leavens and Hopkins (1998)	78	87
	Leavens et al. (2004a)		
	– Visible Banana Condition	76	86
	– Hidden Banana Condition	73	85
	– Experiment 2	11	91
	Leavens et al. (2005b)		
	– Predelivery: Banana	22	91
	– Predelivery: Half-Banana	20	100
	– Predelivery: Chow	24	92
Humans	Bates et al. (1977)		
	– 9.5 Months	25	0
	– 10.5 Months	25	28
	– 11.5 Months	25	36
	– 12.5 Months	25	56
	Lempers (1979)		
	– 9.0 Months	36	8
	– 12.0 Months	36	8
	– 14.0 Months	36	64
	Desrochers, Morissette, and Ricard (1995)		
	– 9.0 Months	25	0
	– 12.0 Months	25	13
	– 15.0 Months	25	54
	– 18.0 Months	25	79
	– 24.0 Months	25	100

Notes. [a]All chimpanzees sampled from the same population at the Yerkes National Primate Research Center, Atlanta, Georgia, U.S.A., and aged between 3 and 56 years. All human gestures are index-finger points. Methodological differences in the assessment of visual orienting behaviour between studies of apes and humans render these comparisons more qualitative than quantitative. Specifically, gaze alternation in apes was defined as looks to an experimenter during an observational interval that varied substantially between subjects and studies (typically, these observation intervals ranged between 1s and 60s), whereas human visual orienting was typically defined as looks to caregivers from 1s before point onset to 1s after point termination.
[b]"Subjects w/GA" means "percent of subjects gesturing with gaze alternation."

Also like people, chimpanzees in captivity monitor facial expressions of their human caregivers in social referencing contexts (Russell, Bard and Adamson 1997), thus alternating their gaze between social partners and distant entities in both information-providing and information-seeking contexts.

4.3   Sensitivity to attentional status of an observer

There is a widespread misconception that captive apes are relatively insensitive to the attentional status of others (e.g. Povinelli et al. 2000, 2003a), despite numerous demonstrations to the contrary. Table 3 lists a representative sampling of experimental and observational demonstrations of the sensitivity of chimpanzees to the visual attention of both conspecific and human observers. These studies include captive apes from both ends of an "enrichment" spectrum (i.e. the studies in Table 3 used apes in biomedical research centers and zoos, as well as much more socially enriched language-trained apes). In short, as the studies listed in Table 3 make clear, apes discriminate direct gaze, they follow gaze, and they selectively deploy their communicative signals in accordance with the attentional status of an observer. Apes without any special training display a procedural awareness of the "attentionality" that characterizes human infant communication between approximately 9 and 18 months of age. A recent spate of claims to the effect that in their pre-verbal signaling behaviour human infants evince evidence for some additional representational capacity not available to non-human primates is subject to criticism by appeal to the empirical data which clearly and almost unanimously demonstrate that apes also discriminate visual attention in their social partners.

Table 3. Apes are sensitive to the visual attention of an observer: Representative studies. These studies variously demonstrated that apes discriminated direct gaze, followed the gaze of others, or displayed visual signals selectively when social partners were looking at them.

Type	Study	Species
Observational	Tanner and Byrne (1993)	Gorilla[a]
Observational	Tomasello et al. (1994)	Chimpanzees
Observational	Tanner and Byrne (1996)	Gorilla
Observational	Tomasello, Call, Warren, Frost, Carpenter and Nagell (1997)	Chimpanzees
Observational	Pika, Liebal, and Tomasello (2003)	Gorillas
Observational	Liebal, Call, and Tomasello (2004a)	Chimpanzees
Observational	Liebal, Pika, and Tomasello (2004b)	Siamangs
Observational	Pika, Liebal, and Tomasello (2005)	Bonobos
Observational	Liebal, Pika, and Tomasello (2006)	Orangutans
Experimental	Call and Tomasello (1994)	Orangutans
Experimental	Itakura (1996)	Orangutan
Experimental	Povinelli and Eddy (1996a)	Chimpanzees[b]
Experimental	Povinelli and Eddy (1996b)	Chimpanzees
Experimental	Krause and Fouts (1997)	Chimpanzees
Experimental	Povinelli and Eddy (1997)	Chimpanzees

Table 3   (*continued*)

