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Cultural learning

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Abstract: This target article presents a theory of human cultural learning. Cultural learning is identified with those instances of social learning in which intersubjectivity or perspective-taking plays a vital role, both in the original learning process and in the resulting cognitive product. Cultural learning manifests itself in three forms during human ontogeny: imitative learning, instructed learning, and collaborative learning – in that order. Evidence is provided that this progression arises from the developmental ordering of the underlying social-cognitive concepts and processes involved. Imitative learning relies on a concept of intentional agent and involves simple perspective-taking. Instructed learning relies on a concept of mental agent and involves alternating/coordinated perspective-taking (intersubjectivity). Collaborative learning relies on a concept of reflective agent and involves integrated perspective-taking (reflective intersubjectivity). A comparison of normal children, autistic children and wild and enculturated chimpanzees provides further evidence for these correlations between social cognition and cultural learning. Cultural learning is a uniquely human form of social learning that allows for a fidelity of transmission of behaviors and information among conspecifics not possible in other forms of social learning, thereby providing the psychological basis for cultural evolution.

Keywords: animal cognition; attention; cognitive development; collaboration; cultural learning; culture; imitation; instruction; intentionality; intersubjectivity; social learning; theory of mind

Many animal species live in complex social groups; only humans live in cultures. Cultures are most clearly distinguished from other forms of social organization by the nature of their products – for example, material artifacts, social institutions, behavioral traditions, and languages. These cultural products share, among other things, the characteristic that they accumulate modifications over time. Once a practice is begun by some member or members of a culture others acquire it relatively faithfully, but then modify it as needed to deal with novel exigencies. The modified practice is then acquired by others, including progeny, who may in turn add their own modifications, and so on across generations. This accumulation of modifications over time is often called the "ratchet-effect," because each modification stays firmly in place in the group until further modifications are made. No cultural products exhibiting anything like the ratchet effect have ever been observed in the ontogenetically acquired behaviors or products of nonhuman animals (Tomasello 1990).

The very large difference in product between animal and human societies may be most directly explained by a small but very important difference in process. Simply put, human beings learn from one another in ways that nonhuman animals do not. In particular, human beings "transmit" ontogenetically acquired behavior and information, both within and across generations, with a much higher degree of fidelity than other animal species. The learning processes that ensure this fidelity serve to prevent information loss (the ratchet) and thus, in combination with individual and collaborative inventiveness, form the basis for cultural evolution. Human beings are able to learn from one another in this way because they have very powerful, perhaps uniquely powerful, forms of social cognition. Human beings understand and take the perspective of others in a manner and to a degree that allows them to participate more intimately than nonhuman animals in the knowledge and skills of conspecifics.

This overall perspective is not new, of course, but echoes a central theme in the work of Lev Vygotsky. On a number of occasions Vygotsky (e.g., 1978) contrasted sharply the learning of human children in the "cultural line" of development with their learning (and that of Kohler's [1927] chimpanzees) in the "natural line" of development. The cultural line is characterized not only by the presence of culture, whose important role in human ontogeny Vygotsky so clearly demonstrated, but also by the uniquely human capacity to acquire cultural products. The coevolution of culture and the capacity for its acquisition is also a major theme of the newly emerging paradigm of cultural psychology (e.g., Bruner 1990; Cole 1989; Rogoff 1990; Shweder 1990; Wertsch 1985b). But, following Vygotsky, cultural psychologists have so far chosen to focus almost exclusively on the important role of culture, neglecting for the most part what the individual organism brings to the process of enculturation.

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In this target article we attempt to focus on the individual capacity for acquiring culture, that is to say, on the social-learning processes whereby human children acquire the skills and conventions of those around them. What is new in our account is an attempt to understand social learning in terms of the most recent research and theory on children's social cognition. We believe that as children's understanding of other persons develops – as they learn to understand other persons in terms of their intentions and beliefs, or even in terms of a "theory of mind" – new processes of social learning emerge. Because of their role in the transmission and creation of cultural products, we refer to these uniquely human processes of social learning as cultural learning.

1. Social learning and cultural learning

As typically conceived, social learning is individual learning that is influenced in some way by the social environment (e.g., Bandura 1986). In many cases this influence may be minimal in terms of the actual learning processes involved, however. For example, young animals may follow their mother to a food source and then learn to extract the food by themselves; or human adults may give children objects which they then explore on their own. In these cases the social environment provides exposure only; the actual learning processes are wholly individual in the sense that what is learned is learned through the youngster's direct interaction with the physical environment.

In other instances the social environment may play a more active role, most importantly by drawing the juvenile's attention to a specific object or location in the environment that it otherwise would not have noticed (so-called local or stimulus enhancement; Thorpe 1956). For example, a chimpanzee mother's nut-cracking activities may draw a youngster's attention to the rock-hammer and the open nut, both left on the hard surface necessary for successful cracking; or a human mother may set up a task for the child in a simplified way that invites attention to key elements. Such situations are undoubtedly instrumental in leading the immature organism to make discoveries and to learn things that it would not have learned on its own, even if it were exposed to the proper physical conditions, and this is clearly a very powerful form of social learning. However, it is important that, once again, the learning processes involved in actually acquiring the new behavior may still be seen as individual in the sense that the youngster does not learn anything from the mother's behavior per se – that is, her particular approach to the task (her specific method or behavioral strategies) is not a part of what is learned (Tomasello 1990).

Social learning in the form of stimulus or local enhancement plays an indispensable role in human development, as it does in the cognitive development of many social species. In some cases, however, human beings learn from one another in a qualitatively different way. Human beings sometimes engage in what we call cultural learning. In cultural learning, learners do not just direct their attention to the location of another individual's activity; rather, they actually attempt to see a situation the way the other sees it – from inside the other's perspective, as it were. In this case, learning is social in a way that individual learning enabled or supported by the social environment is not. It is learning in which the learner is attempting to learn not *from* another, but *through* another. This qualitative difference is possible because human beings are able, depending on one's choice of theory and terminology, to take the role of the other (Mead 1934), to take the perspective of the other (Piaget 1932), to attribute mental states to the other (Premack 1988), to simulate the mental states of the other (Harris 1991), to engage in joint attention with the other (Bruner 1983), to engage in mindreading of the other (Whiten 1991), to understand the other as a "person" (Hobson, in press), or to participate with the other intersubjectively (Trevarthen 1979b). We will speak of "perspective-taking" when the learner is attempting to see the situation from another person's point of view and of "intersubjectivity" when both the learner and other person are doing this simultaneously and reciprocally. In all cases, the nature of the perspective-taking attempt depends, in a way that we will spell out later, on how the other "person" is conceived.[1]

It is also important in our definition of cultural learning that what is retained by the learner after the social interaction has terminated is still in essence social. Thus, in all cases of cultural learning the learner must internalize into its own repertoire not just knowledge of the activity being performed by another person, but also something of the social interaction itself – the demonstration or instructions given by an adult, for example. This process of internalization (or, in Rogoff's 1990 preferred terminology, "appropriation") is not something mysterious or magical, in our view, but simply a special manifestation of basic processes of learning. The difference is that in internalization an important part of what is being learned is the point of view of another person (the "voice" of the other, in Bahktin's terminology; cf., Stone, in press; Wertsch 1991) – which may sometimes be intentional, and thus refer to some entity outside that person. The important point for current purposes is that the cognitive representation resulting from cultural learning includes something of the perspective of the interactional partner, and this perspective continues to guide the learner even after the original learning experience is over. This internalization or appropriation of perspectives does not, by definition, occur in noncultural forms of social learning.

This definition of cultural learning will, it is hoped, become clearer and more fully developed as we proceed. Our plan is this: In the section that follows, we lay out the fundamentals of our argument about the relation between social cognition and cultural learning by tracing the ontogeny of cultural learning in the human species. We focus on what we consider the three main types of cultural learning and the social-cognitive concept of person on which each of them depends. We then attempt to bolster our argument by reviewing what is known about the social cognition and social learning of autistic children, followed by a similar analysis of our nearest primate relative, the chimpanzee. In both cases we find that there is something acultural about their learning and social lives. We conclude by discussing the central role of cultural learning in the evolution of human culture and cognition.

2. The ontogeny of cultural learning

In virtually all discussions of the psychological bases of culture and cultural transmission the focus is on imitation

by immature organisms and teaching by mature organisms (e.g., Boyd & Richerson 1985; Galef 1992). We agree with this starting point, but we also feel that it is somewhat incomplete. The first type of cultural learning is clearly *imitative learning*, in which the learner internalizes something of the demonstrator's behavioral strategies. This may occur either inside or outside a pedagogical context. But when teaching is involved, another form of cultural learning may also occur, what we propose to call *instructed learning*. This is essentially Vygotskian learning in which learners internalize the instructions of the teacher and use them subsequently to self-regulate their own attentional, mnemonic, or other cognitive functions. This ensures that the instruction lives on after the original learning situation. We would also like to add a third type of cultural learning to the discussion: *collaborative learning* does not involve transmission from mature to immature organism in the classic sense because, by definition, the situation consists of peers collaborating to construct something new that neither had before the interaction began. It is clear such a process enhances the individual inventiveness that is the leading edge of cultural evolution, but it is also true that in some minority of cases collaborative learning may contribute to the maintenance of cultural traditions, as immature organisms in generation after generation of a particular culture are exposed to similar situations that call forth similar collaborative efforts and solutions. In either case, collaborative learning is, in our view, an important part of the total picture of cultural learning and evolution.

