in the so-called *weak central coherence* hypothesis (Frith & Happé 1994). Unfortunately, the empirical evidence for this theory is equivocal (Brosnan et al. 2004; Mottron et al. 2003; Plaisted et al. 1999; Ropar & Mitchell 2001), and the correlations between tests of weak central coherence and TOM tests are low (Jarrold et al. 2000; Morgan, et al. 2003). One reason is that this hypothesis lacks specificity: It may apply to all kinds of information integration, from low-level perceptual processing (e.g., perceptual grouping and Gestalt formation) to cross-modal perceptual integration and to more semantic forms of integration. Another reason may be that TOM tests do not require fast and complex integration. Despite these limitations, this perceptual integration deficit hypothesis offers a promising alternative to Tomasello et al.'s motivational explanation.

In summary, we think it is premature to explain autism by the theory of shared intentionality: The available empirical evidence suggests alternative mechanisms. In any event, it is very worthwhile to reassess all the putative modules of the theory of shared intentionality, specifying developmental pathways amongst them, and testing these in typically developing individuals as well as in individuals with developmental disorders such as ASD. Such an extensive research program is really needed before bringing evolutionary anthropology (EVA) to autism and development of abilities of the mind (ADAM) will fructify.

"Einstein's baby" could infer intentionality

John S. Watson

Department of Psychology, University of California, Berkeley, CA 94720-1650. **jwatson@berkeley.edu**

Abstract: Some implications of Tomasello et al.'s theory derive from incorporating a variant of a common assumption that humans are biologically adapted to take an intentional stance in relation to conspecifics. I argue that, rather than being cued, intentions and other dispositional states may be inferred logically from an evolved commitment to determinism and evidence of state-dependent behavior.

Tomasello et al. propose a bold theory of how "shared intentionality" arises within human ontogeny and provides the basis for other capacities that are also apparently unique to humans. The major novelty of this proposal is in the details of how and why an infant's attribution of intention to another person develops to sharing an intention with another person and ultimately to incorporating a representation of the other's intention within his own. I have no quarrel with the fascinating theory of transition in their control-systems model, but I am concerned with the authors' explicit claim of how the system gets started.

The authors propose that infant humans and other primates come to view conspecifics as intentional agents by virtue of having an innate bias to do so and by experiencing intentional states within themselves. Others have made similar assumptions about bias. For example, in his book *Descartes' Baby* (2004), Bloom proposes that humans are endowed with a dualistic bias to view physical objects as subject to external causes and animate objects as subject to internal causes (e.g., intentional states). Because these internal causes are not visible, it has been commonly assumed that they are brought into play cognitively by stimulus triggers (e.g., animacy, humanoid features of face or hand) that have coevolved with the advantageous strategy of the "intentional stance" that they elicit (Dennett 1971, 1987).

This view may be right, but it is not as obviously right as the authors appear to assume, as when they say "understanding actions as goal directed is a biological adaptation" and "understanding intentional action depends on species-typical social interactions early in ontogeny" (sect. 5.2, para. 4). If these starting assumptions are wrong, that need not affect much of their novel view of ontogeny. However, some implications of their theory will be at risk regarding the evolutionary story and the perspective on autism. Consider then, the following alternative for getting the system started.

A large body of evidence on human-infant learning is at least consistent with an assumption of an endowed capacity to analyze and adapt to the causal contingencies of a determinant world (Tarabulsy et al. 1996). Let us assume that this broadly adaptive capacity evolved to a form of what might be called the *determinist's stance*. Two central features of this stance are that all events are the effects of causal laws ("God does not play dice"), and causal laws are complete and universal (not sometimes true and sometimes false or somewhere true and elsewhere false). Even from the perspective of probabilistic determinism, all things being equal, if a sufficient cause occurs, then the effect should occur with specified probability over repeated instances (e.g., not 0.8 sometimes and 0.2 at other times).

A notable feature of good laws from the determinist stance is that they are not symmetrical in the relation of cause and effect. With a good law, if you know the causal context is complete, then you know the exact effect that will occur (or, in probabilistic determinism, the probability of that effect). But the reverse is not entailed. Alternative causes may exist for a specific kind of effect. In such cases, knowing that a specific effect has occurred leaves open the question of which of the alternative causes was the determinant.