Type	Study	Species
Experimental	Tomasello, Call, and Hare (1998)	Chimpanzees
Experimental	Itakura and Tanaka (1998)	Chimpanzees, Orangutan
Experimental	Itakura, Agnetta, Hare and Tomasello (1999)	Chimpanzees
Experimental	Peignot and Anderson (1999)	Gorillas[c]
Experimental	Povinelli, Bierschwale, and Cech (1999)	Chimpanzees[d]
Experimental	Tomasello, Hare, and Agnetta (1999)	Chimpanzees
Experimental	Hare, Agnetta, Call, and Tomasello (2000)	Chimpanzees
Experimental	Hare, Call, and Tomasello (2001)	Chimpanzees
Experimental	Hostetter, Cantero, and Hopkins (2001)	Chimpanzees
Experimental	Bodamer and Gardner (2002)	Chimpanzees
Experimental	Okamoto, Tomonaga, Ishii, Kawai, Tanaka and Matsuzawa (2002)	Chimpanzee
Experimental	Povinelli, Theall, Reaux, and Dunphy-Lelii (2003)	Chimpanzees
Experimental	Liebal, Pika, Call, and Tomasello (2004c)	Chimpanzees
Experimental	Leavens, Hostetter, Wesley, and Hopkins (2004b)	Chimpanzees
Experimental	Braüer, Call, and Tomasello (2005)	Bonobos, Chimpanzees, Gorillas, Orangutans
Experimental	Melis, Call, and Tomasello (2006)	Chimpanzees
Experimental	Poss, Kuhar, Stoinski, and Hopkins (2006)	Gorillas, Orangutans
Experimental	Hostetter, Russell, Freeman, and Hopkins (2007)	Chimpanzees
Experimental	Hopkins, Russell, and Leavens (In press)	Chimpanzees

Notes: [a]A gorilla covered her facial expression with her hand, implying an awareness of the social consequences of her expressions in the visual domain.
[b]This study is often cited as evidence against discrimination of human gaze by chimpanzees but, in fact, the chimpanzees readily discriminated human gaze in almost all experimental contexts either spontaneously or with a modicum of training.
[c]The gorillas in this study readily discriminated head orientation, but not eyes only.
[d]The authors interpreted their data to indicate that chimpanzees lacked a "high-level" model of mental functioning, but the chimpanzees in this study outperformed the human children in an object-choice task, using aspects of an experimenter's attentional cues and, furthermore, reliably followed the experimenter's gaze to a point behind them.

There are two empirical grounds on which some researchers base claims for a uniquely human cognitive adaptation in the domain of non-verbal communication: (a) an occasional absence of discrimination by apes of the focus of the eyes, specifically, and (b) the phenomenon of pointing to distant events or objects by human babies in the apparent absence of any attempt by the baby to manipulate the social partner to act on that distal element (so-called "protodeclarative" communication, Bates et al. 1975; see also Brinck this volume; Susswein and Racine this volume). With respect to discrimination of eye direction, we have argued that

"whether discriminations are based on eye direction, head orientation, or other postural cues is irrelevant to the cognitive implications, which are simply that humans and great apes discriminate different states of visual attention in others" (Leavens et al. 2005a: 294). In other words, if an organism can use the behavioural correlates of visual attention in social agents to exercise choice over their modality of signaling, to find food, to effectively manipulate others to retrieve food, etc. – all of which have been well-demonstrated in apes – then the concept of visual attention is manifest in the interplay of that organism with its social environment, and this is true irrespective of the specific behavioural cues that organism might use (see Table 3).

Every extant, published, alleged species difference between apes and humans in the capacity to discriminate and use visual attention in others is predicated on an experimental confound between early rearing history and species classification: apes are typically orphans raised in cages without primary, stable adult attachment figures and humans are raised by their biological parents in rich environments filled with laughter, joy, and frequent face-to-face interaction with their primary caregivers. Consider the following thought experiment: raise human boys from birth in the same relatively impoverished circumstances in which captive apes are typically raised. Let the comparison group be human girls raised by their biological parents in their homes, who are cherished, and unreservedly and reliably loved by their caregivers. Years later, assess the sensitivity of the boys and the girls to subtle cues of visual attention in human adults. Suppose the girls, unsurprisingly, perform better than the boys – would any researcher in their right mind attribute the difference to a gender difference between boys and girls? Of course not, rearing history is clearly confounded with the gender of the subjects. Yet substitute apes for boys and humans for girls in this research design and how often have researchers trumpeted a "species difference" between apes and humans in various aspects of sensitivity to visual attention (e.g. Povinelli and Eddy 1996a; Theall and Povinelli 1999)? If the practice of almost completely ignoring the effects of pre-experimental experience (or what used to be called the "preparation" of the organisms under scrutiny) were not so widespread in contemporary comparative psychology, this would be laughable (for a notable exception to this general methodological failing, see Carpenter, Tomasello and Savage-Rumbaugh 1995). The reports listed in Table 3 adequately demonstrate that captive apes discriminate different states of visual attention in others, despite the impoverishment of their early rearing histories.