Though highly oversimplified, Figure 1 presents the three basic interactional situations just described: (i) imitative learning, with the single arrow depicting the learner's efforts at perspective-taking and learning; (ii) instructed learning, with the reciprocal and asymmetrical arrows depicting the instructor's efforts at perspective-taking and instruction and the learner's efforts at perspective-taking and learning (together leading to an asymmetrical form of intersubjectivity); and (iii) collaborative learning, with the reciprocal and symmetrical arrows depicting each of the collaborator's efforts to take the perspective of and to learn through the other (in this case in a symmetrically intersubjective fashion). Our major ontogenetic claim is that the three types of cultural learning emerge in a highly predictable order in human ontogeny, dependent in each case on the development of specific social-cognitive underpinnings (i.e., the development of specific concepts of "person"). This order, however, is only clear if each type of cultural learning is clearly differentiated from the social learning processes that resemble it. We discuss each of the three in turn.

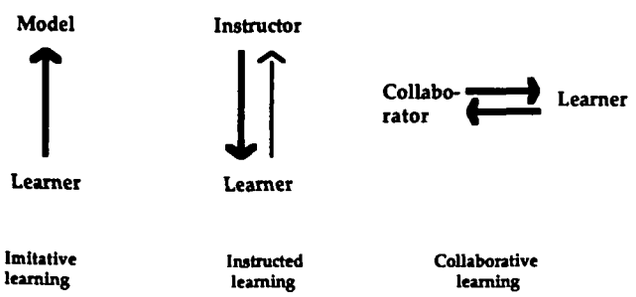

Figure 1. Direction of intentionality in the three cultural learning situations.

2.1. Imitative learning. Human infants are social creatures. They smile at human faces and engage in rhythmic interactions with other human beings practically from birth. They also reproduce some behaviors they observe being performed by other persons (e.g., tongue protrusions and head turnings) within the first few weeks of life (Meltzoff & Moore 1989). Impressive though they may be, however, and even if they are necessary for cultural learning later in ontogeny, these social matching behaviors are not instances of imitative learning *qua* cultural learning quite simply because nothing new is being learned. Neonatal imitations all involve behaviors that infants produce spontaneously with some regularity; none involve the acquisition of new behaviors.

Also not qualifying as clear cases of cultural learning are the attempts of infants to attain goals after adults have attained them (e.g., Kaye 1982), but using their own methods of execution – what Wood (1989) calls emulation. The problem is that what is often happening in such cases is that the child is learning about the affordances of an object or situation, not about the adult's goal or perspective. Thus, an infant might see an adult open a jar and then do the same, using established behavioral strategies, because it now sees that the jar affords opening. Conversely, if the infant reproduces the precise form of the adult's behavior but does not understand its goal, we may say that the infant is only mimicking the adult; for example, the infant might make twisting motions on the lid as the mother did, but without applying pressure, not knowing that the goal is to open the jar. Again, in this case nothing is learned about the adult's goal or perspective. True imitative learning in our definition involves the infant's reproducing the adult's actual behavioral strategies in their appropriate functional contexts, which implies an understanding of the intentional state underlying the behavior.[2]

True imitative learning first emerges in the second half-year of the infant's life, primarily in two domains: object-directed actions and the use of communicative symbols. In the case of object-directed actions, the first imitative learning of novel actions occurs at 9–14 months of age, with the precise age depending on the particular tasks used and the criterion of novelty in effect (e.g., Abravonal & Gingold 1985; Masur & Ritz, 1984; McCall et al. 1977; Meltzoff 1988a; 1988b). The problem in identifying imitative learning in object-directed actions is that infants have preexisting proclivities to manipulate objects in particular ways. The actions modeled must therefore be clearly novel for the child and there must be a control group of subjects to further ensure that the modeled actions are not ones that children would perform spontaneously with that object or in response to generic adult attention to the object (thus ruling out stimulus enhancement and/or emulation as potential learning processes). Perhaps the best example is that reported by Meltzoff (1988b), who found that 14-month-old infants could learn to activate a light by bending at the waist to touch a panel with their foreheads, as they had seen a model do. This seemed a clearly novel action for most infants; not one child in a control condition spontaneously performed it. This demonstration, and several others in various other experiments, strongly suggests that in the months immediately before their first birthday human infants are able to imitatively learn novel object-directed actions on the

basis of only one or a few observations of adult performance. The fact that in some instances they go on to use these behaviors in appropriate novel circumstances argues that they are not simply mimicking them.

The imitative learning of conventional linguistic symbols provides further support for this conclusion. Infants typically begin to acquire conventional symbols during this same developmental period, the final quarter of their first year of life (e.g., Bates 1979). This is important because the appropriate use of a conventional symbol can *only* be learned imitatively; it is unlikely to the point of impossible that infants will discover for themselves the same arbitrary connection between sound and referent that adults have conventionalized (i.e., learning by means of stimulus enhancement and emulation is not possible with conventional behaviors and thus experimental controls are not necessary). The first use of conventional symbols – in appropriate novel circumstances to rule out mimicking – is thus important corroborating evidence that infants' imitative learning skills are beginning in the months just prior to their first birthdays.

To understand this newly emerging ability we must look at what other new things infants are doing at this age. We do not have to look very hard. At around 9 months of age infants begin to engage in a number of new behaviors that herald the emerging ability to coordinate attention to people and objects (Trevarthen & Hubley 1978). During this period infants begin for the first time to follow into the perspective of adults: They look at objects the adult is looking at, even participating in extended bouts of joint attention (Bakeman & Adamson 1982), and they also begin to look to adults for their emotional reaction to novel people and objects, often using them as social reference points (Uzgiris & Kruper 1992). At this age they also begin trying to get others to tune into *their* focus of attention by means of various communicative gestures, often accompanied by alternation of gaze between person and object (Bates 1976). What all these behaviors have in common is a reliance on understanding persons as intentional agents that are clearly different from inanimate objects. Infants do not attempt to look where their doll is looking, they do not attempt to use a chair as a social reference point, and they do not request actions from their bottle. They do these things only when they are interacting with another person, and this is because they understand the behavior of other persons in terms of underlying perceptions and intentions. In fact, only if the infant has some notion of intentional agent, we would argue, do these behaviors make any sense at all.

It does not require great insight to see that this emerging ability to treat others as intentional agents also underlies the 9-month-old's emerging ability to imitatively learn novel instrumental behaviors from them: just as infants can follow into the adult's visual focus of attention, so they can follow into the adult's behavior and reproduce it. Reproducing an adult's novel behavior in both its form and appropriate function (i.e., imitative learning) clearly requires some understanding of what the adult is perceiving and intending because without such understanding the child cannot know which aspects of the adult's behavior are relevant or irrelevant. In flying the toy airplane is it necessary to throw it overhand, as the model has done, or can it be thrown underhand? In blowing bubbles, is it necessary to blow them in an upward direction, as the model has done, or will any direction do? In using a fork must one stab the food, as the model has done, or may it be used as a spoon? In each of these cases the child must understand the adult's behavior in intentional terms in order to determine what is the purpose of the behavior and how one goes about accomplishing that purpose. Without such understanding the best the child can do is either to reproduce the adult's behavior blindly (i.e., mimic) or else to devise some idiosyncratic way of attaining the result observed (i.e., emulate it). When children can attempt to see a situation from the perspective of another person, on the other hand, they can at that point reproduce both means and ends in one imitative act for themselves.

The situation is even clearer in the child's acquisition of conventional linguistic symbols. A child in Quine's (1960) famous "Gavagai" situation has no way of figuring out for itself the referent of a novel linguistic item. But in the real world young children learn new pieces of language almost always in highly contextualized, often routinized, mutually understood (i.e., intersubjective), nonlinguistic formats such as the feeding situation, diaper changing, book reading, taking a walk, or playing a game of peek-a-boo (Bruner 1983; Ninio 1985; Tomasello & Farrar 1986). These contexts are so replete with information about adult intentions – from the child's past experience in similar situations, as well as from the adult's current direction of gaze, tone of voice, and specific behaviors toward objects – that they even support the acquisition of words for referents that are not perceptually present. Thus, children in their second year of life learn most of their words for actions (verbs) as adults are either telling them what to do or anticipating their impending actions (Tomasello 1992a). Even though no action is perceptually present when the adult utters the word, young children learn words in these situations nonetheless, and in some cases, better than they do in ostensive contexts (Tomasello & Kruger 1992). Some very powerful skills of perspective-taking are clearly at work here, as children in these situations must understand the adult's intentions in a way that allows them to determine the adult's focus of attention outside the immediate perceptual context. Strong evidence for this view is the positive correlation between young children's joint attentional skills and their imitative learning of new linguistic symbols during the second year of life (Tomasello 1988; Tomasello & Farrar 1986; Tomasello & Todd 1983). The overall point is that there are a number of new behaviors that emerge at around 9 months of age that rely on the infant's ability to take the perspective of a person considered as an intentional agent – in terms of its perceptions and intentions – and imitative learning is just one manifestation of this skill.

