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The Cognitive Implications of Intentional Communication:

A Multi-faceted Mirror

David A. Leavens*

University of Sussex

*Corresponding author: David A. Leavens, School of Psychology, University of Sussex,
Falmer, East Sussex, BN1 9QH; davidl@sussex.ac.uk

Abstract: There is a central concern in contemporary cognitive science with the validity of the use of epistemic and intentional terms to interpret the communication patterns of non-human animals. Here I argue (a) that the human developmental transition to intentional communication is a well-described phenomenon, from an empirical standpoint, (b) that the behavioural patterns that characterize intentional communication in our own species are also well-described in the communication of our nearest living relatives, the great apes, (c) that the presence of the behavioural markers for intentional communication in non-human primates does not unambiguously implicate any particular one of a large number of often mutually contradictory hypothetical psychological process models, and (d) that intentional communication by young humans is also consistent with hypothetical process models that are, themselves, mutually contradictory. Intentional communication is a class of behaviour that is open to public, objective measurement. In contrast, the hypothetical cognitive processes supporting intentional communication in both human and non-human animals are not specified by the fact that intentional communication has occurred--they could not be, except when there is an unambiguous behavioural index of invisible psychological processes, which is a contradiction in terms. In this chapter, I will examine a number of contemporary scientific practices that purportedly reveal aspects of psychological processes underlying intentional communication, and demonstrate the deficiencies of these protocols. In general, these methodological infelicities support a systematic, discipline-wide double standard of interpretation of the communication of animals and humans. I will conclude that there is no convincing evidence extant of different psychological processes in the intentional communication of apes and preverbal humans.

Keywords: Social cognition; Hominoidea; species comparisons; Idols of the Theatre; great apes; intentional communication; experimental methods

A circle looks at a square and sees a badly made circle

-Jeff Vandermeer, *Authority*

Cheetah, a matronly chimpanzee, pointed to a banana, looked at me, and then pointed into her open mouth. With Bill Hopkins, I reported this as an example of an intentionally communicative gesture (Leavens and Hopkins 1998). What else could we do? If you came across a human being in a cage who pointed to a banana somewhere in your vicinity, looked directly into your eyes, and then pointed to her mouth, would you be cast into an epistemological tempest of doubt over the question of whether that human being was intentionally communicating with you? Most of us would accept without further evidence that we had been the recipient of a communicative signal that was directed at us and that was manifestly about a banana that existed in our shared perceptual space. But claim that an ape pointed intentionally and, all of a sudden, the claimant is faced with highly educated, sober researchers who grimly shake their heads as though it is some kind of deep mystery whether the animal is communicating intentionally, in the way that humans allegedly do. My central claim in this chapter is that cognitive scientists simply find it easier to attribute higher-order reasoning skills to humans than to animals, notwithstanding that the psychological processes supporting pointing gestures have never been directly measured in any organism of any species, ever. There is, thus, a double standard of proof applied to animals in comparison with humans, notwithstanding the fact that neither animals nor preverbal humans can assert the psychological processes underlying their overt behaviour.

Bacon (1620) noted that scientists were vulnerable to a number of baleful influences that warped their perceptions and their argumentation. One of these classes of error he termed, “Idols of the Theatre,” which he described as “manifestly instilled and cherished by

the fictions of theories and depraved rules of demonstration” (Aphorism LXI). He wrote that, as science advanced, even more numerous such errant dogmas would bedevil those who sought to understand the natural world. This is because scientists, according to Bacon,

take for the groundwork of their philosophy either too much from a few topics, or too little from many; in either case their philosophy is founded on too narrow a basis of experiment and natural history, and decides on too scanty grounds (Aphorism LXII).

One of the current dogmas that, in my opinion, is significantly impeding our understanding of animal cognition is the widespread assumption that human children evince advanced awarenesses of others’ mental processes, even before they can speak (e.g., Tomasello et al. 2007). As we will see, many contemporary researchers employ a “bag of tricks”—what Bacon referred to as “perverted rules of demonstration” (1620, Aphorism XLIV)—to make human children look smart and apes look less clever. These tricks include (a) administering more difficult tasks to the apes than to the humans, and interpreting the better human performance as evidence of an evolutionarily based cognitive advantage in humans (fallacious equivalence of protocol); (b) handicapping the apes by denying them adequate exposure to crucial task-relevant experiences and comparing them to human children who have not been isolated from those formative experiences (fallacious comparisons); (c) interpreting superior performance by apes as evidence of cognitive inferiority (fallacious interpretations); (d) repeatedly subjecting high-performing apes to remedial testing until their performance breaks down (fallacious remediation); and (e) mixing non-handicapped apes with handicapped apes, taking a group average, and then comparing these dubiously aggregated averages to the average performances of non-handicapped human children

(fallacious aggregation). Results from these kinds of fallacious sampling protocols, research designs, and arguments are very popular in the contemporary literature—it is as though scientists are driven by a deep insecurity about humanity’s intellectual superiority over the other animals, and therefore conspire to produce findings that make humans look good in comparison. To be fair, humans are extraordinary animals capable, in groups, of stunning technological and other collaborative feats. The paradox is that when you compare an ape infant with a human infant, the ape is a far more physically competent, more socially aware creature, until about the end of the first year of life, when speech begins to become a unique mode of social expression and learning in our species (e.g., Bard et al. 2014). Yet, the consensus among contemporary scientists and philosophers is that humans have unique competencies in social cognition that are manifest as early as the first year of life. In my opinion, nowhere is the chasm between theories of early human sociocognitive superiority and empirical evidence so wide as contemporary research into the production and comprehension of pointing.

Intentional communication

Pointing is the quintessential intentionally communicative gesture, and it is worth reviewing why that is. Historically, human children’s development of the ability to integrate their object-directed behaviour with communication towards a social partner was heralded as a cognitive milestone variously labelled as *coordinated secondary circular reactions* (Bates et al. 1975), *intentional communication* (Bard 1992; Leavens and Hopkins 1998), or *dual-directional signaling* (Masur 1983). Children in Western cultures, near the end of their first years or in the beginning of their second years of life, begin to visually fixate social partners in smoothly orchestrated triadic communicative episodes in which they more or less simultaneously point to entities in the world. For the first time, near the end of the first year

of life, children, thus, use pointing to integrate communication about something (the gesture as a directed ray) with some particular other (the visual fixation of the social partner).

