from simple (taking a walk together) to complex (providing aid to victims of a large-scale natural disaster). Of the species existing on earth, only humans seem capable of large-scale collaborative ventures, but more simple collaborative activities seem within the capabilities of other species.

For example, our work with captive and wild dolphins suggests that at least some dolphin play behaviors are collaborative. We have observed young captive dolphins taking turns pushing one another along the surface of the water – a game that requires one dolphin to float stationary at the surface (typically on its side), allowing another dolphin (occasionally two other dolphins) to approach and gently contact the side of the floating dolphin, and then to push the floating dolphin sideways, oftentimes at high swim speeds. This dolphin game involves cooperation, and we have also observed dolphins switching from "pushee" to "pusher" during single play bouts, suggesting that the dolphins are in fact taking turns. We have also witnessed cooperative play with an object among a group of three wild rough-toothed dolphins (one youngster and two adults). While we were snorkeling, these three dolphins swam by, one of the adults trailing a piece of plastic from one of its pectoral fins. During the next 15 minutes, the three dolphins passed the plastic back and forth to one another. The cooperative nature of this behavior was evident in two respects. First, the dolphins did not attempt to steal the plastic from one another, but instead swam behind the dolphin with the plastic and waited for the plastic to be released. For example, the dolphin we first observed passed the plastic from its pectoral fin to its fluke and then let the plastic go, resulting in the trailing adult catching the plastic in its mouth. This dolphin then swam ahead of the other two dolphins, where it released the plastic for the now trailing adult to catch with one of its pectoral fins. Second, on several occasions, each of the two adults carefully passed the plastic to the young dolphin by placing the plastic close to the youngster's mouth before releasing the plastic. This suggested to us that the adults were ensuring the younger animal's participation. We have observed similar triadic interactions in captivity where dolphins initiate and maintain ball play with humans by tossing a ball to a person, waiting for the ball to be tossed back, tossing the ball back to the person, and so on. These examples of interactive play seem collaborative, at least in a simple sense, and, in conjunction with evidence of play signaling in other species, suggest the possibility of forms of interaction that might provide the basis for simple forms of culture.

Opponents of the notion of culture in nonhuman species might argue that we are reading too much into these play behaviors. Cautions concerning the dangers of overly rich interpretation of animal behavior have a long history (e.g., see Kuczaj 2001; Morgan 1894), but the same can be said for interpretations of human behavior, particularly that of children (see Brown 1973). For example, although human infants and toddlers are undoubtedly aware at some level of others' intentions and also seem motivated to share feelings and perceptions with others, the extent to which these abilities are present in young children and the extent to which they engage in "full-blooded cultural creation" is as much a matter of interpretation as it is a matter of empirical evidence. The main point of all this is that caution concerning overly rich interpretation is necessary for those who study all species, including humans.

To sum up, we believe that the study of culture would benefit from a comparative perspective, and that future work should address the question of whether various forms of culture are best viewed as falling along a continuum or as discrete categories. In addition, the extent to which the abilities highlighted by Tomasello et al. are also best represented as continuums (for example, "shared intentionality" might be at one end of a continuum that also contains "awareness of others" and "awareness of other's intentions," as well as the more basic ability to form an intentional plan of action) or as discrete categories is important for theories of cultural evolution. Determining the types of culture of which various species are capable and the cognitive prerequisites for such cultures will increase our understanding of the relative extents to which collaboration and cooperation are involved in the creation and maintenance of culture.

Steps toward categorizing motivation: Abilities, limitations, and conditional constraints

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Abstract: Tomasello et al. have not characterized the *motivation* underlying shared intentionality, and we hope to encourage research on this topic by offering comparative paradigms and specific empirical questions. Although we agree that nonhuman primates differ greatly from us in terms of shared intentionality, we caution against concluding that they lack all aspects of it before other empirical tools have been exhausted. In addition, identifying the conditions in which humans spontaneously engage in shared intentionality, and the conditions in which we fail, will more fully characterize this ability.