The nature of the cognitive representation that results from imitative learning is, like other representations, at this point only a matter of speculation. In some cases in which children imitate a novel behavior they internalize their understanding of the model's behavior or behavioral strategy. This is especially apparent when infants reproduce object-directed actions and linguistic symbols only well after adults have demonstrated them (deferred or delayed imitation), which they do from the age of 9 months (Meltzoff 1988a). Deferred imitation of this type would seem to indicate that something of the model itself, not just the child's immediate reaction to the model, is

internalized and retained. Our hypothesis, for which we have no evidence at this time, is that internalization of the adult model occurs in those cases in which children have made a special effort to take the perspective of the adult – most probably when the child is not succeeding as desired while the adult is succeeding, or else when the model surprises the child by doing something cognitively novel. The internalization of learning that takes place on such occasions results in a cognitive representation in which the child represents adult behavior in terms of the simple perspective of an intentional agent.

2.2. Instructed learning. Adults attempt to instruct children practically from birth and children learn more and better in many situations because of this instruction. Not all of these interactions, however, are cultural learning as we define it. Much of children's learning in pedagogical contexts at all ages is really social learning; that is, the child learns about the task individually, with assistance from the fact that the adult has structured and drawn attention to it in ways that facilitate learning. For example, an adult may place a puzzle piece directly adjacent to its appropriate location, helping the child make the individual discovery. The product of this "scaffolding" process is in many cases the child's improved understanding of the task, and there are many ways adults may scaffold children to facilitate their understanding and performance (Gauvain & Rogoff 1989; Goncu & Rogoff 1987; Heber 1981; Ratner 1984; Wood & Middleton 1975; Wood et al. 1978).

Instructed learning as we define it involves more than the child's learning by means of adult task simplification. Whereas in scaffolded learning children learn about the task, with the adult in the background providing help, in instructed learning children learn about the adult specifically, about the adult's understanding of the task and how that compares with their own understanding. As the adult regulates the child's performance, usually through intentional speech acts that occur at critical decision-making junctures, the child tries to understand that regulation from the adult's point of view, that is, to enter into an intersubjective understanding of the task. The cognitive operations children engage in to relate the adult's understanding to their own task understanding are represented in the cognitive product, and are later reenacted in other situations as a Vygotskian dialogue between the two perspectives. In some cases it may be difficult or impossible to distinguish instructed learning from scaffolded learning, because in both cases there is social interaction and juvenile learning. In many cases, however, they may be distinguished by the fact that in instructed learning children later reenact the adult's instructions overtly in regulating their own behavior when faced with the same or a similar situation. This takes the form of such things as performance monitoring, metacognitive strategies, or, most clearly, self-regulating speech. The child's reenactment of the adult instructions would seem to indicate without question that he has attended to and understood them in the original learning context, and that in so doing he and the adult have achieved some form of intersubjectivity in the task situation.

It is important to emphasize that self-regulating behavior is *not* simple mimicking of adult instructions as an accompaniment to behavior. Self-regulation represents a flexible functional system that involves decision-making processes reflecting at least two perspectives. Thus, a 2-year-old child who reaches toward the electrical outlet but then inhibits that reach and shouts "No!" to itself is actually avoiding the outlet for other reasons (e.g., past punishment) and the speech does nothing to actually regulate the behavior. The utterance "No!" is thus not the coordination of two perspectives, or true self-regulation, but simply the performance of two parallel activities, each elicited by the current context (Diaz et al. 1991). In a series of studies directed specifically at the self-regulating function of children's self-directed speech, Luria (1961) found that the self-directed speech of 2- and 3-year-old children was not well coordinated with their behavior in difficult problem-solving situations. It was in fact not regulating their behavior at all but only accompanying it, as demonstrated by children's repeated disregard of their own self-directed speech. From around their fourth or fifth birthdays, however, children in Luria's studies did demonstrate an ability to use their speech to actually regulate their behavior; they coordinated their self-regulating speech with their task behavior in a dialogic manner.

The simple presence of metacognitive strategies or self-regulating speech is not direct evidence of instructed learning, of course, if we do not have evidence that the regulation was appropriated from an instructor. Despite a lack of clear correlations between adult instruction and child learning in all cases, there is some evidence that in this same age range, 4 to 5 years, children are in some contexts capable of internalizing adult behavior and instructions. Ratner and Hill (1991), for example, found that children of this age are able to reproduce the instructor's role in a teaching situation weeks after the original pedagogy. There is also evidence of a correlation between instructor and learner behavior in preschool children. Kontos (1983) found that children who were instructed in how to solve a problem by their mothers showed increases in the amount of self-regulating speech (strategy verbalizations) in their subsequent individual problem solving (relative to children who are not instructed). There is even some experimental evidence that manipulating the style of adult instruction may lead to changes in the amounts of self-regulating speech children use in their subsequent individual attempts in the same problem situation (Goudena 1987).

In our view, then, it is not until children reach approximately 4 years of age that they show evidence of instructed learning, if what is meant by this is the internalization of adult instructions. Recent studies have shown that a variety of self-monitoring and metacognitive skills in cognitive tasks emerge near the end of the preschool period and play an indispensable role in the child's acquisition of many of the most valued skills of Western culture, such as reading and mathematics (DeLoache et al. 1985; Diaz et al. 1991; Palincsar & Brown 1984; Saxe 1991). It is also interesting that during this same age range informal observations reveal children first showing evidence of spontaneous efforts to teach or regulate the learning of others, behaviors of relevance here because self-regulation is, in a sense, teaching oneself.

The social-cognitive bases of instructed learning can be seen in a number of other new behaviors that emerge at around this age. Around 3 to 4, children do things in a

variety of settings (including experimental ones) that demonstrate their nascent understanding of other persons as mental beings with their own individual beliefs, which may be either correct or incorrect and which may be either the same as or different from their own beliefs. The first tentative evidence of this is at around 3 years of age when children first begin to use words that refer to the thoughts and knowledge of others (Shatz et al. 1983). But close inspection of the early use of these terms shows that they do not really refer to mental states at all but simply reflect rote formulae such as "you know" and "I think so" (Shatz et al. 1983). Three-year-olds also begin trying to deceive others, apparently displaying their understanding that others may have beliefs that differ from their own (Chandler et al. 1989). Subsequent research, however, has shown that children of this age often do not understand the effect of their deception on the mental states of the one being deceived; what is going on is something simpler than true deception, something that does not rely on the attribution of mental states to others at all (Sodian et al. 1991).

By 4 years of age children are producing language that clearly refers to mental states and they are deceiving others with full knowledge of its effect on *their* mental states. More important for current purposes, it is at around this same age that children also begin to behave in adultlike ways in the false-belief task by successfully predicting what another child will do when given information the subject child knows to be false. This demonstrates even more clearly children's newly emerging ability to understand that others have mental states differing from their own and, possibly, diverging from the real situation as well (Wimmer & Perner 1983). The 4-year-old child in the false-belief task clearly conceives of other persons as mental agents who have, in addition to the perceptions and intentions of intentional agents, their own individual thoughts and beliefs that guide their behavior, and which, in some circumstances, may be compared and contrasted to the child's own thoughts and beliefs. This is what current theorists mean when they say that the 4-year-old child has for the first time a "representational theory of mind" (see, e.g., the papers in Astington et al. 1988).

Again, it does not require great insight to see that to learn from an instructor culturally – to understand the instruction from something resembling the instructor's point of view – requires that children be able to understand a mental perspective that differs from their own, and then to relate that point of view to their own in an explicit fashion. Without some such cognitive processes, children will only be able to learn individually or socially from, or perhaps to imitate, an adult instructor; they will not be able to engage in instructed learning. Both the false-belief task and instructed learning require the understanding and comparison of the perspectives of two mental agents (one of whom is the self) with differing perspectives on the same situation. The difference is simply that in the false-belief task these perspectives are in conflict with different information, whereas in self-regulated learning they are in dialogue with different roles. It is thus only at around 4 years of age, at the same time they are learning to deal effectively with the false-belief task, that children begin to internalize their understanding of an alternating and coordinated dialogue of mental perspectives and use this dialogue to self-regulate their ongoing cognitive activities.[3]

What is internalized in instructed learning is, as Vygotsky emphasized, a dialogue. In the learning interaction children understand the adult regulation (instruction), but they do so in relation to their own task understanding, which requires a coordinating of the two perspectives. The cognitive representation that results, therefore, is not just of the instructions but of the intersubjective dialogue. This dialogue does not occur at all task junctures in most cases; at many points the child is simply learning about the task with the assistance of adult scaffolding. Our hypothesis is that the adult regulations most likely to be appropriated by the child into an internal dialogue are those that come at difficult points in the task, that is, when the child and adult are not mutually focused on the same aspect of it. This discrepancy becomes apparent to the child through his attempts to understand the adult's instructions. The attempt to reinstate intersubjectivity in this way takes the form of a dialogue; it is this dialogue that the child internalizes and retains for use in future encounters with the same or a similar task. At least some evidence for this hypothesis is provided by the finding that self-regulating speech is used most often by children at difficult points in problem-solving tasks (Goodman 1984). And as in the case of delayed imitation, the delayed reproduction of adult instructions, as evidenced by self-regulating speech that occurs only some time after the original pedagogical interaction, is powerful evidence of internalization.

