sues that arose throughout their article: (1) the support (or lack thereof) for the proposed developmental milestones in the understanding of intentional action and shared intentionality, (2) the significance of autistic children's social-cognitive skills in terms of the current proposal, and (3) whether recent speculation and data on the human mirror-neuron system might provide challenges for the proposal.

With respect to human ontogeny, three developmental milestones are documented concerning the understanding of intentional action and shared intentionality. The first level of shared intentionality that comprises a developmental milestone is observed at 3 months in early dyadic engagements, also called *protoconversations* (i.e., conversations that reflect shared emotions and behaviors). According to Tomasello et al., this level requires that the two conversational partners regard and understand each other as animate agents. To my understanding, there is as yet no direct empirical evidence showing that infants at that age understand that people spontaneously produce behavior, a requisite of animate agents. The discrimination of biological from random motion that has been demonstrated in 3- to 4-month-old infants is not sufficient evidence for such understanding because infants of that age do not associate animals with biological motion cues as provided in point-light displays (Arterberry & Bornstein 2002). The understanding of the object-directedness nature of human actions does not seem well linked to protoconversations either, seeing as this understanding emerges later (6 months) and initially only for reaching actions (Woodward 1998, 2003). In fact, a topic of growing interest and debate revolves around the empirical evidence required to determine when infants understand the act of seeing, as opposed to looking (Poulin-Dubois et al., in press).

Tomasello et al. argue that, around 9 to 10 months of age, infants show some understanding that other people pursue goals – an understanding that coincides with the emergence of triadic engagement (shared goals and perceptions). The evidence is stronger along this line of research, although one can still quibble over the richness of the interpretations provided in some of the studies cited. For example, recent research indicates that infants' ability to distinguish intentional from accidental actions, along with the understanding of failed goals, is an ability that develops significantly between 12 and 18 months of age (Bellagamba & Tomasello 1999; Olineck & Poulin-Dubois 2005). The findings from the "unwilling vs. unable" experiment are intriguing although open to alternative interpretations, such as the presence or absence of hand contact with the object in question.

The final and third level in the ontogeny of shared intentionality involves the understanding that actors can choose among different means (or plans) to achieve a goal. This understanding is apparent at the same time as triadic engagements become collaborative through the emergence of joint intentions and attention (12 to 14 months). Once more, it is my opinion that the developmental sequence described by Tomasello et al. is somewhat too protracted, as data on infants' understanding of planning (or prior intentions) before the age of 24 months are scarce at best (Carpenter et al. 2002). If imitative learning is considered the crowning achievement of animate action understanding, then it would seem critical to document whether infants differentially produce actions demonstrated by human and nonhuman agents (such as computer animations or robots). Preliminary data from my laboratory suggests that infants can perform generalized imitation of actions from demonstrations without a human agent (Poulin-Dubois & St-Pierre, submitted).

The study of atypical cognitive development often sheds a unique light on the mechanisms involved in normal development (Karmiloff-Smith 2002). In the article by Tomasello et al., the authors argue that autistic children show good understanding of human intentional action and perception, though these children do not follow the typical human developmental pathway of social engagement with other persons. In fact, Tomasello et al. show that autistic children's deficits in each of the three types of social engagement bear a striking resemblance to those of great apes. In my opinion, the impaired shared-intentionality pathway better captures the social and communication failure that is at the very core of autistic disorder than the failure to represent mental states such as beliefs (Baron-Cohen 1995). On the other hand, the fact that difficulties in face recognition are common throughout the autism spectrum and that brain activation patterns in adults with autism do not differ for faces and objects are two observations that are difficult to reconcile with the hypothesis that autistic individuals have an intact understanding of people's goals and perceptions (Carver & Dawson 2002; Schultz et al 2000). Although the extent to which autistic children possess cultural learning skills remains to be determined, the case of autism is an interesting one for any evolutionary perspective on human social cognition, seeing as it is a developmental disorder that has a neurological basis in the brain and genetic causes play a major role in its development (Frith 1989).