As I note elsewhere (Watson, 2005), historical criteria for purposive behavior have referred to behavioral persistence and rationality (as do Tomasello et al.) but also to *equi-finality* – an agent producing an equivalent outcome across varying situations by making necessary changes in the instrumental behavior (Heider 1958). Equi-finality provides statistical evidence for the inference of goal-directedness versus coincidence. Stronger still, the determinist stance will provide a deductive implication from evidence of *equi-origin* – an agent behaving differently over instances of equivalent situations. To the extent the situations are held to be equivalent, a determinist will be forced to introduce a dispositional difference in conception of the actor's state (Fig. 1). A deterministic account of the actor's varying behavior requires the cause to reside either in the situation, the actor, or both. If the situations are equivalent, the actor cannot be (as per negation of disjunction – A or B, not B, therefore A). It is perhaps worth noting that the so called cue of animacy is usually presented in a manner that provides evidence of equi-origin (i.e., the animate object changes behavior in an otherwise constant situation).

The idea that very young humans might respond to logical implication is not new. Gopnik et al. (2004) are explicit in the assumption that preschool children are, at least unconsciously, sensitive to logical constraint in their studies of how *causal power* is inferred. More recently, they too have considered the effect of a commitment to determinism as a means of inferring hidden physical causes (Schulz & Gopnick, forthcoming). Piaget (1954) framed the infant's capacity to pass stage IV of object permanence

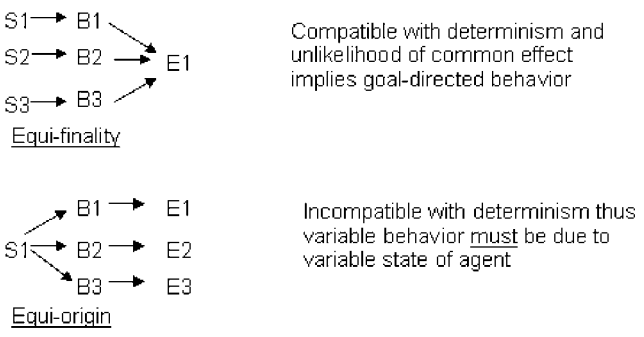


Figure 1 (Watson). Logical impact of observed equi-finality or equi-origin of an agent's behavior (B) across situations (S) in relation to effects (E) of that behavior.

https://doi.org/10.1017/S0140525X05520120 Published online by Cambridge University Press

(around 8 months of age) in terms of underlying capacities for representation and deduction. The contemporary research on physical and social knowledge in infants (e.g., solidity, gravity, numerical object relations, and implications of desire) that relies on manipulation of expectancy (e.g., use of the habituation/recovery method) is at least implicitly assuming logical processing on the part of the infant. Csibra et al. (1999) argue for a view of young infants employing "principle based" reasoning about rational action when engaged in the teleological or intentional stance.

Implications. Contrary to the simulationist perspective favored by the authors, infants (as logical determinists) may conceivably use evidence of equi-finality and equi-origin to provide a causal understanding of others as intentional. Indeed, it is conceivable that they may do this in coming to understand there own intentionality. If infants can infer mental state variation by virtue of a primitive determinist stance and some primitive capacity for causal logic, then these factors should be examined for phylogenetic and ontogenetic differences. If comparative analysis of a commitment to determinism is as challenging as analysis of inference (Watson et al. 2001), it will not be an easy task.

Triadic bodily mimesis is the difference

Jordan Zlatev,[a] Tomas Persson,[b] and Peter Gärdenfors[b]

Departments of [a]*Linguistics and* [b]*Cognitive Science, Lund University, Lund, Sweden.* **Jordan.Zlatev@ling.lu.se** **Tomas.Persson@lucs.lu.se** **Peter.Gardenfors@lucs.lu.se**
url: http://www.ling.lu.se/persons/JordanZlatev.html
url: http://213.80.36.53/temp/lucs/staff/person.asp?id=87&lang=eng
url: http://www.lucs.lu.se/People/Peter.Gardenfors/index.html

Abstract: We find that the nature and origin of the proposed "dialogical cognitive representations" in the target article is not sufficiently clear. Our proposal is that (triadic) *bodily mimesis* and in particular *mimetic schemas* – prelinguistic representational, intersubjective structures, emerging through imitation but subsequently interiorized – can provide the necessary link between private sensory-motor experience and public language. In particular, we argue that shared intentionality requires triadic mimesis.

Tomasello et al. claim that the crucial difference between human beings and apes is "an adaptation for participating in collaborative activities involving shared intentionality" (sect. 6, para. 2), as a result of which human children develop "dialogic cognitive representations." We are sympathetic to this proposal but do not find the nature and the origin of these representations sufficiently clear. Tomasello et al. do not state whether they have an expression-content structure and, if so, whether they are based on language itself, making the account somewhat circular. As for their emergence, it is much too vague to suggest that they are "in some way internalized in Vygotskyan fashion" (sect. 5.2, para. 11).