We should also mention at this point that imitative and instructed learning often interact in very powerful ways. Thus, in many cultures, and on many occasions in Western cultures, children are instructed by means of nonverbal demonstrations. Our depiction of instructed learning in terms of dialogues and self-regulating speech would thus seem somewhat inappropriate for these cases (e.g., Greenfield & Lave 1982; Rogoff 1990). But it must not be forgotten that adults are still instructing youngsters in most of these cases by something like the directive to "watch this," either explicitly or implicitly conveyed, as they perform some activity. The adult then highlights, perhaps by nonverbal means, those aspects of the performance that the child is to attend to and monitors the child's attention (redirecting it to the task at hand if necessary): The child understands, at least to some extent, those attentional directions. Our contention in these cases is that the child attends to and internalizes the nonverbal instructions, even if these are simple indications of the "watch this" variety, where there is an implicit and growing understanding of what the "this" refers to, which in turn constitutes the intersubjectivity involved. When the child then engages in the skill on his own, he uses the nonverbal directives of the instructor to guide his own performance in the same way that he might use the instructor's verbal instructions on other occasions.

2.3. Collaborative learning. Imitative learning and instructed learning are means of cultural transmission: By modeling or instruction the adult passes to the child valued elements of the culture. Collaborative learning is different. Collaborative learning takes place when neither interactant is an authority or expert; the intersubjectivity is symmetrical. Two peers work together to solve a

common problem and, in arriving jointly at a solution, they coconstruct knowledge, as in most cases of scientific collaboration. They then individually internalize this coconstruction. Collaborative learning is thus distinct from the other two processes of cultural learning in that it is a process of cultural creation or coconstruction rather than transmission.

There are many situations in which children of preschool age collaborate. Young children can play cooperatively with peers, often by imitating each other (Eckerman et al. 1989), and they may jointly construct a theme for their play (e.g., Eckerman & Stein 1982). Preschoolers may even coordinate their actions with each other to solve a problem (Brownell & Carriger 1990). It is not clear in any of these contexts, however, that the children are learning anything from the collaboration per se. That is, though the children may be learning individually about how to play with each other or how to solve a particular task, they are not coconstructing new knowledge about the task which is then individually internalized. Collaborative interactions of the type performed by preschoolers thus do not constitute collaborative learning as we define it.

In support of this view, it is well-known that preschoolers experience little if any specific cognitive benefit from peer interaction in such shared tasks as computer program use (Perlmutter et al. 1989) or block building (Azmitia 1988). This is often because rather than collaborating, preschoolers tend to simply act in parallel or, at best, to divide the labor. A variety of studies have shown that young children who learn from peer interaction are not those who act in parallel or divide responsibilities but rather those who share with their partners in the task: engaging in joint planning, responding to each other's ideas, asking for clarification when necessary, and engaging in more discussions of the effects of their joint activity (Azmitia 1989; Behrend & Resnick 1989; Phelps & Damon 1989).

Collaborative learning in school-age children, on the other hand, is a well-established phenomenon. Studies have demonstrated repeatedly that for children of this age problem solving with a peer, even one who is no more knowledgeable than oneself, often leads to greater task understanding than problem solving alone or in the context of instruction. In the case of Piagetian conservation tasks, for example, peer interaction between two nonconserving children results in an understanding of the principle of conservation far more often than the situation in which the child works on the problem alone (Ames & Murray 1982; Doise & Mugny 1979; Glachan & Light 1982). This is possible because the nonconserving peers are often focusing on different aspects of the problem – one saying that the water in the new beaker is higher and the other noting that it is thinner, for example – which together provide a sufficient solution. These competing perspectives come to light in the interaction, and in an effort to reach a consensus the children integrate the perspectives, coconstructing a new perspective, and achieve a greater task understanding (Perret-Clermont & Brossard 1985). A similar process occurs in the social-conventional domain when school-age children discuss moral issues with peers. Compared to their discussions with adults, which tend to be asymmetrical discussions directed by adults, when interacting with peers children engage much more in symmetrical conversations that feature reasoning used to analyze the other subject's thinking and perspective, so-called transactive discussions (Kruger & Tomasello 1986). There is also good evidence that the transactive discussions typical of peer conversations are essential to the development of school-age moral reasoning skills (Kruger 1992).

It is important in establishing the distinct style of intersubjectivity characteristic of collaborative learning that in neither the conservation nor the moral reasoning cases do subjects know the final solution ahead of time, nor can they discover it, in most cases, on their own. The learning is thus not a matter of imitative or instructed or individual learning. In the case of conservation, for example, children's explanations are typically not duplications of those offered by their partners; they each construct their own understanding of the task based on, but not directly reflecting the content of, the collaboration. And in the case of moral judgment, Kruger (1990) found that the transactive discussion of solutions that are ultimately rejected by dyads is more important to cognitive growth than the discussion of accepted solutions (cf. Bearison et al. 1986; Dimant & Bearison 1991; Forman & Kraker 1985). The coconstruction characteristic of collaborative learning is thus in many cases the result of sociocognitive conflict, which is manifestly neither imitative, instructed, nor individual learning.[4]

The social-cognitive bases of collaborative learning are manifest in children's changing conception of a person that emerges at around 6 or 7 years of age. It is not until this age that they become able to understand more complex, second-order mental states,[5] for example, the fact that "Mary thinks that I think John is cute" (Perner 1988; 1991). This relies on the ability to simulate mental agents embedded within one another reflexively, that is, on the concept of persons as reflective agents. Collaborative learning as we conceptualize it relies on precisely this kind of thinking in which the partner's acts toward me and mine toward the partner are simulated recursively at the same time in an integrated fashion, not in alternating dialogue as in instructed learning. In collaborative learning children must be able to criticize another child's criticism of their previous suggestion if they are to engage in a coconstruction process. Such recursive interaction is also necessary if the perspective of both reflective agents are to be synthesized into a single overarching cognitive representation that includes the perspectives of both participants. Although there are no studies that precisely affix the age at which children are first able to engage in collaborative learning, we do know that they can engage in reflective and recursive dialogues and coconstruction from at least 6 or 7 years of age (Kruger & Tomasello 1986; Mugny & Doise 1978), around the same age when they begin to use reflective and recursive language spontaneously. These two sets of skills emerge together, in our analysis, because the social-cognitive foundation of collaborative learning is the child's ability to understand in an integrated fashion the mental perspectives of two or more reflective agents.

As with the other forms of cultural learning, we hypothesize that in collaborative learning individual subjects appropriate into their own cognition a representation of those parts of the learning experience that require active efforts at perspective-taking. Collaborative learning

would seem to be special in this regard, however, because virtually the whole of a collaborative-learning experience involves, by definition, coconstructions in which both participants make specific efforts at intersubjectivity. Retention of the coconstruction from the original learning situation, therefore, always involves to some degree retaining the partner's perspective. The resulting cognitive representation thus involves an integration of all perspectives from the collaborative interaction, none of which is individually sufficient, into one intersubjective conceptualization that meets all the task demands simultaneously (and this may be accomplished in different ways). It is important that this single conceptualization is in some instances not used by the child at all during the original learning interaction, but only in subsequent individual performance. This is once again strong evidence that internalization has taken place.

Note also that in addition to its role in the creation of cultural novelties there are some interesting cases of collaborative learning in which the conditions of coconstruction are so similar for the children within a culture (and conceivably across cultures) that normal peer interactions lead them to coconstruct very similar conceptualizations, and this in a way contributes to cultural "transmission." It is thus possible, for example, as Piaget argued, that Western moral concepts are coconstructed by children with peers, but that given their similar starting places as members of the same culture at the same developmental period, most children construct roughly the same concepts, and this may even persist to some degree across generations. (It is just this inevitability of outcome given certain initial conditions that many teachers exploit as they encourage children to engage in collaborative learning activities with peers.) In this way, then, collaborative learning, in addition to its role in facilitating the innovation of cultural novelties, may also contribute to the maintenance of cultural traditions – albeit in a different way than the other forms of cultural learning.

2.4. Social-cognitive bases of cultural learning. We would argue from this brief review that children's social-cognitive and cultural learning abilities are intimately related. The form of cultural learning that children are capable of engaging in depends on the form of social cognition they are capable of engaging in, quite simply because when children are learning through another person, how they conceive of that person is an integral component of the basic learning process. And though it is likely that the cultural learning experiences that depend on the concept of person in this way comprise only a small minority of all learning experiences in human ontogeny, it is our contention that they are absolutely crucial for the acquisition of many of the most important cultural skills, including language and many of the basic skills in which youngsters receive intentional instruction from adults.