In the foundational theoretical work of Elizabeth Bates and her colleagues (e.g., Bates et al., 1975, 1977), pointing was characterised as an imperative, a request or demand that the interlocutor act in some way. *Protoimperatives* were defined as requests for an interlocutor to act on the world in some way, usually to retrieve and deliver objects to the signaller, and *protodeclaratives* were defined as requests for interlocutors to engage with the child—here, the child uses the object to obtain adult attention and emotional engagement (“laughter, comment, smiles and eye contact—which we have termed ‘attention,’” Bates et al., 1975, p. 216). An example of pointing to elicit engagement would be a child pointing to a number of distant trucks, and turning to his interlocutor with a smile and the verbalisation, “look at all the trucks!” (This example originates in my childhood: evidently, as a toddler I could not yet pronounce “tr-“ and replaced it with “f-“ and, according to family lore, while I did elicit an affective response, it might not have been the affective response I was expecting). Thus, according to this view, pointing to request delivery of an object and pointing to request engagement are both instrumental acts to manipulate the behaviour of an interlocutor, hence, I will refer to this here as the Instrumental Hypothesis, the idea that communicative acts are intentional by virtue of their goal-directed function (Bard 1992; Moore and Corkum 1994; Leavens 2012a; Racine 2012; Racine and Carpendale 2007). Note that this definition does not appeal to sub-organismal processes—irrespective of its neural correlates, in this point of view intentional communication is identified by communicative acts displayed at the level of the whole organism and its praxic context, including manual gestures, vocalisations and other auditory signals, and facial expressions (e.g., Hopkins, Tagliabue, & Leavens 2011; Leavens, Russell, & Hopkins 2005a). Organisms either do or do not work to achieve objectively measurable changes in the state of the world. If we accept that the present author

and the reader hereof are capable of displaying intentional communication, then we acquired that ability in the complete absence of any direct access to the concomitant neurological, endocrinological, or psychological processes of our conspecifics. There is, thus, no reasonable sense in which such privileged access to unobservables can have influenced our own skill acquisition in this domain, and therefore no necessity to include such unobservables in any scientific operationalisation of intentional communication. We all manage to learn how to do intentional communication in the absence of brain scans, blood plasma assays, and any direct measure of psychological processes, and these early scientific approaches to the study of the development of these skills were tightly grounded in the perceptual input to both developing signallers and their social partners.

At about the same time, however, that Bates and her colleagues were developing the interpretation of pointing as a kind of social tool use, other researchers were characterising protodeclaratives as psychologically distinct from mere requests for infant-directed caregiver responses. Rheingold et al. (1976) argued that the claim that children's objective with protodeclarative pointing is "[to] seek attention for themselves is refuted by the observations: they direct the attention of people to objects external to themselves" (p. 1157). Later researchers developed this position to what is now the canon in developmental psychology, that (proto)declarative signalling indexes an early human perception of states of mind in others, and children use these signals to attempt manipulate the states of mind of their interlocutors. This is the Representational Hypothesis (e.g., Mundy et al. 1986; Baron-Cohen 1989; Tomasello 1995; Tomasello et al. 2007), and this stance includes a variety of different theoretical perspectives on intentionality which all nevertheless agree that internal, mental representations of the world (a) exist and (b) cause communicative behaviour. Thus, according to representational perspectives, intentional communication is defined by invisible, unverifiable features of the signaler's motivation and conception of mentality in others. I'll

return to this difference in interpretation of protodeclarative gestures, below, but the essential point, here, is that whenever intentionality is defined in imaginary, hypothetical terms, such as attempting to manipulate the contents of others' minds, as Baron-Cohen (1989) and many others have construed it, then it follows necessarily that empirical study cannot either confirm or disconfirm the hypothetical elements of the definition (e.g., Leavens, Hopkins, & Bard 2008, Leavens, Sansone, Burfield, Lightfoot, O'Hara, & Todd 2014, Leavens, Bard, & Hopkins 2017). While this representational interpretive stance might be useful to philosophers, as Leavens et al. (2008) pointed out, there is an immensely large set of mutually inconsistent hypothetical psychological process models that, nevertheless, do not make different predictions at the level of whole organisms, and therefore cannot be subject to falsification by empirical study; the Representational Hypothesis in its many guises is, inherently, non-scientific, by virtue of the unfalsifiability of its claims about psychological process. The question under consideration, here, is not whether one view of intentional communication is ontologically more appropriate than other views; rather my concerns in this chapter are with the scientific utility of certain contemporary practices in comparative psychology: a practice is scientifically useful if generates falsifiable claims. A corollary of this utility criterion is that measurements ought to be applied using the same measuring scales across different groups—measurements across species must be fairly applied, not because of any ethical principle of fair treatment, but because only fair applications of a measuring instrument will yield accurate results. If the measurements are unfair, then the resulting findings are scientifically unreliable.

Whether one views pointing as an intentionally communicative gesture depends critically on what one means by “intentional.” In an elegant analysis, Gómez (2009) contrasted Cartesian, “theory of mind” approaches with his interpretation of Brentano’s formulation of intentionality as the quality of a mind “being about or pointing to

things other than itself” (p.191). As Gómez described the Cartesian view:

it . . . keeps a sharp conceptual distinction between behaviour and mental phenomena, with the latter being private, unobservable, detachable from their physical manifestations, but ultimately the cause and explanation of observable behaviour, there is a fundamental dualism between minds and behaviour (2009, p. 191).

In terms of intentional communication, the Cartesian perspective, then, forces mental beings to hypothesise and reason about unobservable, causal mental states, and for some proponents of this Cartesian view, evidence for intentional communication does constitute evidence for this kind of reasoning about invisible, mental processes. In contrast, Brentano’s formulation, according to Gómez, emphasises the directedness of minds in relation to things in the world and other mental phenomena. Thus, in the Brentanian perspective, intentionality is a kind of bridge between mental activity and either events in the world or other mental states. Gómez noted that the Brentanian view is compatible with Cartesian approaches—invisible psychological entities form a foundation or platform for meaning and mentality, but he proposed that “Brentano’s intuition of intentionality as the mark of the mental can be developed in a different direction—one in which dualism becomes irrelevant and intentionality is conceptualized as an ‘embodied’ relation with ‘potentially real’ objects” (p. 191). Gómez goes on to describe how gaze direction embodies attentional focus, and provides direct, perceptual access to an observer of the focus of attention of an animal or human, where attention is not conceived of as a purely disembodied, mental phenomenon, in a Cartesian sense, but as an act of casting visual attention by embodied creatures comporting themselves in an objective, potentially shared reality with an observer. Gómez concludes that

