

in utility functions, do not necessarily imply re-individuation of games themselves. Thus, addressing the point at the level of the phenomena, the fact that chimps do not use dialogic representations of intentionality may just result from the fact that they are not motivated to do so, rather than from limitations in their cognitive architecture. None of the experiments discussed by Tomasello et al. seem to provide a basis for discriminating between the hypotheses that (1) humans retain the generic ape cognitive architecture with modified utility functions, and (2) motivational adaptations in hominids led to cognitive adaptations in them. For example (citing a case they discuss), does Kanzi show sharply limited linguistic skills because he lacks the relevant Chomskyan module, or because he is interested only in getting objects he wants from people and has no interest in negotiating meaning? Tomasello et al.'s argument might motivate design of experimental protocols that could discriminate between these hypotheses, perhaps by putting language-trained chimps in situations where they can satisfy their first-order desires only by negotiating meanings. This would of course require some ingenuity on the part of the experiment designer.

In closing, I note one aspect of human behavioral distinctiveness that Tomasello et al.'s hypothesis explains, but that they do not mention. As far as we know, only people engage in violence in order to try to eliminate beliefs that diverge from their own. There is a long tradition of explaining ideological conflict by reference to conflict over material resources. This cannot explain why there are no homologues to such behavior in other intelligent social animals. Thanks to Tomasello et al., we can advance a better explanation: only people care nonderivatively about not only who gets what, but about whether others want the same things as they do. Modeling the evolutionary dynamics of these sorts of interacting motivations is a compelling new challenge for game theorists.

NOTE

1. Clark (2002), Dennett (2003), and Sterelny (2004) all provide supporting philosophical arguments for this view.

Why not chimpanzees, lions, and hyenas too?

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Abstract: Examples are cited of group hunting in chimpanzees, lions, and hyenas consistent with evidence for intentionality, organization, and coordination. These challenge the claim for shared intentionality as uniquely human. Even when rarely performed in this way, the significance of such behaviors should not be minimized, especially if this level of “intelligent” action emerges spontaneously in the wild.

The target article sharpens the terms of an ancient debate – What distinguishes the modern human *Homo sapiens sapiens* from all other animals? – by acknowledging that species such as the chimpanzee *Pan troglodytes* possess the cognitive complexity for social strategizing, sensitivity to the intentional actions of others, and glimmers of a theory of mind (Dennett, 1983; Povinelli 1993; Tomasello & Call 1997). The authors also acknowledge the prevalence of animal *intentionality* when behavior is consistent with the ability to choose a plan of action and stay with this plan to achieve a predetermined goal. Instead, they place the animal–human divide in the realm of *shared mental states*, and specifically in the ability of humans to use *shared intentionality* (hereafter SI). This is expressed in “collaborative activities with shared goals and intentions,” consistent with “shared psychological states” and unique forms of “cognitive representation.” Even if some animal species are capable of understanding the goals, intentions, and perceptions of others, only the human possesses the motivation to share these things in interaction with others.

Since animals are being compared with humans, the argument hinges on documenting observable actions (see Tomasello et al., Fig. 1) and *specifying testable behavioral criteria* for making inferences about underlying SI. This commentary asks whether SI might underlie the apparent convergence between the performances of humans and some animals when *individuals cooperate by coordinating actions for shared outcomes*. Intuitively, *cooperative coordination* (hereafter CC) offers an obvious place to search for SI because individuals develop conjoint actions for shared outcomes based on using each other's behaviors and locations. We have modeled this in rats *Rattus norvegicus* (Schuster 2002; Schuster & Perelberg 2004). But the argument is better made from three examples of CC expressed spontaneously in the wild without the aid of behavioral engineering. All are in the context of group hunting.

In the chimpanzee *Pan troglodytes*, hunts have been described and filmed that are spontaneous and highly organized: a group first gathers and then simultaneously fans out in search for a victim while reducing the chances of detection by avoiding vocalizations and using slow and careful steps to minimize noise (Boesch & Boesch 1989; Mitani & Watts 2001). There is also a division of labor based on roles that was characterized by Boesch and Boesch (1989) as *collaboration*: a “blocker;” a “chaser;” an “ambusher;” and others remaining on the ground to track the hunt and intercept a fleeing target if the opportunity arises. Chimpanzees behave similarly in group territorial “warfare” against members of neighboring groups (Boehm 1992; Watts & Mitani 2001).