In order to make our argument we have elaborated a three-step ontogenetic sequence involving increasingly adultlike concepts of person. Because this view does not match precisely with any of the theoretical formulations currently available in the literature on children's social-cognitive development, we must say a word in its defense by comparing it with them. First, although we have found the classic "theory-of-mind" findings immensely useful (e.g., Astington et al. 1988; Gopnik 1993; Whiten 1991), we have not found it particularly useful to theorize in those terms. This is mainly because the theory-of-mind view does not have a strong developmental basis in children's understanding of other persons as it changes from infancy through childhood: The theoretical vocabulary only allows for a transition from "no theory of mind" to "theory of mind" at around age 4, with perhaps some "precursors" prior to that (see, e.g., Meltzoff & Gopnik 1993; Wellman, in press). This view of development is simply too restrictive for current purposes, placing altogether too much emphasis on the transition at age 4. Nor have we found particularly useful the closely related metarepresentational view (e.g., Leslie 1987) in which developmental changes in social cognition are attributed to developmental changes in the computational power of human cognition at age 4. In addition to the exclusive focus on the single age change, there is also in this view a serious neglect of the social dimension of the cognitive processes involved.

Theories based on the child's simulation of the mental states of others (e.g., Gordon 1986; Harris 1991) have the advantage that different levels of simulation might be described and related to development. Although this has not been done in any systematic fashion, what we have been referring to as perspective-taking could easily be described as the simulation of the perspective of other persons, who might be conceived of in different ways at different developmental periods. We like this formulation. The problem is that the simulation view is often understood to mean that children must first understand their own intentional states before they may use them to simulate the perspective of others. This is clearly not the case empirically – children do not understand their own mental states before they understand the mental states of others (Gopnik 1993) – and, in any case, our view is much more consistent with the opposite, more Vygotskian view that it is the understanding of other persons through social interaction that underlies the understanding of the self (Tomasello, in press). If the simulation view is understood only to claim that children imagine what another person is intending or thinking – and this imagining is not necessarily analogous to children's experience with their own mental states – then the simulation view is fully compatible with our view of social-cognitive development.

Even if the simulation view is compatible with our needs in the current context, however, to be fully adequate it would still need to be supplemented with an account of the child's developing concept of person such as the one we have offered here. Hobson (1987; in press) has been responsible for arguing most forcefully that the essence of human social-cognitive development consists in the changing concept of person. He argues that it is only by keeping this in focus that we can integrate findings from the developmental literature, including all ages from infancy through adolescence, with findings from research on children with social-cognitive disabilities such as autism. Using a variety of lines of evidence, Hobson reveals many of the inadequacies and unnecessary complications of the theory-of-mind and metarepresentational views. He does not have much to say, however, about precisely how the concept of person might change during human ontogeny.

Table 1. *Major features of the three types of cultural learning*

Cultural learning process	Social-cognitive ability	Concept of person	Cognitive representation
Imitative (9 months)	Perspective-taking (e.g., joint attention, social referencing)	Intentional agent (0 order)	Simple (other's perspective)
Instructed (4 years)	Intersubjectivity (e.g., false-belief task, intentional deception)	Mental agent (1st order)	Alternating/coordinated (other's and own perspective)
Collaborative (6 years)	Recursive intersubjectivity (e.g., embedded mental-state language)	Relfective agent (2nd order)	Integrated (dyad's intersubjectivity)

We have thus been forced to explicate for ourselves the different concepts of person with which children at different developmental periods operate. What we have come up with is intentional agent, mental agent, and reflective agent. In each case, the key is the psychological construct the child uses to understand and explain the behavior of other persons: intentions, beliefs, and reflective beliefs, respectively. In each case, there is independent evidence of the same psychological construct at work in other behaviors the child engages in at the same developmental period. Thus, to engage in imitative learning the child must understand the demonstrator in terms of his intentions toward things (i.e., as an intentional agent) in order to distinguish the relevant and irrelevant aspects of the demonstrator's behavior. The same understanding would also seem to underlie the child's early attempt to make social reference, to engage in joint attention, and to communicate intentionally with others. To engage in instructed learning children must understand instructors in terms of their thoughts and beliefs (i.e., as mental agents, what other theorists call a "representational theory of mind") in order to compare the beliefs of instructors with their own. This same understanding would also seem to underlie the child's ability to deal successfully with the false-belief task, which, in our analysis, involves these same comparison processes. Finally, to engage in collaborative learning the child must understand the collaborator in terms of his reflective thoughts and beliefs (i.e., as a reflective agent whose intentional states may refer to the child's own intentional states) in order to carry on the reflective dialogue necessary for true collaboration, as well as to engage in the recursive mental-state language also characteristic of this age.

Our summary of the proposed developmental sequence is presented in Table 1. The sequence is stagelike, but it is only meant to apply within the social-cognitive domain and any other domains that depend on basic processes of social cognition. Thus, a social-cognitive representation in terms of simple perspective-taking would seem to be a necessary precondition for a representation in terms of alternating/coordinated perspectives, which would seem to be a necessary precondition for a representation in terms of integrated perspectives. To put it another way, a reflective agent is a special type of mental agent, who is a special type of intentional agent. The developmental ordering depicted thus results in some sense from the logical dependence of these concepts on one another.

In addition to the developmental synchronies between the different forms of cultural learning and their associated social-cognitive concepts of person (as just reviewed), there are two other important lines of evidence for our claims. The first involves the social cognition and social learning of children who do not engage in social-cognitive activities in the normal human way, that is to say, autistic children. The second involves our nearest primate relative, the chimpanzee, who also engages in social cognition and social learning in its own unique way. We discuss these each in turn.

3. Autistic children

Further evidence regarding the developmental relationship depicted in Table 1 is provided by cases in which these abilities do not develop in the normal way. Most apposite is the unfortunate case of autistic children. Although persons diagnosed with childhood autism are a diverse group, the common denominator among all who share this diagnosis is problems in relating to other persons (Schopler & Mesibov 1986). Autistic children thus show little or no evidence of cultural learning; we believe that this is due to the absence, or seriously diminished quality, of human social cognition in this population.

Beginning with the clearest case, it can be stated with confidence that the vast majority of autistic children do not engage in collaborative learning. Although we are aware of no studies that specifically test for their collaborative learning abilities per se, one robust and recurrent finding is that throughout their development autistic children show significant deficits in their ability to interact with and relate to peers (see Lord 1984, for a review); we are not aware of any observations of autistic children that demonstrate anything beyond very minimal behavioral coordinations with peers. In our hypothesis, the lack of collaborative learning occurs because autistic children do not conceive of others as reflective agents. Evidence that they do not do so is provided by their lack of reflective mental-state language (Loveland 1991) and their inability even to understand reflective mental-state language (Perner 1991).

A similar conclusion may be reached in the case of instructed learning. Autistic children are certainly capable of learning many things from adult instruction, but there are no observations we are aware of that show any

evidence of the internalization of this instruction in the form of a dialogue between the self and the instructor. We have seen no reports of self-regulatory speech in autistic children (which is not the same thing as simply talking to oneself, which they do) or any other forms of metacognition or self-monitoring. In fact, it is a general observation that autistic children are not facile at following social rules and, *a fortiori*, at using rules to regulate their own behavior (Hermelin & O'Connor 1970). In terms of social cognition, instructed learning relies on conceiving of others as mental agents, as best diagnosed by performance in the false-belief task; it is well known that autistic children as a group do not perform well in this task, indicating an atypical conception of others as mental agents (Baron-Cohen et al. 1985).

Imitative learning presents a slightly more complex case and may depend on the autistic child's level of functioning. A basic finding is that autistic children have much difficulty in reproducing any behavior that is novel (Dawson & Adams 1984; Jones & Prior 1985; Stone et al. 1990).[6] It is thus not surprising that roughly half of the children diagnosed as autistic never learn to use language at all, and few if any use language normally (Boucher 1976; Sigman & Ungerer 1984). In general, although their echolalic (mimicking) tendencies are well known, autistic children have great difficulty in imitating meaningful symbolic behaviors in appropriate contexts (Hammes & Langdell 1981), belying in many cases a superficial understanding of how people use language to achieve communicative goals (Tager-Flusberg 1993). Thus, for example, they use their language much less than do normal children simply to show or indicate an object to another person (Baron-Cohen 1991), and they show serious deficiencies in providing adequate descriptions of situations for naive interlocutors in novel situations (Loveland et al. 1990). Perhaps most telling of all are autistic children's notorious difficulties with *I* and *you* (e.g., Loveland 1991), which require a special adaptation of imitative learning.