both this Brentanian sense of intentionality a lá Gómez and the representational, Cartesian sense of intentionality are possessed by humans, but that non-linguistic creatures experience intentionality only in the Brentanian sense (see also a related argument by Moore 2015, 2017). My own view is that this is a theoretical distinction without an empirical assay (see, esp., Leavens et al. 2017; Sehon 2000). Goal-directed *behaviour*, on the other hand, is easily measured in objective terms (Bard 1992), and the remarks that follow are based on the Popperian idea that scientifically useful hypotheses must be potentially falsifiable. To meet the criterion of falsifiability, scientific claims must be grounded in variables that physically exist. Otherwise, as I've argued elsewhere, the presence or influence of hypothetical entities cannot be empirically demonstrated (Leavens et al. 2017), and, of course, there is a long tradition in psychology that calls for a strict conceptual distinction between hypotheses defined entirely by empirical variables (intervening variables) and those that appeal to hypothetical entities, which cannot be directly confirmed (hypothetical constructs, MacCorquodale & Meehl 1948). This is not to advocate for a reactionary return to Behaviourism, but simply to observe that the behavioural (and cognitive) sciences have very substantially constrained rules of inference in comparison with more humanistically oriented scholarly activities, and these constraints are attributable to the scientific requirement to manipulate and measure physical entities.

In the contemporary scientific literature on human psychological development, which is grounded in Western cultures, there is a long-standing set of objective criteria by which most researchers agree that humans have attained the capacity for intentional communication (see Bard, 1992; Bates et al., 1975; Leavens et al., 2005a, for elaboration). In these Western cultures, typical development is characterised, late in the first year of life, by pointing that seems to be used to manipulate others to act on the world. For example, Lock (2001) described from film footage a 12-month-old girl in a feeding chair. At first, she reached

ineffectively for a distant apple, but then she turned to her mother (offscreen), who was not attending to the child, and the girl vocalized, displaying a putative attention-getting signal. The girl monitored her mother, and when the mother turned to look at the child, the girl pointed to the distant apple, in a clear request for the mother to retrieve the apple for her. Like many children of her age, this child acted *as if* she had a goal in advance of her actions, she tactically chose auditory (vocalization) and visual (pointing) signals to match the attentional availability of her mother, and in the process, she alternated her gaze from the referent (apple) to the mother (recipient). Babies of this age will also persist or repeat their signals if the recipient is unresponsive, and even elaborate their signals in the face of recipient inaction (Golinkoff, 1986). In Western cultures, then, there is a large body of empirical evidence that describes human children's developmental transition in terms of the following behavioural innovations: (a) they begin to discern when they have the visual attention of an interlocutor, (b) they tailor their own signalling to the attentional status of an observer (using auditory or tactile signals to attract attention before displaying visual signals), (c) and they develop tactics of repair of communication, when initial signalling attempts fail—they persist and/or elaborate in their signalling behaviour. Thus, human children at about a year of age act *as if* they have goals in advance of signalling, they clearly discriminate different attentional states in other agents, and they have tactics for signal manipulation in the face of recipient incomprehension. All of these patterns in signalling are publicly available and amenable, therefore, to objective measurement. Intentional communication can be, thus, completely defined in objective terms.

Bates and her colleagues (1975) were among the first to apply Austin's Speech Act Theory (1962) to the communication of preverbal children, arguing that that these kinds of phenomena (gaze alternation, signal choice) were consistent with the idea of babies displaying illocutionary force in their preverbal communication. They defined an illocution

as requiring “the intentional use of a conventional signal to carry out some socially recognized function” (Bates et al., 1975, p. 206). In their view, intentionality was a kind of “social tool use”: “intentional use of the listener as an agent or tool in achieving some end” (p. 208). Thus, the scientific basis on which humans are said to attain intentional communication is comprised of evidence that children use pointing to particular ends (behaviour ceases on attainment of goal—e.g., a point to an apple results in delivery of the apple; Lock 2001), to influence particular people (behaviour ceases on response of particular people: Povinelli & Eddy 1996; Woodruff & Premack 1979), and that their pointing is about (under the stimulus control of) specific entities in the world (behaviour ceases on attainment of a specific goal, not just any response: Cartmill & Byrne 2007; Leavens et al. 2005a). All of these objective characteristics of intentional communication have been well-described in the communication of young humans (Bates et al. 1975) and great apes (Leavens et al. 2005a).

Although for some decades, pointing was portrayed as a human-unique, species-specific gesture (e.g., Butterworth & Grover 1988), in a program of research spanning a number of decades, it has been amply demonstrated that chimpanzees and other great apes use pointing to particular ends (Leavens et al. 2004a; Menzel 1999), to influence particular people (Woodruff & Premack 1979), with respect to specific entities in the world (Call & Tomasello 1994; Cartmill & Byrne 2007; Leavens et al. 2005a; Menzel 1999; Roberts, Vick, Roberts, & Menzel 2014). It is in this sense—the use of these gestures to manipulate others to act on the world, or social tool use—that researchers claim to have demonstrated intentional communication in great apes (e.g., Bard, 1992; Leavens & Hopkins, 1998): great apes display the same objectively measurable patterns in their social tool use that are displayed by human children in Western cultures, near the end of the first years of their lives; these are goal-directed sequences of behaviour in which the animals use their signals to manipulate people

to act on the world, and the animals' signal choices display the same kind of sensitivity to the attentional state of the recipient (e.g., Cartmill & Byrne 2007; Hopkins et al. 2007; Leavens et al. 2004b, 2010) that is displayed by human children. Today, it is widely accepted that chimpanzees request objects through protoimperative pointing, and that this is an intentionally communicative signal for these animals, when applying the same objective behavioural criteria to humans and apes (Leavens 2012a,b; Tomasello et al. 2007). It is in this sense of these physically grounded patterns of behaviour that animals and preverbal humans communicate intentionally—obviously, if the reader is wedded to Cartesian conceptions of behaviour as consequences of mental activities, then the nature of the evidence might seem a bit thin, but it is no more inadequate for nonhuman animals than it is for preverbal humans (Leavens et al. 2017). Thus, while the Instrumental Hypothesis allows one to interpret communicative behaviour in terms of measurable, physical events, the Representational Hypothesis requires interpretation in terms that cannot be verified: human infants' discernment of epistemic states in others, for example, is not something that can be subject to direct, objective measurement.

