nitive skills required to understand intentional action, in all its many dimensions, and also, in equal measure, on the social motivations and dialogic representations that underlie the collaborative activities and collective artifacts that structure human culture and cognition.

NOTES

1. Note that in a situation in which current reality matches the desired goal state, the organism will not behave (it will have no desire to behave because its goal is already met). It is also possible that, in some cases, inaction is a good strategy for bringing the world in line with one's goals. That is, in some cases, inaction may be intentional action, an insight possible only if one considers all of the components of a control system working together.

2. This study – or any other with its same logic – has yet to be done with younger children. It might be argued that the study by Gergely et al. (1995) showed that infants know that organisms adjust their behavior to reality constraints in the form of obstacles. But the dishabituation methodology does not enable such an inference because the child does not have to choose an action plan herself (as in imitation studies). Thus, in that study, infants only needed to discriminate normal from abnormal behavior: goal-directed agents do not normally take circuitous routes to goals. (A similar argument applies to the study by Woodward & Sommerville 2000.)

3. In some accounts of shared intentionality, it is enough that we both have the same goal and know that we do (i.e., have mutual knowledge of the fact that we both have the same goal). But this is not enough; we might each want the box open and know that the other does also, but still not form a shared goal (perhaps we will compete to see who can open it). Further, it is also not enough simply to have goals about our behaving together. If I suggest we go to the movie together, my desire is not that you come because your mother forced you to but because you want to – I want us to have a shared commitment. (Note, however, that because of the hierarchical structure of action, there may exist many mixed cases in which you collaborate reluctantly because of competing goals and so forth.)

4. In a different experimental paradigm, Myowa-Yamakoshi and Matsuzawa (2000) and Call et al. (2005) both used Meltzoff's (1995) behavioral reenactment procedure (involving trying and failed attempts) with chimpanzees. Both found that chimpanzees, like children, performed the target action equally as often when they saw a failed attempt as when they saw the completed action. However, in both studies, chimpanzees also performed the target action at high levels in a baseline condition containing no demonstration at all, which seriously limits what can be concluded about the subjects' understanding of the modeled action.

5. Vervet monkey alarm calls and the like do not need to be interpreted as referential, and indeed individuals have very little control over their production at all (Owren & Rendell 2001). Moreover, there is no evidence that any ape species uses such calls (Tomasello & Call 1997).

6. Although sometimes presented in this way, the study by Povinelli et al. (1992) has other interpretations not involving role reversal (Tomasello & Call, 1997).

7. Evidence for this view is provided by experimental studies in paradigms such as (1) the ultimatum game in which individuals offer more money to others than would be beneficial from a selfish viewpoint, at least partly because this seems like the "fair" thing to do (Gintis et al. 2003); and (2) experimental games in which individuals go to great lengths to punish others who are not being "fair" even when this punishing act could not possibly lead to future benefits for the punisher that outweigh the costs (on altruistic punishing, see Fehr & Gächter 2002).

8. That is, at least with respect to basics – specific environmental differences may of course create important individual differences, some considered atypical or even pathological.

9. Barresi and Moore (1996) are focused on a different problem, claiming that in order to attribute psychological states to others at all the infant must first interact with them in situations in which they both have similar psychological reactions. We are focused on collaboration and dialogic cognitive representations among agents who already understand one another intentionally, and our hypothesis is that the child internalizes these interactions into cognitive representations that encompass simultaneously both first-person and third-person perspectives.

Open Peer Commentary

Language first, then shared intentionality, then a beneficent spiral

Derek Bickerton

Department of Linguistics, University of Hawaii, Honolulu, HI 96822.
derbick@hawaii.rr.com **www.derekbickerton.com**

Abstract: Tomasello et al. give a good account of how shared intentionality develops in children, but a much weaker one of how it might have evolved. They are unduly hasty in dismissing the emergence of language as a triggering factor. An alternative account is suggested in which language provided the spark, but thereafter language and shared intentionality coevolved.