Consistent with their difficulties with imitative learning, autistic children also have significant problems with joint attention and perspective-taking. They show a number of deficits in the ability to jointly attend to objects with others (Loveland & Landry 1986), and they engage very little in symbolic or pretend play, which in many cases involves adopting the role of another (Wulff 1985). Some high-functioning autistic children can follow the gaze of another (Hobson 1984), indicating some degree of perceptual role-taking in this subgroup, but lower-functioning autistic children are very poor in accommodating to another's perceptual perspective (Loveland et al. 1991). Langdell's overall conclusion (cited in Baron-Cohen 1988) is that autistic children as a group have "difficulty in taking another person's point of view."

The most significant finding relevant to the current hypothesis is that individual differences in joint attentional abilities of autistic children are systematically related to their ability to learn new linguistic symbols, in the same way that these two abilities are related in normal children. Two independent teams of investigators have found that autistic children who showed greater abilities in joint attention with an adult have more advanced language skills (Loveland & Landry 1986; Mundy et al. 1990). It has also been observed that autistic children who are better at perspective-taking display more pragmatically appropriate social skills of all types, including language (Dawson & Fernald 1987). Because autistic children differ from one another so greatly in their various abilities and disabilities, these very specific correlations would seem to indicate quite strongly that the imitative learning of a particular autistic child is in large measure a function of his ability to take the perspective of the person from whom he is learning.

The deficits in the social-cognitive and cultural learning capacities of autistic children are thus intimately related. Autistic children have deficits in the way they conceive of other persons; as a consequence they do not learn from or through them normally. Most autistic children do not simulate mental or reflective agents, and thus do not engage in instructed and collaborative learning at all. Autistic children vary in their ability to take the simple perspective of intentional agents and in their ability to imitatively learn from others. These findings are consistent with Loveland's (1991) overall characterization that most autistic children are basically acultural, reflecting a general deficit in the ability to acquire culturally conventional human behaviors.

4. Chimpanzees

A third line of evidence concerning the relation between social cognition and social learning is provided by our nearest primate relatives. The case of chimpanzees has some similarities to that of autistic children in that neither has certain social-cognitive and cultural learning abilities that normal human children have, and these seem to be selectively present or absent in general conformity with our developmental account. The case of chimpanzees presents an interesting twist, however, because chimpanzees that have been enculturated by human beings in various ways (including exposure to humanlike systems of communication) seem to have more humanlike social-cognitive and cultural learning abilities.

To begin again with the most clearcut case, it may be said with confidence that chimpanzees do not engage in collaborative learning. Chimpanzee youngsters may learn to pull together on a rope to obtain out-of-reach objects too heavy to be pulled in by either alone (Nissen & Crawford 1936; Yerkes 1943), and chimpanzees in a group often take on different roles when hunting and chasing colobus monkeys (Boesch & Boesch 1989). But neither of these is a case of true collaboration if what we mean by this term is a kind of coordination among animals in which each is aware of the role being played by the other(s). In the two reported cases, it does not seem to be the case that one animal ever monitors the efforts of another and gauges its own behavior accordingly, simultaneously assessing the effects of that behavior on the problem-situation of the other. The most plausible interpretation in both these cases is that each participant has determined what to do in the situation to increase its own chances of success in obtaining the object or capturing the prey, without specific regard for the other and its behavior. In any event, even if these are cases of true collaboration, there is certainly no hint in either case of collaborative *learning* in which two individuals coconstruct something new.[7]

Nor do we see clear cases of collaborative learning by

chimpanzees who have been enculturated by humans. Savage-Rumbaugh et al. (1978) report that their subjects were able to collaborate in solving a complex task requiring different roles for each performer (one had to decide what tool was needed and communicate this to the other, who had to retrieve the designated tool). But what is important for current purposes is that before engaging in this task both subjects were first trained by humans in each of the two collaborative roles; the test was simply to see whether they could play the roles with each other. Thus, all of the task *learning* occurred as a result of human training, not as a result of chimpanzee collaboration.

Neither wild nor enculturated chimpanzees learn collaboratively from other chimpanzees or humans, in our hypothesis, because they do not conceive of others as reflective agents – they do not mentally simulate the perspective of another person or chimpanzee mentally simulating their perspective. The problem, of course, is that this reflective ability is made manifest in human children mostly through linguistic formulations such as "She thinks that I think that . . ." It is therefore not clear what a nonenculturated, nonlinguistic chimpanzee could do to demonstrate such an ability, nor is it clear that enculturated chimpanzees have been given the linguistic tools or communicative opportunities to construct such linguistic expressions. Nevertheless, at this point in time there is no known evidence that chimpanzees, whatever their background and training, are capable of thinking of other interactants reflectively, or hence of collaborative learning.

With regard to instructed learning, it may be said quite simply that in their natural habitats chimpanzees do not actively instruct their young. The most one can say is that they prevent them from doing certain things, and, in some cases, they behave in ways that serve to facilitate certain juvenile behaviors. For example, Nishida et al. (1983) observed chimpanzee mothers taking poisonous foods away from their youngsters; Goodall (1986) observed that when mothers walk away from youngsters they often turn and wait for them, which seems to encourage attempts at independent locomotion; and Boesch (1991) recently observed two instances of mothers in the wild seeming to slow down their tool use when infants were watching. It does not seem in any of these cases, however, that the adult is intentionally attempting to instruct the young, as they do not persist in their behaviors until the youngster has reached a critical level of performance (cf. also Bard & Vauclair 1984).

Nor does there seem to be much (if any) intentional teaching among enculturated chimpanzees (Savage-Rumbaugh, personal communication). The one reported case of a chimpanzee who uses sign language to "teach" signs to its offspring (Fouts et al. 1989) is based on only a few anecdotal and potentially ambiguous observations of one adult chimpanzee. Regardless of the interpretation of these "teaching" behaviors, however, there is certainly no evidence in any of these cases that young chimpanzees are internalizing anything social or intersubjective from these interactions. Although there is no question that they can learn many things from human instruction, as can other animals, we are aware of no reports of self-regulating language in chimpanzees, or any other forms of cognitive self-monitoring that would suggest they have internalized the instructions of another chimpanzee or human. The only hints of this are in the well-known films of Washoe practicing her signs in a room by herself. It does not appear in any of the filmed cases, however, that she is using these signs to direct her own attention or behavior.[8]

Chimpanzees cannot internalize instruction and use it to regulate their own behavior, in our view, because they cannot conceive of others as mental agents having thoughts and beliefs that may be contrasted with their own. The most compelling evidence against this view is the observation of chimpanzees deceiving both conspecifics and their human caregivers (de Waal 1986; Woodruff & Premack 1979). [See also Whiten & Byrne: "Tactical Deception in Primates" *BBS* 11(2) 1988.] The interpretation of these observations is far from straightforward, however, as what are called deceptive behaviors may simply be behaviors learned associatively in specific circumstances as a way of bringing about or avoiding particular reactions from others (e.g., a fear grimace has in the past evoked aggression from others, and its hiding, discovered fortuitously, has deflected aggression from others). In either case, however, we would argue, as we have argued in the case of human children, that deceptive behaviors do not by themselves reflect social-cognitive abilities sufficient to support instructed learning; only a more stringent test such as the false-belief task provides such support. The closest approximation to such a test was conducted by Povinelli et al. (1990), who found that their human-reared chimpanzees were able to discriminate, after training, between a person who had acquired information about a food's location by watching its being hidden, from a person who had no such information because he was out of the room or had a bag on his head. Successful performance in this task, however, is not comparable with successful performance in the false-belief task: subjects in this task are not required to alternate between and compare two discrepant beliefs about the same situation. They are merely required to learn the cue (and huge amounts of training were required) as to which human is most reliably associated with the food. Until they can alternate and coordinate mental perspectives on the same situation, they will not be able to engage in self-regulated (i.e., instructed) learning.

The imitative learning of chimpanzees presents a complex and very interesting picture, and one that requires us to differentiate sharply between wild chimpanzees in species-typical environments and their human-reared and enculturated conspecifics. First with regard to wild chimpanzees, a number of behaviors in their natural habitats suggest the possibility of imitative learning (Goodall 1986). None of these survives close scrutiny, however, as other explanations based on individual learning and stimulus enhancement are possible in every case (Galef 1988; Tomasello 1990). Moreover, studies in more controlled environments have produced uniformly negative results. With respect to object-directed actions, Tomasello et al. (1987) and Nagell et al. (in press) found that nonenculturated chimpanzees did not learn tool-use behaviors by imitation. In both these studies chimpanzee subjects did benefit from observing a demonstration of tool use, but they did not learn the precise methods used by the demonstrator that would clearly show imitative learning; in both studies the chimpanzees used the tool in the same way regardless of the type of demonstration they observed. Human children also participated in the more

recent of these two studies and did learn the methods of the demonstrator, as evidenced by the different methods they learned to use in the two different modeling conditions. In both studies, the chimpanzees simply were learning that the goal could be obtained with the tool – they were emulating – whereas the human children were learning something about the demonstrator's strategies in using the tool – they were imitating.