It could be, of course, that neither the Instrumental nor the Representational perspectives are ontologically true for any species, and there are other theoretical perspectives on pointing beyond these two. Two examples, which I cannot summarise adequately, here, due to space constraints, are the accounts of Carpenter and Liebal (2012) and Gómez (2007). Carpenter and Liebal (2012) argued that what makes pointing a psychologically unique phenomenon in humans is the state of joint attention that ensues between people, even babies, upon producing or perceiving a point; their claim is that it is not that the two individuals are simultaneously looking at a common focus, nor is it that a signaller exerts control over the visual orienting behaviour of another, but that this state of affairs constitutes a kind of communion or psychological interdigitation of attention between

the two interlocutors. Although I think this idea suffers from some of the same issues of verifiability to which the Representational Hypothesis is vulnerable, it is a potentially non-representational perspective on intentional communication. Developing this idea of “knowing together,” Carpenter and Call (2013) argued that this state of we-ness is unique to humans; with respect to great apes, as they put it, “there is no unequivocal evidence that they do so with the sole (and spontaneous) goal of sharing attention and interest with others about something” (p. 57). Of course, as noted by Leavens et al. (2017) in their discussion of this paper, (a) there is no unambiguous evidence that humans do this (e.g., Liszkowski et al., 2004, for evidence that human babies did not do this in a joint attention context) and (b) any time a scientist claims that an act was *spontaneous*, what this means, in reality, is that the scientist is ignorant of the developmental pathway to that behaviour—it signifies nothing more than that. (A reviewer thought this summation was too strong, asking whether all “spontaneous” behaviour must have a developmental history; the short answer is “yes”; all living creatures begin life as single cells that are manifestly incapable of the kinds of communicative behaviour under discussion, here—this does not necessarily imply that all communicative signals are socially learned, per se, but they do have developmental histories.)

Another example of an alternative view to the instrumental vs. representational contrast under discussion, here, Gómez (2007) argued that the development and comprehension of pointing in human children could be manifested on a psychological platform that is implicitly, but not explicitly Gricean (i.e., Cartesian or representational): “that behaviours are directly perceived as intentional, that is, as being directed to things other than themselves in the essential sense of Brentano’s notion of intentionality ..., but without necessarily representing that they are driven by unobservable mental states” (Gómez 2007, p. 730; and see Moore 2015, 2017). Only later in development, according to Gómez, are human children and adults able to engage in a more complex psychological process that would

constitute a full-fledged system of reasoning about inner psychological states in others.

The psychological processes that allegedly support pointing *are nothing more than* interpretations by some researchers committed to a particular model of psychological functioning; these interpretations do not necessarily exist in the brains or the minds of the pointing individuals—human or otherwise—they exist in the belief systems of the observers, and are not subject to interrogation by introspection or objective measurement (see, esp., Nisbett & Wilson 1977). One might imagine two cognitive scientists pointing for each other, and it might be the case that each of them has a belief about their own and their interlocutor's psychological functioning, and they might use similar language to describe these imaginary psychological processes. Empirically, however, neither scientist can discover the psychological causes of their own pointing through introspection (if they could, there would be no scientific debate on the psychological causes of pointing—we would have an easy unanimity on a taxonomy of causes of pointing, which we lack, Leavens 2012a), nor can either scientist directly discern these psychological causes in the other—there is no such thing as an Intentionality-O-Meter that a person can go down to the hardware store and buy. Thus, the psychological mechanisms that support pointing gestures are, in all cases, *imaginary* or hypothetical, and they come into play only in contexts in which one or both interlocutors are engaging in the practice of causal ascription; this is axiomatic. Pointing does not reveal its causes (Racine 2012; Racine & Carpendale 2007).

If Cartesian, Gricean, or Brentanian-a lá-Gómezian causes of pointing cannot be revealed through scientific inquiry, through the manipulation and measurement of variables that have physical existence, then this has significant implications for how intentional communication is studied in animals. One implication is that all contemporary claims for insight into the psychological processes of animals or young humans who point are unsupported by direct, empirical data. Now, of course, it is entirely possible that the present

author's stance on what constitutes the legitimate and necessary constraints on scientific theory development is unduly and perhaps unrealistically pessimistic. In the following sections, I will briefly outline how even if this true, even if we reject the epistemological concerns briefly sketched above, there remains a persistent and widespread methodological bias against animals' performances in tests of their social-cognitive abilities. The effect of these biased assays is that everybody, of every theoretical stripe or school or stance is hampered in their theory development by a grave misrepresentation of animals' abilities; in short, the empirical record pertaining to the cognitive abilities of animals is wildly inaccurate due to unfair comparisons between and double standards of interpretation of the communication and cognition of human children and great apes.

Fallacious equivalence of methods

Notwithstanding the fact that pointing does not unambiguously specify its own psychological causes, many contemporary researchers attempt to explain pointing in psychological process terms. A set of rules of demonstration of these psychological processes has emerged in the scientific literature, and here I wish to examine these rules critically. For example, even while conceding that apes do display protoimperative gestures, some have argued that human protoimperative pointing by 12-month-old babies is cognitively more sophisticated than the protoimperative pointing of much older, even adult great apes (Tomasello et al. 2007; van der Goot et al. 2014). van der Goot et al. argued that because human babies sometimes signalled to a desired toy from distances of approximately 1-2 meters, this constituted evidence that these children had a psychological appreciation of a state of common ground with their social partners. In their study, none of the 10 great apes in their sample pointed or otherwise gestured towards food from a distance—they always approached as closely as the cage mesh would allow to the desired food, and they signalled

from there. van der Goot et al. interpreted this as evidence that great apes do not understand common ground, but it is worth pointing out that the apes in their study were situated significantly further from the desired food—about 6 meters—than were the human babies from their desired toys. Moreover, the human and ape testing protocols differed in numerous additional features, and there was no attempt to match the two groups on either life history stage or task-relevant pre-experimental experience. Leavens and his colleagues (2015) placed an experimenter and desirable food approximately 1.5 meters apart (thus, approximating the distances presented to the human babies in van der Goot et al., 2014), outside the enclosures of 166 chimpanzees, and they found that, on any given trial, about half of the apes pointed or otherwise gestured from a distance, which is the same finding van der Goot and her colleagues reported for human babies. Thus, simply matching the distance between an unreachable, but desirable object seemed to eradicate the “species difference” reported by van der Goot et al. Because a difference in approach behaviour was the evidence for the alleged psychological differences van der Goot and her colleagues claimed to exist between human babies and much older great apes, therefore, based on Leavens et al.’s findings, either great apes also appreciate common ground or—and I think this is far more likely—differences in propensity to approach distant entities during requests do not diagnose the psychological mechanisms supporting this approach or avoidance behaviour. This curious design feature, making the distance of the target and the subject three to six times further way than the distances used with the human infants, is an example of administering a more difficult task to apes than to humans, finding a difference, and then attributing this difference to the cognitive superiority of humans with their different evolutionary histories (fallacious equivalence of methods). Close consideration of van der Goot et al. reveals numerous, systematic differences in sampling protocols, test procedures, pre-experimental task-relevant preparation, and age (the humans were 12 months old, and the apes were, on

average, 18 *years* old) that are inextricably intertwined with their preferred explanation for the group differences they reported—evolutionary history; in fact, it is logically impossible to isolate species classification (evolutionary history) as the relevant factor in these apparent group differences, and this constraint on interpretation exists for a large proportion of the scientific literature in this area (see Leavens et al. 2015, 2017, for extended discussion). But the current scientific literature on intentional communication, particularly the development of intentional communication in humans, largely ignores this truth.