Tomasello et al. reject the foregoing as evidence for SI by suggesting that individuals are indeed *acting together* but not collaborating in a way that provides undeniable evidence for joint intentions and coordinated plans. Instead, each participant is said to be performing its own particular role as a response to the locations and behaviors of others and the momentary “state of the chase.” Hunts are thereby characterized as helter-skelter running in all directions, with the lucky hunters opportunistically making a kill if an unfortunate victim comes their way. Stanford et al. (1994) suggest that the hunts observed at the Gombe Reserve site are mostly of this type.

Have Boesch and Boesch (1989) exaggerated the levels of intentionality, spontaneity, and organization? Or, as seems more likely, chimpanzee hunts may run the gamut from random and disorganized to deliberate and planned, with the likelihood of each varying both across populations and within populations but across seasons and locations. If so, it would be misleading if the examples of opportunistic and random attacks were used to cancel out the significance of those instances *when chimpanzees do engage in organized, intentional group attacks*. Why would we expect chimpanzees – or any other species, including our own – to rely exclusively on the most complex tactics if success is achievable by lesser means? Moreover, intelligent, creative action is almost by definition limited to *some* members of a population and then only on those limited occasions when *automaticity* in actions and thoughts does not work (Bargh & Chartrand 1999). This variability is reflected in the current criteria for publishing research on themes linked to animal intelligence – political scheming, tool use, deception, or theory of mind – where data may be cited from only those few subjects that exhibit the phenomenon or even from $n = 1$ (e.g., see Premack & Woodruff 1978). The hypothesis of SI in chimpanzees should not be rejected even if organized and intentional hunts are rare.

More interesting for SI in animals is the performance of group hunting in less “cognitively endowed” mammals such as the African lion *Panthera leo* and the spotted hyena *Crocuta crocuta*. The overall picture resembles that in chimpanzees. Schaller (1972) noted that lions are usually opportunistic hunters capable of chasing after prey that suddenly appears, whether acting either alone or in groups that happen to be there. But he added,

[O]n 29 occasions lionesses encircled prey, sometimes by detouring far to one side. . . . The other lions waited during the flanking movement

as if in anticipation of prey fleeing in their direction. . . . During such hunts lions integrated their actions solely by observing each other's posture and movement; no sounds were used nor were facial expressions employed which, at any rate, would not have been useful at night. *Encircling implies that lions are aware of the consequences of their actions in relation both to other group members and to the prey.* (pp. 250–51, italics mine)

The same behavior was observed by Griffin (1984, pp. 85–87) and studied in detail by Stander (1992).

The hypothesis of SI would be strengthened if animals spontaneously assemble into groups whose size is related to differences in the prey that are going to be hunted and *before the prey have been spotted*. In lions, for example, the larger males are more likely to participate in hunts when the prey is also large, for example, buffalo *Syncerus caffer* or zebra *Equus burchelli* (Schaller 1972). Kruuk (1972) explicitly noted this evidence for group intentionality in the spotted hyena:

[T]he differences in numbers of hyenas setting out are often apparent long before the hyenas have sighted a quarry; when hyenas are seen in a pack, even if there are no herbivores near, one can predict with a fair degree of certainty that they will eventually hunt zebra, even if this means walking for miles through herds of wildebeest. *This means that hyenas set out to hunt a certain kind of prey to the exclusion of others.* . . . the hyena's hunting methods are very well adapted to the requirements of catching different kinds of prey; the antipredator mechanisms of wildebeest and zebra are so unlike each other that they call for very different hunting action. If the hunting formation has to be taken up before meeting the adversary this would have the consequence of causing hyenas to concentrate on one kind of prey only. (pp. 201–2, italics mine)

It may not be coincidental that behaviors consistent with SI are shown by hyenas, lions, and chimpanzees when engaging in group hunting and aggression that, like so many human behaviors, are structured around individuals using one another to coordinate behaviors for shared outcomes. SI may be more obvious in humans because its widespread use – in culture-based activities such as science, art, music, and religion – was facilitated by language and culture by a process of *exaptation*. In sensu Rozin (1976) and Mithen (1996), it is only in modern humans that SI becomes conspicuous because it can be applied to activities for which it was not originally designed. The flip side is that animals exhibit only minimal SI because it is *not* an open and accessible program but one that is restricted only to task-specific contexts such as group hunting and group territoriality for which it evolved. But the possibility for a limited expression of context-specific SI in animals is an alternative worth considering, and one that may shed some light on its origins.