Other observations of less complex behaviors suggest a more optimistic appraisal of the imitative learning of nonenculturated chimpanzees. For example, de Waal (1982) reported instances of youngsters walking like an injured groupmate; there are also some communicative gestures that suggest the possibility of imitative learning (McGrew & Tutin 1978; Nishida 1980). The most serious problem for current purposes is that these are all naturalistic observations in which it is impossible to tell whether two animals behave similarly for reasons other than imitative learning, for example, they experienced similar environmental learning conditions in the past. It is also impossible to tell whether the behavior involved is a novel one for the learner or an already known one that is simply evoked by the sight of its performance by another animal (and thus not imitative *learning*). Moreover, Tomasello et al. (1989; 1992) found that most, if not all, the intentional gestures of chimpanzees are learned through the individual learning process of conventionalization, involving the "shaping" of gestures through repeated interactions with others; few, perhaps none, are learned through the imitation of conspecifics (cf. also Tomasello et al. 1985). Finally, it is telling that almost every one of the anecdotal observations judged to be a case of true imitation by Whiten and Ham (1992) concerns chimpanzees enculturated in various ways by human beings. Our overall conclusion, therefore, is that in general imitative learning is not a social learning process that chimpanzees engage in with regularity in their species-typical environments.[9]

The case of imitative learning in enculturated chimpanzees provides a very interesting contrast. There are two experimental studies of the imitative abilities of enculturated chimpanzees (cf. also the anecdotes summarized in Whiten & Ham 1992). Hayes and Hayes (1952) showed their enculturated chimpanzee Viki and a nonenculturated chimpanzee Frans behaviors that they knew to be novel for them. Although the control conditions required to rule out other forms of social learning were somewhat weak in this study, the Hayeses concluded that Viki's behavior indicated the imitative learning of various object-directed actions, whereas Frans's behavior did not. Tomasello et al. (in press) performed a similar experiment with not only enculturated chimpanzees and nonenculturated chimpanzees but human children as well. In this study, novelty of behavior (and thus learning) was insured both by a priori judgments (some very unusual activities were demonstrated) and by the fact that each action was paired with a control action with the same object; there was also a baseline free play period with each object. The coding of subject behavior (only actions not produced in the free play or control conditions were counted) indicated whether subjects reproduced the results of the action and whether they reproduced the demonstrator's means of execution. Overall, it was found that the enculturated chimpanzees were as successful as 2-year-old children – and much more successful than nonenculturated chimpanzees, who were successful very infrequently – in reproducing both the ends and means of experimental demonstrations of novel object-directed behaviors. Moreover, these chimpanzees had received no specific training directed at imitative learning earlier in their lives; they had just been brought up in humanlike environments with a great deal of social and linguistic interaction around objects (which did, of course, include some social encouragement and reinforcements for doing things that were modeled for them). It is also important that the pygmy chimpanzee Kanzi (and at least one common chimpanzee since) has acquired humanlike symbols through observation, with little direct training of any kind, suggesting skills of imitative learning in this domain as well (Savage-Rumbaugh et al. 1986).

To be consistent with our hypothesis, the perspective-taking skills of enculturated and nonenculturated chimpanzees should show distinct differences. The problem is that there is very little solid research. With regard to nonenculturated chimpanzees in species-typical environments, it should first be noted that wild chimpanzees perform a number of behaviors suggestive of an ability to take the simple perspective of others, for example, they routinely use the gaze direction of others to discover interesting things in the environment (de Waal 1982; Menzel 1971). As in cases of deception, however, simpler explanations are possible, that is, the gaze direction of others may be used as a simple associative cue; individuals have learned that looking in the direction in which another is looking is often rewarding. However, following the gaze direction of others is manifestly not sufficient to support imitative learning – to learn from another imitatively the learner must take the perspective of the other as an intentional agent with perceptions and intentions, not just use the other's gaze direction as a cue. It should also be noted that chimpanzees' use of gaze following is extremely limited as compared with its use by human infants (Bard & Vauclair 1984). (Preliminary results from a more systematic ongoing investigation corroborate this result; MT and collaborators.)

Chimpanzees enculturated by human beings seem to show more sophisticated skills of perspective-taking. This is documented daily by Kanzi and other enculturated chimpanzees as they routinely anticipate the goals and intentions of their human caregivers (personal observations – MT; cf. also reports on the joint attentional skills of enculturated gorillas by Gomez 1991). In line with this, and in a more experimental vein, Premack and Woodruff (1978) found that their enculturated chimpanzee Sarah was able to choose correct solutions to the videotaped predicaments of other human beings which required her, in their analysis, to take the human's point of view. Although there may be disagreement about what was required of chimpanzees in this task, it would certainly seem that more than simple gaze following was required. Once again, preliminary results currently in progress (MT and collaborators) from a direct comparison of the joint attentional abilities of enculturated and nonenculturated chimpanzees suggest that the joint attentional abilities of enculturated chimpanzees far outstrip those of their nonenculturated counterparts.

There are very difficult methodological issues embedded in all of this, and we must be careful not to use a

double standard, one with humans and another with chimpanzees. However, using a common set of standards we believe that enculturated chimpanzees meet the main criteria used with human children in demonstrating simple perspective-taking skills, relying on the conceptualization of others as intentional agents, but that nonenculturated chimpanzees do not. As a result of these different social-cognitive abilities, the two types of chimpanzees show very different skills of imitative learning, with enculturated chimpanzees showing much greater skill in simulating the intentional states of others. This difference may be attributed, in our interpretation, to the fact that enculturated chimpanzees have been subjected to what Vygotsky calls the "socialization of attention": They have been raised in an environment in which joint attention to objects is a regular and important part of their social lives with their human caregivers. This has led them to develop more fully their latent capacities for engaging in joint attention and for taking the perspective of intentional agents. Their abilities of imitative learning are thus nothing more than the expression of their normal abilities of individual learning (which are presumably the same as those of their nonenculturated conspecifics) in combination with the skills of social cognition that have developed as a result of their human enculturation. The difference between chimpanzees raised in species-typical and humanlike environments thus provides another line of evidence for the correlation we are postulating: When chimpanzees are raised in ways that enhance their social-cognitive abilities, their imitative learning abilities are enhanced as a result.

Although we cannot review all of the evidence here, it is also important to note in this context that the correlation we have hypothesized between specific social-cognitive and cultural learning abilities holds up quite well when the behavior of our more distant primate relatives is examined. A variety of monkey species have shown something less than human or even chimpanzee abilities in terms of both social cognition (Cheney & Seyfarth 1990 [see also multiple book review, *BBS* 15(1) 1992]) and cultural, specifically imitative, learning (Visalberghi & Fragaszy 1990).[10]

5. Cultural learning and human culture

No one piece of evidence we have adduced is decisive. The synchronies between social-cognitive and cultural learning abilities in human ontogeny may be explained in more than one way, and the precise ages of emergence are not available for all key behaviors. The correlated impairment of social-cognitive and cultural learning abilities in autistic children may be explained in a number of ways as well, and once again the data are not as complete as we might like. The differences in the behavior of enculturated and nonenculturated chimpanzees clearly have multiple potential explanations, with more data on the social-cognitive abilities of chimpanzees of both types sorely needed, but we believe that together these three lines of evidence are telling. Children acquire a particular cultural learning skill at around the same time they are showing evidence of the logically related social-cognitive skill; when a form of cultural learning is missing in a child or other animal the corresponding form of social cognition is typically missing as well; and when the social-cognitive skills of chimpanzees are purposely enhanced in early ontogeny, new cultural learning skills become evident as a result.

With this argument in mind, we return to our original observation: Many animal species live in complex social groups, but only humans live in cultures. We must acknowledge at this point, however, that not everyone agrees with this claim when it is stated so baldly. A number of primate researchers, in particular, systematically downplay the differences between human social organization and the social organization of other species, using the terms "culture" and "cultural transmission" for a wide variety of primate behaviors (e.g., Goodall 1986; McGrew 1992; Nishida 1987). It is in fact widely believed in the scientific community that a number of primate species have "cultural traditions" that are, in all important respects, like human cultural traditions. In the best-known case, for example, a Japanese macaque invented a potato-washing behavior and then others in the group followed suit, with her close acquaintances acquiring the behavior first (Kawamura 1959). Similar observations have been made of a number of chimpanzee behaviors, for example, the termite fishing of the Kasakela group in the Gombe National Park (Goodall 1986).

In both of these cases the behaviors are learned, population-specific traditions, in the sense that they persist across generations in the population. But they are not, we would claim, cultural – at least not in the human sense of that term. They are not cultural in our view because they lack three essential characteristics. First, all human cultures have some cultural traditions that are learned by virtually all group members; any child who did not learn them would simply not be considered a normal member of the group. This is true of such things as language and religious rituals in many cultures, as well as more mundane subsistence behaviors having to do with food, dress, and the like. In the case of potato washing by monkeys or termite fishing by chimpanzees, on the other hand, there are many group members who never engage in the practice. In a period of over four years, barely half of the Japanese macaques learned to wash potatoes, and although no systematic data on the termite fishing of individual chimpanzees have been published, Goodall (1986) reports her general impression that not all group members participate. To our knowledge, there is not a single case of a primate behavioral tradition that is practiced by all group members (e.g., the chimpanzee grooming handclasp reported by McGrew & Tutin [1978] was practiced by 9 of 17 adults/adolescents observed – 9 of 27 group members when juveniles are included); in fact, in a recent survey of the behavioral innovations of primates, two prominent researchers concluded that across many primate species including chimpanzees: "Of the many [innovative] behaviors observed, only a few will be passed on to other individuals, and seldom will they spread through the whole troop" (Kummer & Goodall 1985, p. 213).