Fallacious comparisons

Another perverted rule of demonstration emerges from the direct comparison of humans and apes: differences between representatives of humans and apes are implicitly interpreted as though the responses elicited are completely uninfluenced by the individual learning histories (i.e., life experiences) of both the humans and the apes, so that any differences that may become apparent are attributable to evolutionary, rather than developmental processes (see Bard & Leavens 2014; Leavens and Bard 2011, for discussion). For example, it is widely, yet incorrectly held that great apes—humans’ nearest living relatives—have difficulty comprehending the intentional signals of humans (e.g., Burkart et al. 2009; Tomasello et al. 2007). Burkart et al. (2009) attribute this alleged superiority in understanding deictic cues to the cooperative breeding of humans. Tomasello and colleagues (e.g., 2007) attribute this putative superiority to what they believe is a human-unique capacity for shared intentionality, by which they seem to mean that human babies perceive both (a) a joint attentional context and (b) a cooperative motivation, and they bring these perceptions to the interpretation of pointing and other deictic cues. I (Leavens 2012b, 2014; Leavens et al. 2010, 2017) and others (e.g., Lyn et al. 2010) have noted that when some slight effort is made to match apes with humans’ early rearing histories, so that apes gain something

approximating the same level of exposure to human communication practices that our children experience, then they have no difficulty passing tests of comprehension of human pointing cues. This widespread belief that great apes have some kind of difficulty understanding simple deictic cues (e.g., Miklósi & Soproni, 2006; Povinelli et al., 1997; Tomasello et al., 2007) is predicated on poorly designed experimental comparisons in which the ape and human subjects are not matched on task-relevant pre-experimental experiences (e.g., Leavens 2014, 2017; Lyn et al., 2010). This collapse in methodological rigour is not limited to studies of apes' comprehension of pointing or other deictic cues; in fact, virtually every contemporary claim for the superiority of human children over apes in socio-cognitive reasoning is based on comparisons between typically reared human children in postindustrial, Western cultures and great apes that have been, to varying degrees, isolated from these kinds of rich enculturation experiences, either because the animals have been raised in zoos or biomedical research centres (e.g., Povinelli et al. 1997; van der Goot et al. 2014) or raised in their natural habitats for their early years and then subsequently taken to sanctuaries after having witnessed their entire social groups exterminated in their presence (e.g., Hermann 2007; Kirchhofer et al. 2012). Thus, the majority of the evidence brought in to support claims of human uniqueness in social cognition involve comparisons of psychologically handicapped apes with non-handicapped humans (fallacious comparisons).

Fallacious interpretations

Failure to match apes and human on early rearing experiences is not, by any means the only infelicity in the majority of ape-human comparisons. Another common tactic used by researchers who seem to have a vested interest in demonstrating human superiority at all costs, is to invoke double standards of interpretation. For example, even when apes display superior performance, compared with human children, researchers will attribute their superior

performance to their cognitive inferiority. A classic example is a study by Povinelli et al., (1999). These researchers compared three-year-old human children with chimpanzee adolescents on their ability to use human gaze cues to identify which of two containers was baited (a standard object-choice task). In the Head + Eyes condition, the experimenter looked directly at the baited container whilst simultaneously turning her head in that direction; the apes and the children had no apparent difficulty following this cue, as evidenced by their above-chance performance. In a second cue presentation, the Eyes Only condition, the experimenter kept her head oriented straight ahead, but fixated her gaze on the baited container. In this condition, neither the apes nor the human children performed above chance, and hence, again, there was no difference in performance between the humans and the apes. In the third, Above Target condition, the experimenter looked to the same hemispace in which the baited container was located, but oriented her head and eyes in such a way as to fixate at a point that was substantially above the baited container. In this condition, the apes were significantly above chance in choosing the baited container, whereas the human children performed at random, chance levels; thus, the apes, but not the humans, were able to use this clue. Povinelli and his colleagues interpreted this superior performance by the apes as evidence for their “low-level” understanding of visual attention, arguing that the humans had a sophisticated, mentalistic comprehension of gaze as a referential cue that apes lack (i.e., that the human children’s poor performance was attributable to the children’s superior understanding of the psychological bases of visual attention, which they termed a “high-level model”). Some years after this study was published, we reasoned that, under this theoretical perspective, human adults must have the most sophisticated extant reasoning skills to bring to bear on these kinds of tasks, so we administered this battery of cues to adult, human university students; we found that, like the adolescent chimpanzees in Povinelli et al. (1999), human university students had no difficulty using the critical Above Target cue to find hidden

treats (Thomas et al., 2008). Thus, great apes are damned if they do succeed and damned if they don't succeed. Povinelli and his colleagues (1999) interpreted any systematic difference between their human subjects and their ape subjects as evidence *for* greater human cognitive sophistication; in this case, they interpreted *superior* performance by chimpanzees as evidence for *inferior* cognitive processing capabilities (fallacious interpretations). Had they simply validated their protocol by including some human adults, then they would have realized that it was, in fact, the chimpanzees and the human adults who were displaying the advanced response profiles, not the much younger human children.

Fallacious remediation

Another tactic in the comparative study of cognition is that of testing until failure. Povinelli et al. (1997), again, provide an example of this. They submitted human children and adolescent chimpanzees to a series of object choice tasks, with a variety of different cue types. In the first experiment, two of the chimpanzees (Kara & Apollo) demonstrated good comprehension of the deictic cues. When these two apes performed more poorly in a second series of different cues, the authors used this finding to argue that they did not truly understand deictic cues in the first experiment! They argued that because the index finger was close to the baited container in the first series of tests, the apes were using them as associative cues in the absence of an understanding of these cues as intentional signals. Yet, it is well-demonstrated that, developmentally, human children proceed from early stages of understanding pointing as a cue to objects that are close to the pointing hand to much later generalisation of this understanding to more distant entities (e.g., Butterworth, 2003). Here, the assumption is that these institutionalised apes housed in a biomedical research centre are not disadvantaged in any way, compared with the preschool human children, with respect to having had pre-experimental opportunities to learn to generalise from proximal to more distal

pointing cues, despite their obvious isolation from these European conventions of nonverbal signalling (e.g., Leaven et al. 2017).