As an alternative, we suggest that a crucial difference between us and other animals is our advanced capacity for *bodily mimesis*, in particular in its relation to the formation of the *sign function* (Sonesson 1989). Departing from the work of Piaget (1948) and Donald (1991, 2001), we have developed an account of how bodily mimesis provides a "missing link" in both human evolution and child development (Zlatev in press; Zlatev et al., 2005) which we here suggest as an alternative to Tomasello et al.'s account.

Bodily mimesis is based on the ability to match the largely proprioceptively defined *body schema* and more multimodal and consciously accessible *body image* (Gallagher 1995) with perceptions from other modalities. We propose a four-stage model of the development of bodily mimesis that we call the *mimesis hierarchy* and argue that it can be applied to ontogeny as well as phylogeny.

The simplest form, *protomimesis*, involves "body matching," but lacks either clear differentiation between the body schema of the subject and the phenomenon that it is being matched to – paradigmatically the body of the other – or volitional (conscious) control or both. We believe that this is what underlies the neonatal mirroring of human infants (Meltzoff & Moore 1977) and chimpanzees (Myowa-Yamakoshi et al. 2004). The next step is *dyadic mimesis*, which features both differentiation between one's body and whatever it corresponds to and conscious control of the body's representational movements. We consider the capacity for *deferred imitation* to be clear evidence for such differentiation and volition, as well as the capacity for *mirror-self recognition*. (In the latter case, it is the mirror image that is the signifier, while one's own body is the signified.) What these very different skills share is a basic form of the sign function: understanding that one entity can *correspond to* another. Deferred imitation is claimed to be witnessed in human infants as early as 6 weeks (Meltzoff & Moore 1994), but this is rather controversial. At any rate, by 14 months children can perform bodily mimes of actions and events that they have observed previously (Piaget 1948), and around the same time they pass the mirror self-recognition test (Amsterdam 1972). Apes have some difficulties with both of these skills, but it appears that they are indeed capable of dyadic mimesis, reflected in both mirror-self recognition (Lin et al. 1992) and the ability to copy bodily shapes on command (Custance et al. 1995).

The crucial difference is in the next step in the hierarchy, *triadic mimesis*, when the sign function is recruited for communicative means so that an intentional bodily movement, a gesture, stands for an action, event, or object for an addressee. This *communicative sign function* is in essence what is involved in both indexical gestures (i.e., declarative pointing) and iconic gestures. Apes that have not been "enculturated" (cross-fostered) are poor at these skills, though some rudiments have been observed in captive gorillas (Tanner & Byrne 1996) and bonobos (Savage-Rumbaugh et al. 1977). Considering that acts of mimesis can be *interiorized* – that is, performed covertly in imagination – such covert mimetic schemas can be hypothesised to ground the meaning of the child's first words, and in particular the first verbs, the acquisition of which is claimed to be "the major turning point in children's transition to adult-like competence" (Tomasello 1992, p. 7). *Mimetic schemas* are representational and dynamic structures that are accessible to consciousness and *prereflectively shared*. Since they derive from imitating culturally salient actions and objects, both their representational and experiential content can be intersubjective – though not in the strong sense of being mutually known to be shared in the manner of symbols or conventions. What differentiates mimesis from language is above all that the latter is (in principle) fully conventionalized, that is, an object of common knowledge (Clark 1996) and systematic. Thus, signed languages such as American Sign Language constitute the fourth step of the mimesis hierarchy: *postmimesis*.

As sketched above, humans and apes begin to diverge as early as dyadic mimesis, but the difference becomes blatant with triadic mimesis, when mimetic acts and schemas are used for intentional communication. Considering this difference, it is unsurprising to find major differences in apes' and children's capacity for language acquisition. Bodily mimesis is also implicated in intersubjectivity. Gärdenfors (2003, ch. 4) proposes that the capacity for theory of mind be split up in several levels, which fits well with the general approach of Tomasello et al. In particular, we believe that the "shared intentionality" that is the focus of the target article cannot arise without the presence of triadic mimesis. The reason is that the participants can only identify (or create) the shared goal if they can communicate referentially about it, which can be achieved through triadic mimesis.

In conclusion, we hypothesize that the source of human cognitive specificity lies above all in two, mutually enforcing factors: (1) the capacity to form mimetic schemas: representations derived from imitation of public events, and thus basically intersubjective, and (2) the use of mimetic schemas for intentional communication: triadic mimesis. The first of these factors is predominantly representational and the second is communicative, and it is likely that the two have co-evolved. Like Tomasello et al., we consider the crucial human adaptation to be one of social cognition not specifically related to language, but to the motivation and ability

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