With respect to so-called protodeclarative pointing, there are very few reports of pointing by apes with the apparent goal of merely directing the attention of their social partners to distant goals; this scarcity has been noted by, among others, Baron-Cohen (1999), Butterworth (2001), Povinelli et al. (2003b), and

Tomasello (1999). These authors suggest that the absence or scarcity of protodec-larative pointing in apes and in humans with autism is diagnostic of an inability to represent the perspectives or mental states of others. However, in the original formulation by Bates et al. (1975), *protoimperatives* were described as pre-verbal attempts by human babies to elicit action from a social partner, and *protodeclara-tives* were described as attempts to elicit positive emotional engagement from a social partner. Thus, in the original formulation, both protoimperative and proto-declarative pointing were presented as instrumental, imperative gestures, differing only in the apparent goals of the signaler (retrieval of objects and social responses, respectively). Hence, the term "protodeclarative" has undergone an equivocation, changing from a label for an instrumental act that signifies the same cognitive processes as protoimperative pointing, to a label for a communicative act that indexes a nascent theory of mind. This has occurred in the absence of any sig-nificant new empirical findings on typical human communicative development; indeed, recent research confirms the necessity of positive emotional engagement to satisfy babies who point protodecaratively (Liszkowski, Carpenter, Henning, Striano, & Tomasello 2004). If, as Bates and her colleagues originally claimed, babies sometimes point to elicit positive affective responses from their caregiv-ers, then any apparent absence of such pointing in certain psychopathological human populations, or in nonhuman populations, can only signify a difference in motivation, not a difference in representational capacities, as the latter are not implicated in protodeclarative pointing. If human babies typically receive posi-tive emotional consequences to their signaling behaviour, it is not implausible to suggest that they may increasingly act to bring about such consequences as they mature. Therefore, we suggest that if these kinds of consequences are necessary for the development of protodeclarative pointing in human children, then it is reasonable to suggest that humans learn to point protodeclaratively (cf. Moore and Corkum 1994). In other words, humans may develop protodeclarative point-ing in human species-typical caregiving contexts that may not require human species-unique cognitive capacities.

Moreover, empirically, there are several reports of apparent declarative point-ing by apes (pointing in the absence of any evidence that apes are attempting to instrumentally manipulate a social partner to act on the indicated element): the single report of pointing by a wild ape was an apparent declarative (Veà and Sabater-Pi 1998), and there are numerous reports of apparently declarative point-ing by language-trained apes (e.g. Miles 1990; Savage-Rumbaugh et al. 1998). These language-trained apes are notable in particular for having experienced unusually close emotional bonds with human caregivers; the putative species difference in propensity to point declaratively may, therefore, be attributable to differences in the degree of exposure to particular kinds of caregiving practices. To put this another

way, humans may inculcate the *motivation* to share attention to distant events by making such shared attention reinforcing through extravagant displays of contingent joy. Organisms with histories of joyful consequences to shared attention might reasonably be expected to instigate such episodes in the future. The much-touted "species difference" in propensity to point declaratively may simply reflect different degrees of exposure to some, particularly Western, caregiving practices.

5.   Heterochrony and the Referential Problem Space

Both the *propensity to point* and the *form of pointing* in captive apes are influenced by rearing history (as may be also the motivation to engage in declarative behaviour). The propensity to point with outstretched arms and fingers can be characterized as a cultural difference between wild and captive apes, in the same way that differential propensities to point with the lips is a human cultural difference. Apes are, thus, malleable in their gestural repertoires (e.g. Bard 1998; Leavens et al. 2005b; Pika et al. 2005a; Tomasello et al. 1994). Given this flexibility, what is it about captive environments, which are so impoverished in many respects, that fosters the development of pointing in captive apes, in the absence of explicit training? We believe a plausible answer lies in consideration of the circumstances in which human infants begin to point.