In the second experiment, one of the chimpanzees, Candy, performed very well, and rather than conclude that therefore Candy understood the second experiment, she (alone) was remedially tested until her performance broke down, and they concluded, again, that therefore she must not have understood the earlier task when she performed well. This practice of testing your animals until you get the expected result (fallacious remediation) will at first render the appearance of conformity with theoretical models of human exceptionalism, but on closer scrutiny will undermine such models—theories of human exceptionalism in social cognition are not strengthened by diligent post-hoc inquiry into high performance by apes, with no commensurate investigation of the high performances of human participants. In Povinelli et al. (1997), not one of the human children who performed well in the second set of experiments was subjected to remedial testing. This is not a valid procedure, to systematically interrogate to the point of failure previously successful representatives of one group, but not the other group. Hence, again, if you're an ape under scrutiny by researchers who are offended by your cleverness, then you are liable to be tested and re-tested and tested again until you deliver the performance that the researchers want.

Fallacious aggregations

These studies also demonstrate another type of sophistry. Recall that the only empirical measure of comprehension in these kinds of studies is the organisms' performances. Researchers compare groups of human children with groups of apes who have been put at a disadvantage (typically through isolation from human communicative conventions, in tasks in which good performance requires an understanding of human communicative conventions). Then, the researchers report that, on average, the humans

outperform the apes. If there are individual apes in the comparison who clearly do understand the tasks (by definition, high performance is the operationalised measure of comprehension), this evidence for ape comprehension is buried in an aggregate measure of performance for the group (a group mean). Leavens (2014) noted that when some of the apes have been enculturated, then this aggregation is dubious: if there are apes that have been raised in human homes or subject to language training, typically these animals far outperform the institutionalised or wild-reared apes. The correct interpretation when enculturated apes outperform non-enculturated apes is that there seems to be an effect of socialisation on the comprehension of human communicative cues. Instead, what researchers have repeatedly done is to average across both enculturated and non-enculturated animals to achieve a group average that is lower than that of the human children in the comparison group (Itakura et al., 1999; Tomasello et al., 1997), among others. In Itakura et al. (1999), Peony—a home-raised chimpanzee—correctly followed human gaze cues in 96 of 96 consecutive trials (a sustained, perfect performance level), but because her data were averaged with the performance data of non-enculturated animals (fallacious aggregation), these researchers concluded that apes have difficulty in following human gaze cues in object choice tasks (see Leavens 2014 for elaboration).

As noted by Leavens and his colleagues (2015, 2017; Bard & Leavens, 2014), there is not one published claim of a species difference in social cognition between apes and human children that has matched the organisms on task-relevant pre-experimental histories, matched the organisms on age, or administered the same procedure to the two groups. To put this claim a little more bluntly, as of this writing, in the year 2018, there is not one iota of evidence that humans and other organisms point with different psychological processes. When researchers routinely handicap their ape subjects by isolating them from early and intense exposure to human communicative practices, then test them on their understanding of

human communicative cues and then compare these animals' understanding with human children who are not so handicapped, then is the conclusion that it is the apes who lack cleverness when the animals perform poorly in these kinds of assessments? I think not.

To be fair, however, it is not practically or ethically possible to systematically cross foster apes by human caregivers. For the animals' survival, particularly in zoo environments, sometimes infant apes are home-raised by humans when they are rejected or otherwise neglected by their mothers, but there is no systematic, contemporary cross-fostering project, anywhere in the world, to my knowledge, outside the language-training projects. Because young apes grow up to become lethally dangerous animals, any home-raised ape must eventually be encaged for the safety of their human caregivers. This seems to me to be a significant ethical barrier to the a priori matching of apes and humans on pre-experimental experience, which is required by good experimental design. However, there are a number of great apes who have been cross-fostered, either in zoos for their survival or in the course of ape language-training projects, and the scientific importance of these individuals ought not to be, in my opinion, hidden under the bushel (as it were) of group averages that include institutionalised animals (Leavens 2014). Cross-fostered apes manifest skill sets not characteristic of either wild apes or apes housed in more institutional settings (Bard & Leavens, 2014; Call & Tomasello 1994; Leavens & Bard 2011; Leavens et al. 2010).

Conclusions

I think a better approach is to catalogue the interplay between life experience and performance on the assays used to assess social competence. For example, whereas pointing by wild apes is very rare (Hobaiter et al. 2014; Veà & Sabater-Pi 1998; but see Douglas & Moscovice 2015); approximately half of institutionalised apes will point in experimentally administered triadic tasks (Leavens & Hopkins 1998; Leavens et al. 2004a); and essentially

all home-raised or language-trained apes point (Call & Tomasello 1994; Krause & Fouts 1997; Pedersen et al. 2009; Roberts, Vick, Roberts, & Menzel 2014; Savage-Rumbaugh et al. 1985). This pattern of results clearly indicates that pointing is phenotypically variable in great apes, and therefore extremely malleable in the face of different ecological factors influencing their pointing behaviour (Leavens et al. 2005b, 2010). The extreme rareness of pointing by wild apes does not constitute evidence that wild apes lack a cognitive capacity for social understanding that is displayed by captive apes; rather, the obvious implication is that pointing is not as useful for free-ranging, highly mobile apes in their natural habitats as it is for apes living in cages in captivity, or as useful as it is for helpless, motorically ineffectual human babies who are also subject to chronic physical restraint in car seats, cribs, feeding chairs, slings, backpacks, and the like (Leavens et al. 2005b). Every subject in a study of social cognition, human or otherwise, brings to the study a learning history. Every published claim of human superiority over apes in social cognition, manifest in our species before the infants can even speak, is predicated on an implicit assumption that the human children have learned nothing relevant to these tests, in the many months of life experiences they bring to the study. So, to believe that human babies evince superior social understanding to usually very much older great apes, one has to believe something to be true that is patently false: that human babies do not learn anything useful in their production or comprehension of pointing and other social cues, prior to being tested. As soon as it is admitted that human children might learn something useful about triadic communication in their first months of life, then the absurdity of failing to match apes with humans on relevant learning experiences becomes too obvious to ignore (see also Boesch 2012; Leavens & Bard 2011; Leavens et al. 2017).