The target article raises far more questions than it answers, but the nature of the questions suggests to us that Tomasello et al. are onto something important. *Shared intentionality* is described as the outcome of a union between primate-general understandings of goal-directed behaviour and human-specific social motivations. *Motivation* may be an appropriately vague term at this point in theory development, but obviously it is not detailed enough to explain fully the human-nonhuman socio-cognitive distinction. How much of this motivation is intrinsic and how much is extrinsic? What are the underlying mechanisms? Do nonhuman primates share at least some aspects of this motivation? We push here for a detailed characterization of this motivation and hope to offer some steps forward through (1) comparative paradigm development and (2) important future experimental questions.

Recent comparative research has proven fruitful for characterizing socio-cognitive abilities in human and nonhuman primates (e.g., aspects of intentional action and perception [Hare et al. 2000, 2001]). We suggest that shared intentionality should continue to be approached in this manner – we are not as ready to dismiss chimpanzees in the *present/absent* manner as Tomasello et al. do. Of course, we are likely *not* going to find a chimpanzee system of shared intentionality that is on par with ours, but such research will lead to a more specific sense of where their limitations lie and what makes the human system work. Indeed, as Tomasello et al. point out, most attempts to find chimpanzee instances of cooperation and collaboration toward goal completion have come up empty-handed.

However, just as the studies by Hare et al. (2000, 2001) demonstrate the importance of task designs that fit natural chimpanzee social, goal-directed behaviour (i.e., competitive tasks), we argue that there also might be tasks that are more likely to *motivate* shared intentionality within this species. In past experiments, subjects were asked to cooperate toward a common food goal, yet this is not a species-typical behaviour for chimpanzees. We suggest that a testing situation is needed in which shared intention is required to compete or protect against a third entity. There is some suggestive evidence that this might work. In an ongoing project by Boysen et al. (in preparation) – using a paradigm modeled after the work by Cheney & Seyfarth (1990) – a chimpanzee dyad is placed in close proximity to a predator: an experimenter with a tranquilizer dart gun. Chimpanzees will engage in species-typical alarm behaviour toward their partner (e.g., vocalization and swaying) more often when the partner is ignorant (lacks perceptual ac-

https://doi.org/10.1017/S0140525X05380125 Published online by Cambridge University Press

cess) of the presence of the predator than when he is knowledgeable (has perceptual access). Such behaviour is often followed by the partner's movement away from the testing arena into safety. These data seem to meet Tomasello et al.'s criteria for *dyadic engagement* and may even approach *triadic engagement*: the chimpanzees may be perceptually monitoring the goal-directed behaviour and perceptions of their partners, and engaging in informative signal production, possibly toward the shared goal of the endangered chimpanzee's safety. This type of design combines the competitive elements that are ecologically relevant to chimpanzees (e.g., opposition to a third party) and the cooperative elements that are essential to sharing intentions (e.g., between the two chimps). We offer this as a stepping-stone for the future comparative examination of shared intentionality and argue against dismissing these abilities completely in nonhumans so early in the research endeavour.

Of course, the very fact that we have to design particular types of tasks to find evidence of shared intentionality capacities in nonhuman primates speaks to some obvious differences between us and them. As detailed in the target article, humans do this flexibly across a variety of situations. But do humans do it equally across all situations? Do situations differ in terms of the level or type of motivation for social engagement? Perhaps humans, too, are more likely to engage in shared intentionality – and exhibit it earlier in development – when the stakes are high (e.g., working together against a common enemy), compared with situations in which the goal is less evolutionarily relevant.

Just how good are we at shared engagement, and what cognitive mechanisms might underlie it? An examination of the conditions under which humans *fail* to engage in shared intentionality may help to shed light on the mechanisms underlying the ability (in much the same way that examining the specific conditions under which humans fail to appreciate fully what others know helps characterize *theory of mind*, [e.g. see Birch & Bloom 2004]). In fact, as humans, we must spend a lot of time enculturating shared intentionality in children (e.g., group projects in school, team sports). As much as we seem to develop an intrinsic social motivation to engage in some truly collaborative activities, we also sometimes require external motivation. In this way, the relationship with the development of culture appears bidirectional – shared intentionality can enable culture creation, and culture can encourage shared intentionality.

In sum, the function and existence of shared intentionality even before the second year of life is made quite clear by Tomasello et al., and we agree that it is a strong candidate for an important socio-cognitive difference between humans and other animal species, including our closest primate relatives. However, we propose that a detailed characterization of the social motivation underlying shared intentionality is still required and may be achieved by identifying both abilities and limitations in humans as well as nonhumans.