Human infants have both endogenous and exogenous barriers to free movement. With considerable inter-individual variability, humans do not achieve bipedal locomotion until approximately a year of age and mastery of this mode of locomotion takes several years (e.g. Cheron, Bouillot, Dan, Bengoetxea, Draye and Lacquaniti 2001). Chimpanzees, on the other hand, are capable of independent quadrupedal locomotion (technically known as "knucklewalking") by about five months of age (van Lawick-Goodall 1968). The significant delay in locomotor development in our species, relative to other primates, is largely attributable to maturational factors affecting the stability of the trunk in a vertical mode – humans are biomechanically unstable in this posture for much of the first year of life (e.g., Adolph and Berger 2005). Direct evidence for bipedal locomotion in hominids (*Australopithecus afarensis*) dates to over 3.5 million years ago with the footprints in the Laetoli lava beds (Leakey and Hay 1979) and more controversial claims exist for bipedal locomotion in much older hominids dated to nearly twice that old (*Orrorin tugenensis*, Senut, Pickford, Gommery, Mein, Cheboi and Coppens 2001). It is an open question whether the relatively protracted, peripatetic ontogeny of locomotor development that characterizes modern humans was also characteristic of the earliest bipedal hominids or whether this is a more recent feature of human development related to the very oversized heads of infant
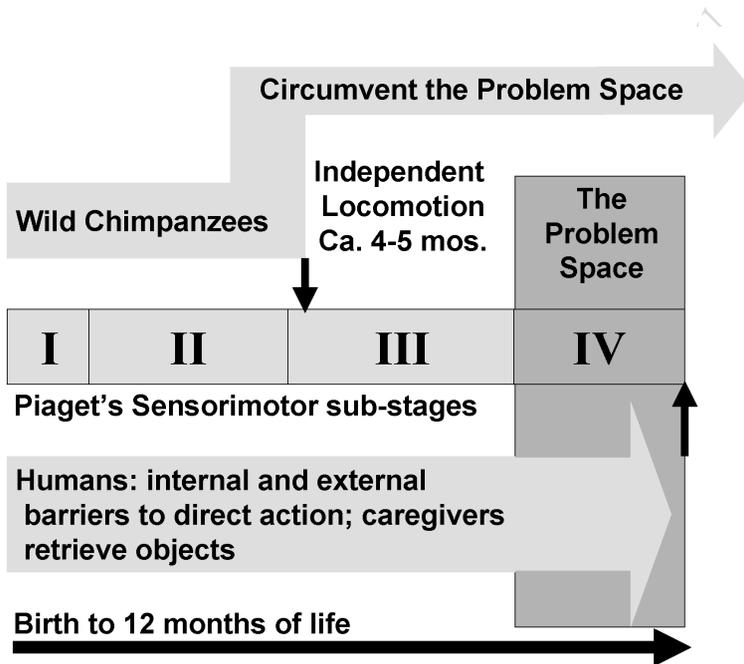
Figure 2. The Referential Problem Space. Wild chimpanzess, because of their ability to independently travel to virtually any object of interest, do not need to apply their problem-solving skills to referential contexts (downward-pointing arrow at 4–5 months indicates the onset of independent locomotion). Apes go on to display means-ends problem-solving capacities in foraging domains, but do not develop pointing as an instrumental tool because it is not required in those contexts (but see Pika and Mitani 2006). In contrast, humans and captive chimpanzees experience both barriers to direct attainment of desirable objects and long histories in which caregivers deliver desirable objects to them. By virtue of humans' long-delayed development of bipedal locomotion (upward-pointing arrow), they are restricted in movement and dependent upon others to act on their world at a time in development in which they have sophisticated problem-solving capacities. Pointing emerges, then, in this problem space.

representatives of the genus *Homo*, dating from about 2.5 million years ago. The difference between humans and apes in the attainment of independent locomotion constitutes a change in our lineage in the relative timing of this motoric competency, or heterochrony. In addition to these endogenous limitations that uniquely affect human babies, secondary consequences of bipedal locomotion in adult caregivers give rise to widespread exogenous barriers to free movement in babies: babies are carried in restraining devices or left physically restrained in a variety of settings, such as cribs or feeding chairs, typically for their own safety (e.g. Super 1990).