In conclusion, the state of contemporary research into comparative social cognition is dire, from methodological and logical perspectives. Perhaps it is to be expected that humans see psychological continuity between themselves and their children, but not between

themselves and our nearest living relatives, the great apes. This perceptual bias permeates every aspect of comparative social cognition, from the administration of unfair tests, to the selection of psychologically handicapped comparison animals, to the flat refusal to see superior performance by apes as evidence of superior competency, to the lambasting of clever apes with repeated testing until they fail, to the dissolution of superior individual animal results into group averages of ape subjects that have incommensurate life histories—there is no shortage of contemporary, perverted rules of demonstration in common use by researchers to bolster theoretical commitments to human cognitive exceptionalism. Like the fabled Queen who, hearing from her mirror that she might not be the most beautiful, and sets about poisoning her rival, we are systematically extorting the answers we want to hear from our species comparisons (our mirrors) until we get the answers that we want. Great apes and humans share a profound similarity in their intentional communication, when subjected to the same ecological constraints, and there is no objective evidence for the kinds of mental state reasoning by humans in their infancy and toddlerhood that many contemporary researchers claim differentiate humans from their nearest living relatives, notwithstanding the obvious species differences that ensue with the onset of speech in humans. Contemporary claims to the contrary are all smoke and mirrors.

References

- Austin JL (1962) *How to do things with words*. Oxford: Clarendon Press
- Bacon F (1620) *Novum organum*. New York: P. F. Collier & Son (1902 edition)
- Bard KA (1992) Intentional behavior and intentional communication in young free-ranging orangutans. *Child Dev* 62:1186–1197
- Bard KA, Leavens DA (2014) The importance of development for comparative primatology. *Ann Rev Anthropol* 43: 183-200

- Bard KA, Bakeman R, Boysen ST, Leavens DA (2014) Emotional engagements predict and enhance social cognition in young chimpanzees. *Dev Sci* 17: 682-696
- Baron-Cohen S (1989) Perceptual role taking and protodeclarative pointing in autism. *Br J Dev Psych* 7: 113–127
- Bates E, Benigni L, Bretherton I, Camaioni L, Volterra V (1977) From gesture to the first word: On the nature of cognitive and social prerequisites. In: Lewis M, Rosenblum L (eds) *Interaction, conversation and the development of language*. New York: Wiley
- Bates E, Camaioni L, Volterra V (1975) Performatives prior to speech. *Merrill-Palmer Quart* 21: 205–226
- Boesch C (2012) *Wild Cultures: A comparison between chimpanzee and human cultures*. Cambridge: Cambridge University Press.
- Burkart JM, Hrdy SB, van Schaik CP (2009) Cooperative breeding and human cognitive evolution. *Evol Anthropol* 18: 175-186
- Butterworth G, Grover L (1988) The origins of referential communication in human infancy. In: Weiskrantz L (ed) *Thought without language*. Oxford, Clarendon Press
- Call J, Tomasello M (1994) Production and comprehension of referential pointing by orangutans (*Pongo pygmaeus*). *J Comp Psych* 108: 307-317
- Carpenter M, Call J (2013) How joint is the joint attention of apes and human infants? In: Metcalf J, Terrace HS (eds) *Agency and joint attention*. Oxford: Oxford University Press
- Carpenter M, Liebal, K (2012) Joint attention, communication, and knowing together in infancy. In: Seemann A (ed) *Joint attention: New developments in psychology, philosophy of mind, and social neuroscience*. Cambridge, MA, The MIT Press
- Cartmill EA, Byrne RW (2007) Orangutans modify their gestural signaling according to their audience's comprehension. *Curr Biol*. 17: 1345–1348
- Douglas PH, Moscovice LR (2015) Pointing and pantomime in wild apes? Female bonobos

use referential and iconic gestures to request genito-genital rubbing. *Sci Rep* 5:13999

Golinkoff RM (1986) 'I beg your pardon': The preverbal negotiation of failed messages. *J Child Lang* 13: 455-476

Gómez J-C (2007) Pointing behaviors in apes and human infants: A balanced interpretation. *Child Dev* 78: 729–734

Gómez J-C (2009) Embodying meaning: Insights from primates, autism, and Brentano. *Neur Networks* 22: 190-196

Herrmann E, Call J, Hernandez-Lloreda MV, Hare B, Tomasello M (2007). Humans have evolved specialized skills of social cognition: the cultural intelligence hypothesis. *Science* 317: 1360–1366

Hobaiter C, Leavens DA, Byrne RW (2014) Deictic gesturing in wild chimpanzees? Some possible cases. *J Comp Psych* 128: 82-87

Hopkins WD, Taglialatela JP, Leavens DA (2007) Chimpanzees differentially produce novel vocalizations to capture the attention of a human. *Anim Behav* 73: 281-286

Hopkins WD, Taglialatela JP, Leavens DA (2011) Do chimpanzees have voluntary control of their facial expressions and vocalizations? In: Vilain A, Schwartz J-L, Abry C, Vauclair J (eds.), *Primate communication and human language: Vocalisation, gestures, imitation and deixis in humans and non-humans* (pp. 71-88). Amsterdam: John Benjamins.

Itakura S, Agnetta B, Hare B, Tomasello M (1999) Chimpanzee use of human and conspecific social cues to locate hidden food. *Dev Sci* 2: 448–456

Kirchhofer KC, Zimmermann F, Kaminski J, Tomasello M (2012) Dogs (*Canis familiaris*), but not chimpanzees (*Pan troglodytes*), understand imperative pointing. *PLoS ONE* 7(2): e30913

Krause MA, Fouts RS (1997) Chimpanzee (*Pan troglodytes*) pointing: Hand shapes, accuracy, and the role of eye gaze. *J Comp Psych* 111: 330–336

Leavens DA (2012a) Pointing: Contexts and instrumentality. In: Pika S, Liebal K (eds) Current developments in primate gesture research. Amsterdam: John Benjamins

Leavens DA (2012b) Joint attention: Twelve myths. In: Seemann A (ed) Joint attention: New developments in psychology, philosophy of mind, and social neuroscience. Cambridge, MA, The MIT Press

Leavens DA (2014) The plight of the sense-making ape. In: Cappuccio M, Froese T (eds) Enactive cognition at the edge of sense-making. Basingstoke, UK: Palgrave Macmillan

Leavens DA, Bard KA (2011) Environmental influences on joint attention in great apes: Implications for human cognition. *J Cogn Ed Psych* 10: 9-31

Leavens DA, Hopkins WD (1998) Intentional communication by chimpanzees: A cross-sectional study of the use of referential gestures. *Dev Psych* 34: 813-822