One line of research that is ignored that might present a challenge for the present proposal concerns characteristics of the mirror-neuron system in humans (Rizzolatti & Craighero 2004). More specifically, the dissociation between intentional action understanding and shared intentionality in autistic individuals seems at odds with the fact that the human mirror-neuron system is involved in action understanding, imitation, and language processing. In conclusion, the target article provides the readers with a good working hypothesis that biological and cultural roots are essential in any effort to unify the evolution and development of human cognition. How this approach fares in handling data from the latest research in developmental cognitive neuroscience is yet to be determined and will surely be an interesting story to follow up on.

Reinterpreting behavior: A human specialization?

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Abstract: Tomasello et al. argue that the "small difference that made a big difference" in the evolution of the human mind was the disposition to share intentions. Chimpanzees are said to understand certain mental states (like intentions), but not share them. We argue that an alternative model is better supported by the data: the capacity to represent mental states (and other unobservable phenomena) is a human specialization that co-evolved with natural language.

Is there a meaningful difference between representing mental states versus representing behavior? This is a pivotal issue, because no one disputes that chimpanzees (or many other species) represent and reason about the behavior of others. Unfortunately, Tomasello et al.'s definition of what it means to *understand intentions* includes the ability to represent the actions associated with achieving a goal. Later, this definition allows them to argue that, because apes exhibit the ability to form complex representations of action, they possess at least part of the ability to understand intentions! As we shall show, this overlooks an alternative possibility: these representational codes evolved separately.

To begin, we note that the experiments they cite in support of the idea that chimpanzees represent intentions are designed in a manner that cannot distinguish between whether they are reasoning about behavior alone, or behavior and mental states (Povinelli & Vonk 2003, 2004; Tomasello et al. 2003a, 2003b). Why? Because the experimental manipulations *presuppose* that the subjects can distinguish between two classes of action (e.g., accidentally dropping a grape versus pulling it back in a taunting manner [see Call et al. 2004]), and once this is granted, then there is no unique causal work left for the purported intention attribution.

To put these empirical issues into proper perspective, consider

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the evolutionary model we have offered (see Povinelli et al. 2000). The *reinterpretation hypothesis* posits that the ancestor of the ape/human group possessed a suite of systems dedicated to representing and reasoning about behavior (detailed in Povinelli & Vonk 2004), but not intentions or other mental states. Further the model posits that, at some point in the evolution of the human lineage (probably coincident with evolution of natural language), a new system for encoding the behavior of self and other in terms of mental states was grafted into these ancestral systems for representing and reasoning about behavior. In modern humans, then, these two systems are now complexly interleaved into each other. Thus, the model stipulates that many of the same invariants in the behavior of others that humans explain in terms of underlying mental states, were discovered and exploited long before we evolved to re-code them in a mentalistic fashion. Furthermore, the model suggests that humans still do both: every time we attribute a mental state, we have already isolated a behavioral abstraction. The reinterpretation hypothesis thus suggests that it is not only *possible* to consider that chimpanzees and other species represent behavior without representing mental states, it suggests that, this is the typical case. Humans are the exception.

In this theoretical light, it is easier to see why the empirical data cited by Tomasello et al. do not demonstrate that apes represent intentions as mental states. Reconsider the unwilling/unable study. Although humans can attribute different intentions in cases where someone intentionally withholds something versus cases where it is accidentally dropped, and although this attribution can be causally implicated in generating aggressive reactions in the first case, but not the second, there is no reason why these reactions need to be mediated by an intention attribution. Even in humans, much of the time they probably are not. Although different intentions do indeed underlie the two actions, the chimpanzee (or human) need not know this to keep track of the behavioral invariances. And because these invariances must be represented anyhow (that is the basis upon which the different intention attributions are purported to be based), then what additional explanatory work does the intention representation perform in explaining the experimental results? As far as we can tell, none. The reinterpretation model suggests why: the ability to represent mental states co-opted the systems for behavioral representation that were already in place.