At the age at which modern human babies begin to point, near the end of the first year of life, they exhibit novel capacities for means-ends reasoning, or tool use (Bates, Thal and Marchman 1991; Leavens 2004; Sugarman 1984). Thus, at the same age at which babies begin to point and to otherwise use communication instrumentally, there is a concomitant advent of the use of indirect means to achieve goals, characteristic of late Piagetian sensorimotor sub-stage IV (coordinated secondary circular reactions) and early sub-stage V (tertiary circular reactions) cognitive development. These capacities are also well-demonstrated in the great apes (e.g. Bard 1990; Gibson 1996; Parker 1999; Potì and Spinozzi 1994). However, in the wild, because apes develop independent locomotor competence many months prior to the advent of means-ends reasoning, they are not dependent upon others to act on the world for them. In contrast, human infants experience multitudinous barriers to the direct attainment of distant objects and are reliant upon others to retrieve those objects for them: this is the Referential Problem Space, a related series of circumstances in which babies are dependent upon the successful capture and re-direction of the attention of their caregiver to specific loci for instrumental ends (Figure 2). In order to obtain distant items, babies manipulate their caregivers to deliver them, and this requires a means to capture and re-direct the attention of others. Because infants have long histories in which their caregivers have retrieved distant items for their manipulation, the caregivers become established means to an end. The innovation of pointing is that it combines an established means (caregiver) with a novel means (pointing) to numerous established and novel ends.

When apes are raised in captivity, we put them directly into the Referential Problem Space. Captive apes have no access to food without the direct provisioning by human caregivers, so histories of dependencies upon caregivers are well-established in these populations. Pointing to request food or other items develops in this problem space (e.g. Call and Tomasello 1994; Krause and Fouts 1997; Leavens and Hopkins 1998; Leavens et al. 1996, 2004a, 2005a, b; Figure 2). Because wild apes develop early locomotor competence, they circumvent the Referential Problem Space: they are never reliant upon others to retrieve distant objects for them. They go on to manifest their problem-solving capacities in well-documented foraging contexts: fishing for termites, using stones to crack nuts, etc., but pointing or otherwise manipulating others to act vicariously on the world does not develop. In contrast, both human infants and captive chimpanzees face the Referential Problem Space: they cannot retrieve distant objects except through manipulation of others and they have the advanced sensorimotor problem-solving capacities to use existing means (human caregivers) to act on the world for them (Bard 1990; Leavens 2004).

One implication of this hypothesis is that there is no human-specific adaptation for definite reference through non-verbal means. This suggestion runs counter to an existing body of theory that either explicitly or implicitly construes non-verbal reference as being derived from human species-specific cognitive adaptations for symbolic reference (e.g. Butterworth 2003). Because of the heterochronic changes in locomotor independence in our lineage, possibly long before the development of speech our ancestors experienced novel ontogenetic conundrums for which the development of referential behaviour had tangible payoffs. Because apes in similar circumstances also spontaneously point, this implies that a trajectory into referential communication does not require adaptations for speech or adaptations for bipedal locomotion, as apes have evolved neither capacity. According to this view, pointing derives from an interaction between a particular set of environmental circumstances (the Referential Problem Space) and cognitive capacities for means-ends reasoning that are shared by humans and the great apes. Babies and some apes who point and then experience very positive emotional responses from their caregivers to this pointing, may come to point "declaratively," yet nonetheless instrumentally to elicit these states of positive mutual engagement; i.e., they may generalize their pointing to request action on distant objects to contexts in which pointing leads to positive emotional, rather than physical reinforcement, when the social environment provides those affective contingencies (Leavens 2004; Moore and Corkum 1994).

Thus, we do not believe that pointing by apes implies any cognitive capacity not also manifest in wild apes, in problem-solving contexts. Indeed, we believe one of the reasons captive apes so frequently point to request food from human observers may be because, in many captive contexts, humans are so oblivious to subtle indicators of gaze by chimpanzees that these apes are forced to deploy extraordinarily explicit means of capturing and re-directing human attention. Through pointing, apes are able to scaffold humans into more responsive interactions (cf. de Waal 2001).

Acknowledgements

Autumn Hostetter, Jim Hurford, Mark Krause, Maria Legerstee, Katja Liebal, Ulf Liszkowski, Chris Moore, B. E. Mulligan, Simone Pika, Vasu Reddy, Connie Russell, Jamie Russell, Chris Sinha, Roger Thomas, Mike Tomasello, Colwyn Trevarthen, Katherine Whitcome, Nicola Yuill, and many others.

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