Baby steps on the path to understanding intentions

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Abstract: Tomasello et al. lay out a three-step ontogenetic pathway for infants' understanding of intentional action. By this account, before 9 months, infants do not understand actions as being goal directed. However, we caution against drawing strong conclusions from negative findings, and, based on recent findings, propose that a key aspect of goal knowledge is present well before 9 months.

To describe the development of infants' understanding of intentions, Tomasello et al. lay out a three-step ontogenetic pathway. Step 1: Early in the first year, infants understand that others' actions are spontaneously produced. Step 2: Beginning around 9

months, infants understand others' actions as driven by internally represented goals. According to Tomasello et al.'s definition of *goal*, this means that infants know that agents monitor the outcomes of their attempts and persist in their efforts when unsuccessful. Step 3: By 12 to 14 months, infants understand others' choice of plans in order to achieve goals. Frameworks like this one are invaluable to the field because they provide the foundation for understanding developmental change. For this reason, it is critical that the framework be right. We suggest one caveat and one revision to Tomasello et al.'s framework.

We take issue with the evidence used to argue that infants do not understand the persistent nature of goal-directed activity before 9 months. To support this claim, Tomasello et al. cite two studies. One is the habituation work by Csibra et al. (1999), in which 9- and 12-month-olds, but not 6-month-olds, responded with longer looks when a computer-animated dot moved in an "irrational" way. The other is work by Behne et al. (2005), which revealed that 9- and 12-month-olds, but not 6-month-olds, communicated more impatience when an experimenter was unwilling to give them a toy than when she was unable to do so.

The claim that these failures of 6-month-olds indicate a lack of goal understanding is problematic because it relies on negative evidence. Both studies required infants to interpret complex or abstract physical constraints and their implications for the agent's ability to attain a goal. As Csibra et al. (1999) pointed out, 6-month-olds may understand goal-directed action, but be unable to infer the physical constraints that make an action rational or a goal unattainable in these experiments. A further concern regarding Behne et al.'s study is that even if the 6-month-olds understood the physical constraints involved, they probably lacked the communicative competence to express their frustration.

Given these concerns, we are left with three possibilities for what 6-month-olds understand about agents' pursuit of goals. One possibility, consistent with Tomasello et al., is that these infants entirely lack this understanding. A second possibility is that this understanding is fully developed by 6 months. Neither possibility can be supported until the appropriate studies have been conducted.

A third possibility, and the one we think most likely, is that 6-month-olds have some basic understanding of goal-directed action that is less developed than at 9 months, but more developed than is suggested by Tomasello et al.'s first step. Well before 9 months, infants understand agents' actions as organized by the agent's relation to an external object. This conclusion is supported by habituation experiments showing that infants display selective and robust novelty responses to changes in the relation between a person and the object at which her actions are directed (Sommerville et al. 2005; Woodward 1998, 1999, 2003, 2005).

Tomasello et al. gloss these findings as evidence that infants expect people to reach for the same object again and again. We do not believe this is the correct interpretation. For one, it is not clear that such an expectation could be derived from experience: people do not normally reach for the same object repeatedly. Moreover, our habituation method is a measure of infants' novelty detection rather than a violation-of-expectation paradigm. Rather than viewing apparently impossible events, infants in these studies saw events that differed on one of two conceptually important dimensions, and their novelty responses indicated which dimension was central to their event representation.

Infants represent meaningful human actions as object directed. They do not represent the motions of inanimate objects (Jovanovic et al. 2002; Woodward 1998) or other human movements in this way (Woodward 1999). Thus these findings do not reflect a general tendency to encode spatial relations, but rather a specific propensity to encode people's actions in terms of agent-object relations. Infants do this for concrete actions, like grasping, early in the first year (Sommerville et al., in press; Woodward 1998), and for abstract ones, like looking, by the end of the first year (Phillips et al. 2002; Sodian & Thoermer 2004; Woodward 2003). Moreover, consistent with Tomasello et al.'s suggestion that infants' own actions structure their emerging concepts of intention, infants'