Nobody could dispute Tomasello et al.'s major premise – that shared intentionality forms the basic infrastructure of the uniquely human capacity to collaborate. Nor would one argue against their conclusion that apes possess at least the rudiments of intentionality, plus a spot of primitive mind reading (although parents of autistic children may not be too happy about having them compared with apes). The authors are right to look for a missing, uniquely human ingredient.

But in their search for such an ingredient they walk right over it at the very beginning. In their introduction, they state that collaborative acts are "structured by shared symbolic artifacts, such as linguistic symbols and social institutions, facilitating their 'transmission' across generations." The question that immediately arises is whether language merely structures these acts and facilitates their transmission, or whether it is itself the missing ingredient, both a necessary and sufficient condition for the capacities at issue. If so, looking for another cause would violate Occam's razor.

We are told that we are biologically adapted for shared intentionality, but the authors devote most of the target article to an ontogenetic rather than a phylogenetic analysis, and offer only a skeleton outline of the evolutionary processes involved. Some of the developmental studies they cite are indeed impressive; perhaps most of all that by Tomasello and Haberl (2003), which suggests we should take another look at accounts claiming children under age 4 have no theory of mind. However, unless one swallows Haeckel wholesale, there are no grounds for assuming that the ontogenetic order of the developments described precisely mirrors that of their phylogenetic emergence.

Indeed, when the authors attempt an evolutionary account, they are reduced to implausible just-so stories. It is suggested that early humans may have merely intensified a primate trait in which small bands competed for scarce resources, leading to greater intragroup cooperation, or that some "change in the ecology of *Homo*" caused groups that contained more collaborators to outcompete groups that contained fewer. What scarce resources? What change in ecology? Why did humans, rather than any of the other primate species, begin to collaborate? Why did their collaboration grow to such a vast extent while other primates still do not

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collaborate at all? No answers are provided. Moreover, there is not one shred of evidence in the entire paleontological record for the kind of scenario sketched here.

But some such scenario was more or less forced on the authors by their decision that language could not have been the missing ingredient. In section 6, they make the bald assertion that "Language is not basic; it is derived." They ask, "What is language if not a set of coordination devices for directing the attention of others?" Well, any number of things, but most importantly an entirely novel means of structuring experience and representing the world (Bickerton 1990).

It is claimed that the notion of linguistic communication without understanding and sharing intentions is incoherent. But what about protolinguistic communication (Bickerton 1990)? The authors would be right if the understanding and sharing of intentions, on the one hand, and language, on the other, had suddenly emerged ready-made; if we did not understand and share intentions the way we do now, language as we know it now would indeed be unworkable. But none of these things dropped from the skies in their current state. All evolved, presumably from very humble beginnings, and it is in dealing with these beginnings that the article is weakest.

The word *coevolution* is tossed around pretty freely these days, but here is where a really strong case could be made for it. Very little understanding or sharing of intentions – perhaps little if any beyond what contemporary apes possess – would have been required to comprehend and act on the kind of single-unit utterances with which language must have begun. (Or do the authors propose that our ancestors suddenly started spouting full grammatical sentences, like the infant Lord Macaulay?) But once the process began, every increment in linguistic skill could lead to an increase in shared intentionality, and vice versa.

The question is, of course, a chicken-and-egg one. Did language trigger shared intentionality, or vice versa? One interesting difference between the two lies in the fact that shared intentionality had primate precursors, whereas language didn't. Tomasello et al. themselves list some of those precursors in section 4.1.1; the differences between apes and children that they point out in section 4.1.2 are mainly matters of degree. Language, however, differed radically and qualitatively from anything that had gone before. It seems plausible to suppose that the radical difference triggered the spurt in the more scalar one rather than vice versa.

A commentary with a thousand-word cap hardly gives room to flesh out an alternative scenario. However, I would urge the authors to consider the kind of coevolutionary account I have merely hinted at here. When all is said and done, is it too trivially obvious to ask what force could have driven shared intentionality more effectively than the ability to tell one another our intentions?