This issue plagues all experiments cited by Tomasello et al. (see Povinelli & Vonk 2004). For example, the authors describe a series of food-competition experiments to support the claim that chimpanzees "understand that what others see affects what they do." We have already shown in detail why this attribution is unwarranted by using the reasoning just described (Povinelli & Vonk 2003, 2004). Furthermore, empirical findings show that the robust effects of these studies are easily accounted for by nonmentalistic construals of the situation (some as simple as "on the basis of previous experience, don't approach food if it is in the unobstructed path of a dominant individual" [see Karin-D'Arcy & Povinelli 2002, experiments 3 to 6; Povinelli & Vonk 2003, 2004]).

Importantly, the authors overlook other data that have experimentally analyzed how chimpanzees interpret social cues related to "seeing" in simple social situations in which they can request food from one of two caretakers. *Without training*, chimpanzees base their choices on full body orientation (who is facing them) and, *with training*, they rapidly learn to base their choices on the direction of the head or even whether their recipient's eyes are open or closed (Povinelli & Eddy 1996; Reaux et al. 1999). Using slightly different methods these findings have been largely replicated by Tomasello and colleagues (Kaminski et al. 2004). These results suggest that the learned social cues remain subordinate to cues that tend to covary with someone "seeing" them, but have no bearing on "seeing." For example, even after they learn to gesture to the person whose eyes are open (as opposed to the person whose eyes are closed), chimpanzees will nonetheless prefer to gesture to someone whose eyes are closed if that person is facing them, as opposed to someone facing away, but looking (eyes open) over their shoulder toward them! One interpretation of these data is that the behavioral abstractions formed by chimpanzees are essentially postural heuristics that have nothing to do with "seeing" at all.

So, are Tomasello et al. correct that chimpanzees and humans both *understand* certain mental states, but only humans share them? The reinterpretation hypothesis argues that only humans represent mental states at all – and that, in turn, is why we are the only species who shares them. Further, it offers more explanatory power: it explains all the differences that Tomasello et al. catalog between human and great-ape cultures in one evolutionary step. Tomasello et al. require two distinct evolutionary steps: the evolution of the ability to conceive of intentions, followed by the disposition to share them. In the reinterpretation model, sharing such states comes for free, because the original code in which mental states were represented was inextricably embedded in a predominantly social capacity: natural language. And that may be the big difference that made a big difference.

Illusions of intentionality, shared and unshared

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Abstract: Intention, shared or unshared, is based on the presumption of unknowable and unnecessary motives and mental states in ourselves and others.

Until proven otherwise, why not assume that intention does not play a role in human and animal behavior? Although it may seem radical on first hearing, this is actually the conservative position that makes the fewest assumptions. The null position is an antidote to our tendency to presume rational, conscious control over processes that may be unconscious and not require a ghost in the neurological machinery. The argument here is not that we lack consciousness, but that we overestimate the conscious control of behavior and cannot trust its narrative as an explanation of our actions. Proving this proposition is a challenge because it's difficult to think about consciousness and the causes of our behavior, intentional or otherwise. We are misled by an inner voice that generates a reasonable but often fallacious narrative and explanation of our actions, and we use this account to interpret the actions of others. Is the presumption that human cognition "sticks out like an elephant's trunk, a giraffe's neck, a peacock's tail" an illusion in the eye of the beholder? Is the critical level of neurological processing one step removed from the user-friendly but unreliable interface accessible through introspection? That the beam of conscious awareness that illuminates our actions is on only part of the time further complicates the task. Since we are not conscious of our state of unconsciousness, we vastly overestimate the amount of time that we are aware of our own actions, whatever their cause.

My thinking about unconscious control and associated issues of intentionality was shaped by my field studies of the primitive play vocalization of laughter (Provine 2000). When I asked people to explain why they laughed in a particular situation, they would concoct some reasonable fiction about the cause of their behavior – "someone did something funny," "it was something she said," "I wanted to put her at ease." Observations of social context showed that such explanations were typically unfounded. In clinical settings, such post hoc misattributions would be termed *confabulations*, honest but flawed attempts to explain one's actions. How different is our account of intentions?

Subjects in my laughter study also incorrectly presumed that laughing is a choice (intention) and under conscious control, a reason for their confident, if bogus, explanations of their behavior (Provine 2000). But laughing is not a matter of speaking "ha-ha," as we would choose a word in speech. When challenged to laugh on command, most subjects could not do so. In certain, usually

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