Shared intentions without a self

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Abstract: Shared knowledge of intentionality as well as shared knowledge of anything depends on the organism's understanding of itself, others, and the possible relations between self and other. This understanding involves mental representations of *me*, which emerges in the second half of the second year in the human infant, and it is this ability that gives rise to humanlike social understanding and complex self-conscious emotions.

The problem Tomasello et al. present is an important one for it asks how shared intentionality comes about and, most importantly, how the use of shared intentionality becomes the basis of all human exchange. Their premise is that the understanding of intentionality of others is not sufficient for humanlike cultural activities; what is needed, in addition, is shared intentionality, the motive to share things with others.

In the study of social cognition, we, as well as others, have argued that a person needs knowledge of themselves, others, and the relationship between self and other (cf. Asch 1952; Hamlyn 1974; Lewis & Brooks-Gunn 1979a, 1979b; Merleau-Ponty 1964). I have suggested that the development of social cognition proceeds in the following order: (1) I know, (2) I know I know, (3) I know you know, and finally (4) I know you know I know (Sullivan et al. 2003). R. D. Laing's *Knots* (1970) makes a similar point when he speaks of the complex interconnection between people, best captured in such meaningful language phrases as "I know, you know, that I know, you know that I will go to the football game on Saturday." The target article speaks to this same issue.

My concern here is how "by 9 months . . . infants understand that people have goals and persist in behaving until they see that their goal has been reached . . . [that people are] happy when the goal is reached and disappointed if it is not" (sect. 2.4, para. 1). Certainly, we have learned that infants know a lot. In fact, the history of infant research in the last 45 years has been one in which the infant has gone from the James (1950) insensate unformed organism to a highly complex one. But the question remains as to what kind of knowledge is responsible for these newfound skills and abilities? As Putnam (1981) has warned us, just because an ant can trace a face in the sand does not necessarily imply that the ant knows anything about faces. Indeed, I should like to argue that just because the 9-month-old infant can perceptually discriminate between two conditions does not necessarily mean that the infant knows about them if we mean that they know as we adults know. Perhaps we are back to the rheostat – in this case a very complex one. As I have tried to argue, the first step, "I know," is equivalent to machine or zombie knowledge. It is not until the second step, "I know I know," that we can distinguish between machine ability and mental states – in particular, the mental state of *me* – for not until we have such a mental state of me, "I know I know," is it possible to have the fourth step or true social cognition, namely, the interaction of symbols and knowledge between two humans. This shared intentionality is possible only between two selves, both of which have knowledge about themselves and others. Certainly, there may be early precursors of such knowledge. There is no question that the complexity of the machine that exists in infants at very young ages can allow for subsequent shared intentionality. Nevertheless, it is not enough.

Our work (Lewis 2003; Lewis & Ramsay 2004) has shown a slow development toward the mental state of the idea of me. We have shown that starting around 15 months, infants exhibit three classes of coordinated behavior – self-recognition, personal pronoun usage, and pretend play – which suggest the emergence of this mental state. Moreover, there is little evidence to indicate that the emergence of this mental state has much to do with environmental causes (Lewis et al. 1985). In fact, data from magnetic resonance imaging studies strongly suggest the importance of maturational factors, in particular the myelination of brain regions thought to support this mental state of me (Carmody et al. 2004). Such data suggest that the maturation of particular brain regions may be the cause of the emergence of the mental state of the idea of me – the "I know I know" and "I know you know" – which then subsequently allows for "I know you know I know." There is little doubt – at least at this point – that the earlier capacity of the machine as exquisitely described by Tomasello et al., can possess this knowledge. The complexity of the organism from early ages on may become the material used once the mental state of me emerges. However, it may not be the cause of the mental state itself. Rather, it remains to be shown that much of the abilities ascribed to infants reflect only "machine ability," and not until the emergence of the mental state of the idea of me can this machine ability be put to use in a humanlike fashion.

Interestingly, the emergence at 15 months of this capacity "I

https://doi.org/10.1017/S0140525X05380125 Published online by Cambridge University Press