Joint cooperative hunting among wild chimpanzees: Taking natural observations seriously

Christophe Boesch

Department of Primatology, Max Planck Institute for Evolutionary Anthropology, 04103 Leipzig, Germany. **boesch@eva.mpg.de**

Abstract: Ignoring most published evidence on wild chimpanzees, Tomasello et al.'s claim that shared goals and intentions are uniquely human amounts to a faith statement. A brief survey of chimpanzee hunting tactics shows that group hunts are compatible with a shared goals and intentions hypothesis. The disdain of observational data in experimental psychology leads some to ignore the reality of animal cognitive achievements.

In the past, philosophers and scientists have regularly proposed new definitions of human uniqueness based on their personal convictions and intuitions of what animals are or are not able to do. Nowadays, over 45 years of field studies on wild chimpanzees provide a wealth of observational data against which to confront these preconceptions. In this sense, it is more than surprising to find only a single reference to animal field data in Tomasello et al.'s long citation list. Not surprisingly, their portrayal of cooperative hunting in chimpanzees reminds one of the old philosophers' claims. This is especially disappointing in that their proposition that the ability to share goals and intentions is a uniquely human capacity rests squarely on the assumption that no other species can do so.

I will briefly outline an analysis of the hunting behaviour among wild chimpanzees showing that individual hunters' behaviour is noticeably compatible with sharing goals and intentions. Hunting has been observed in all chimpanzee populations studied so far, and large differences in hunting strategies have been documented, especially in the propensity to hunt in collaborative groups (Boesch 1994a; 1994b; Mitani & Watts 1999; 2001; Nishida et al. 1992; Stanford 1998; Stanford et al. 1994a; 1994b; Watts & Mitani 2000; 2002). Natural observations can address only the question of performance, but we know from human observations that comprehension often exceeds performance (Birch & Bloom 2004; Keysar et al. 2003). During 77% of the 274 group hunts followed, Taï chimpanzees performed four complementary hunting roles (Fig. 1). Briefly: The *driver* initiates the hunt by slowly pushing the arboreal prey in a constant direction, *blockers* climb trees to prevent the prey from dispersing in different directions, the *chaser* may climb under the prey and by rapidly running after them try a capture, and the *ambusher* may silently climb in front of the escape movement of the prey to block their flight and close a trap around the prey (Boesch 1994a; 2002; Boesch & Boesch-Achermann 2000). Hunting success increases with the number of hunters, so that large groups in which all roles are performed are very successful (63 to 89% of captures achieved). During such collaborative hunts, each hunter synchronizes and spatially coordinates his movements to those performed by others, and sometimes anticipates their future actions. Each individual hunter can perform most complementary roles and individuals may even shift roles during a given hunt, demonstrating a capacity for role reversal and perspective taking. Tomasello et al. suggest that a chimpanzee hunter "simply assesses the state of the chase at each moment and decides what is best for it to do." However, drivers and ambushers achieve only 1% and 11% of the captures respectively, while 81% are achieved by individuals following the hunt from the ground. Consequently, drivers are granted about three times less meat than captors of the prey (Boesch 2002; Boesch & Boesch-Achermann 2000). Interestingly, ambushers that anticipates movements of the prey and the other hunters are granted an amount of meat equal to captors, even when they have not made the capture.

Thus, under a selfish hypothesis, chimpanzees should only wait on the ground for the prey to fall or perform the ambusher role that guarantees more meat. Group hunting would become rare. This is not the case as Taï chimpanzees hunt about 250 times per year (Boesch & Boesch-Achermann 2000). On the other hand, a joint goal hypothesis seems more compatible with the observations, with individual hunters assessing whatever role needs to be performed for the joint hunt and able to flexibly perform the roles needed independently of their short-term benefit. Like in a team of soccer players, individuals react opportunistically to the present situation while taking in account the shared goal of the team. Some players will rarely make a goal, like defenders and goalies, but the success of the team will critically depend upon their contribution. This is very reminiscent to group hunting in chimpanzees where synchronization of different coordinated roles, role reversal, and performance of less successful roles favor the realization of the joint goal. Thus, the group hunting behaviour of the Taï chimpanzees fulfills the criteria set by Tomasello et al. for shared goals and intentions. I am not claiming that chimpanzees perform like humans; I am merely emphasizing that the evidence published on hunting in chimpanzees is compatible with the scenario of shared goals and intentions proposed by Tomasello et al.

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