Leavens DA, Bard KA, Hopkins WD (2010). BIZARRE chimpanzees do not represent “the chimpanzee. *Behav Brain Sci* 33:100-101

Leavens DA, Bard KA, Hopkins WD (2017) The mismeasure of ape social cognition. *Anim Cogn* (Published online in advance of print)

Leavens DA, Hopkins WD, Bard KA (2005b) Understanding the point of chimpanzee pointing: Epigenesis and ecological validity. *Curr Dir Psych Sci* 14: 185-189

Leavens DA, Hopkins WD, Bard KA (2008) The heterochronic origins of explicit reference. In: Zlatev J, Racine T, Sinha C, Itkonen E (eds.) *The shared mind: Perspectives on intersubjectivity* (pp. 187-214). Amsterdam: John Benjamins

Leavens DA, Hopkins WD, Thomas RK (2004a) Referential communication by chimpanzees (*Pan troglodytes*). *J Comp Psych* 118: 48-57

Leavens DA, Hostetter AB, Wesley MJ, Hopkins WD (2004b) Tactical use of unimodal and bimodal communication by chimpanzees, *Pan troglodytes*. *Anim Behav* 67: 467-476

Leavens DA, Reamer LA, Mareno MC, Russell JL, Wilson D, Schapiro SJ, Hopkins WD

- (2015) Distal communication by chimpanzees (*Pan troglodytes*): Evidence for common ground? *Child Dev* 86: 1623-1638
- Leavens DA, Russell JL, Hopkins WD (2005a) Intentionality as measured in the persistence and elaboration of communication by chimpanzees (*Pan troglodytes*). *Child Dev* 76: 291-306
- Leavens DA, Sansone J, Burfield AR, Lightfoot S, O'Hara S, Todd BK (2014) Putting the 'joy' in joint attention: Affective-gestural synchrony by parents who point for their babies. *Front Psych* 5(879): 1-7
- Liszkowski U, Carpenter M, Henning A, Striano T, Tomasello M (2004) Twelve-month-olds point to share attention and interest. *Dev Sci* 7: 297–307
- Lock A (2001) Preverbal communication. In: Bremner JG, Fogel A (eds) *Blackwell handbook of infant development*. Oxford: Blackwell
- Lyn H, Russell JL, Hopkins WD (2010) The impact of environment on the comprehension of declarative communication in apes. *Psych Sci* 21: 360–365
- MacCorquodale K, Meehl PE (1948) On a distinction between hypothetical constructs and intervening variables. *Psych Rev* 55: 95-107
- Masur EF (1983) Gestural development, dual-directional signaling, and the transition to words. *J of Psycholing Res*, 12: 93–109
- Menzel CR (1999) Unprompted recall and reporting of hidden objects by a chimpanzee (*Pan troglodytes*) after extended delays. *J Comp Psych* 113: 426-434
- Miklósi Á, Soproni K (2006) A comparative analysis of animals' understanding of the human pointing gesture. *Anim Cogn* 9:81-93
- Moore R (2015) Meaning and ostension in great ape gestural communication. *Anim Cogn* 19:223–231
- Moore R (2017) Gricean communication and cognitive development. *Philos. Quart.* 267:303-326

- Moore C., Corkum V (1994) Social understanding at the end of the first year of life. *Devel Rev* 14: 349–372
- Moore C, D’Entremont B (2001) Developmental changes in pointing as a function of attentional focus. *J Cogn Dev* 2:109-129
- Mundy P, Sigman M, Ungerer J, Sherman T (1986) Defining the social deficits of autism: The contribution of non-verbal communication measures. *J Child Psychol Psychiat & Allied Discip* 27: 657–669
- Nisbett RE, Wilson TD (1977) Telling more than we can know: Verbal reports on mental processes. *Psych Rev* 84:231-259
- Pedersen J, Segerdahl P, Fields WM (2009) Why apes point: Pointing gestures in spontaneous conversation of language-competent Pan/Homo bonobos. In: Potocki E, Krasinski J (eds) *Primateology: Theories, methods, and research*. Hauppauge, NY: Nova
- Povinelli DJ, Eddy TJ (1996) What young chimpanzees know about seeing. *Monogr Soc Res Child Dev* 61(3):i-vi, 1–152
- Povinelli DJ, Bierschwale DT, Čech CG (1999) Comprehension of seeing as a referential act in young children but not juvenile chimpanzees. *Br J Dev Psych* 17: 37-60
- Povinelli DJ, Reaux, JE, Bierschwale DT, Allain AD, Simon BB (1997) Exploitation of pointing as a referential gesture in young children, but not adolescent chimpanzees. *Cogn Dev* 12: 423–461
- Racine TP (2012) Getting beyond rich and lean views of joint attention. In: Pika S, Liebal K (eds) *Current developments in primate gesture research*. John Benjamins, Amsterdam
- Racine TP, Carpendale, JIM (2007) The role of shared practice in joint attention. *Br J Dev Psych* 26:3-25
- Rheingold HL, Hay DF, West MJ (1976) Sharing in the second year of life. *Child Dev* 47: 1148-1158

- Roberts AI, Vick S-J, Roberts SGB, Menzel CR (2014). Chimpanzees modify intentional gestures to coordinate a search for hidden food. *Nat Comm* 5:3088
- Savage-Rumbaugh ES, Rumbaugh DM, MacDonald K (1985) Language learning in two species of apes. *Neurosci Biobeh Rev* 9: 653–665
- Sehon SR (2000) An argument against the causal theory of action explanation. *Philos Phenomen Res* 60:67–85
- Thomas E, Murphy M, Pitt R, Rivers A, Leavens DA (2008) Understanding of visual attention by adult humans (*Homo sapiens*): A partial replication of Povinelli, Bierschwale, and Čech (1999). *J Comp Psych* 122: 428-436
- Tomasello M, Call J, Gluckman A (1997) Comprehension of novel communicative signs by apes and human children. *Child Dev* 68: 1067-1080
- Tomasello M, Carpenter M, Liszkowski U (2007) A new look at infant pointing. *Child Dev* 78: 705-722
- van der Goot MH, Tomasello M, Liszkowski U (2014) Differences in the nonverbal requests of Great Apes and human infants. *Child Dev* 85: 444–455
- Veà JJ, Sabater-Pi J (1998) Spontaneous pointing behaviour in the wild pygmy chimpanzee (*Pan paniscus*). *Folia Primat* 69: 289–290
- Woodruff G, Premack D (1979) Intentional communication in the chimpanzee: The development of deception. *Cognition* 7: 333–362