Second, the methods used by human children in acquiring cultural skills are highly similar to the methods used by adults. Children tend to accomplish concrete tasks in the way they have been shown, in using a hoe or weaving cloth, for example, with perhaps some individual idiosyncrasies. In the case of social-conventional behaviors such as linguistic symbols or religious rituals, individ-

ual discovery and idiosyncratic use are not viable options – these behaviors would not be functional unless the methods of the mature users were reproduced rather faithfully. Systematic observations on the similarity of potato-washing and termite-fishing techniques among individuals in the two primate groups are unfortunately not available, but many keen observers have noted that individual chimpanzees often use their own idiosyncratic techniques in all kinds of "cultural" behaviors from termite fishing (Goodall 1986), to nut cracking (Hannah & McGrew 1987), to grooming hand-clasp (McGrew & Tutin 1978), to communicative gesturing (Tomasello et al. 1989; 1992). Experimental results corroborate these observations (Nagell et al., in press).

The third unique characteristic of human cultural traditions derives from the second and is perhaps most telling. Human cultural traditions often show an accumulation of modifications over generations (i.e., the ratchet effect). Thus, for example, the history of hammerlike tools shows a gradual increase in complexity over time in human prehistory; the evolution of modern hammers in Western culture up to and including steam-driven pile drivers shows a similar increase in complexity over time (Basalla 1988). Although an increase in complexity is perhaps not the best way to characterize the history of human languages in the modern era, languages have presumably also become more complex during human phylogeny; and it is certainly true that in modern times they remain capable of substantial modification in only a few generations to meet the changing communicative needs of their speakers (Bates & MacWhinney 1979). The point is that although cultural traditions are generally passed on rather faithfully from one generation to the next, if a modification is made it is the modified version that is passed on to the next generation, just as faithfully as the original was passed on in earlier generations. The result is that human children are born into a world in which most of the tasks they are expected to master are collaborative inventions – either explicitly so because they were created by contemporaries who engaged in collaborative learning, or in the derived sense that many individuals over time have contributed to the current form of an artifact, convention, or skill. Other species of animal, including our nearest primate relatives, do not have behavioral traditions showing the ratchet effect, quite simply because they do not learn collaboratively in either of these two senses, thus precluding the possibility of humanlike cultural traditions that have "histories."[11]

These large differences in human and primate behavioral traditions may plausibly be attributed to differences in the social learning process. Thus, it is likely for a number of reasons that Japanese macaques do not learn to wash potatoes through imitative learning; rather, they learn to do so individually, as the original inventor did, after following a conspecific into the water while holding potatoes or while reaching for potatoes that are underwater (see Galef 1990, for more details of this analysis). Similarly, it is likely that chimpanzees learn to fish for termites individually by following their mothers to the termite mound where they are exposed to propitious learning conditions (e.g., a stick on the ground, termites crawling on the stick, holes to poke the stick into, etc.) along with the attention-enhancing effects of their mother's behaviors directed at the mound (see Tomasello 1990, for more details of this analysis). These interpretations are supported by the generally negative findings of laboratory studies of imitative learning in monkeys (Whiten & Ham 1992) and chimpanzees (Tomasello et al. 1987; Nagell et al., in press). Although nonimitative social learning processes may be perfectly effective for these species in these contexts, what it means for cultural learning is that there will be very little sharing of techniques among individuals and thus very little cultural transmission, strictly defined. Nonhuman animals maintain their behavioral traditions with social learning processes that are different from those used by human beings.

We thus answer Galef's (1992) question as to whether the behavioral traditions of nonhuman primates are actually homologous with human cultural traditions in the negative. We believe they are only analogous, with different evolutionary origins, not only because human and nonhuman primate behavioral traditions differ in the three general organizational characteristics outlined above, but also because they are maintained by different proximate mechanisms of social learning. It is our view, in agreement with Galef (1992), that cultural traditions of the human kind evolved only some time after humans and other apes began their distinctive phylogenetic histories.

We should also record at this point our skepticism that chimpanzees who have been raised within a human culture, if suddenly placed in a single group and left to their own devices, could or would create cultural traditions of the human kind. The problem is that their cultural learning skills are confined to imitative learning, and imitative learning by itself can accomplish only so much. The acquisition of many humanlike cultural skills necessarily involves extended pedagogical encounters in which the learner is instructed and internalizes the instruction, or, at the very least, it involves interactions in which the adult scaffolds the child's individual learning. This is true even of some skills that are acquired primarily through imitative learning – in many cases experts intentionally demonstrate behaviors for novices to imitate within an extended instructional interaction, sometimes in modified form or speed intended to assist the learner. Even in cases such as language acquisition, in which intentional teaching would seem to play a minor role, adults nevertheless speak to children in simplified ways that make the child's task of acquiring linguistic skills a more manageable one. It is therefore likely, in our view, that imitative learning by itself – without assistance from mature members of the culture who desire to instruct and learners capable of internalizing those instructions – could only lead to cultural traditions of some limited kind in some limited situations, and that in many cases they would not be stable over time because of the unreliability of encounters between learners and practitioners for many cultural tasks (cf. Bullock 1987). Thus adults' desire and skill to teach – an aspect of the cultural learning process that we have not highlighted here – is clearly an essential ingredient in the human evolutionary scenario; and the ability to teach depends, as we have argued previously, on an understanding of others as mental agents. Chimpanzees, even those who have been raised in humanlike cultural environments, do not, in our view, understand others in

this way. This means that they can neither teach nor internalize the instructions of others, not to mention learning from one another collaboratively.

Like many behavioral biologists, we believe that the primary evolutionary context in which primate cognition evolved was a social one and that most of the unique features of primate cognition are therefore adaptations to social problems such as communication, cooperation, competition, deception, and social learning (see the papers in, e.g., Byrne & Whiten 1988 and Whiten 1991; see also Whiten & Byrne "Tactical Deception in Primates" *BBS* 11(2) 1988). Primates are social strategists without equal in the animal kingdom. Our contention is simply that in this context human beings evolved species-specific social-cognitive abilities to understand the psychological states of conspecifics in terms of their perceptions and intentions, their thoughts and beliefs, and their reflective thoughts and beliefs, which allowed them to take the perspective of others and to participate with them intersubjectively. These processes of social cognition then led humans to the species-specific ways of learning from one another that we call cultural learning, which then kicked off the evolutionary and historical processes that led to the species-specific form of social organization known as human cultures.

6. Conclusion

Following the overall proposals of Tooby and Cosmides (1989), our goal has been to investigate the psychological mechanisms that underlie human cultures (cf. also Hinde 1987). We have focused on the processes of social cognition and social learning that make human cultures possible. To do this we have drawn not only on recent work in cultural psychology, which is based explicitly on the premise that human cognition is social and cultural to its core, but we have also drawn on recent work in the behavioral biology of primates, which is coming increasingly to recognize the decisive role played by processes of social cognition and social learning in the evolution of primate intelligence in general. It is also true, however, that many of the unique cognitive abilities of humans do not seem to have social foundations at all. Although it is of course possible that this is the case, and that human cognition is a complex admixture of social and nonsocial components, given the current working hypotheses of cultural psychology and the behavioral biology of primates it would be that much more exciting if it were found that many seemingly nonsocial human achievements have, in one way or another, social or cultural bases, as Vygotsky argued many years ago.

One relevant observation is that in many domains of human cognition we see systems, for example, the various systems of mathematics and the various grammars of human languages that have been created by human cultures. In the theory of Piaget (1985), and even more clearly in the theory of Karmiloff-Smith (1986), these systems are made possible by the fact that human beings have the seemingly unique capacity to treat their own behavior and cognition as "objects of contemplation" in their own right, a process Piaget calls reflective abstraction. Karmiloff-Smith has presented a very convincing theory of the dialectic of action and reflection in human ontogeny and has shown in a quite detailed manner how this process forms the basis for the human system-making ability in many diverse cognitive domains: The child behaves, and then observes and "redescribes" at a "higher" level his behavior and the cognitive organization it makes manifest. Systems of thought emerge from this reflective activity because self-observation uses all of the categorization and analytic skills that are used in perceiving, understanding, and categorizing the outside world. The result is thus the construction of more efficient and abstract cognitive systems as ontogeny proceeds.

We believe that this reflective process may be seen as another manifestation of the processes of social cognition and cultural learning we have been describing; it is cultural learning turned on the self. Thus, in some cases in which I am simulating the point of view of another person, that person is focused on me. I may attempt to learn through this simulation in the same way I attempt to learn through other simulations, and indeed this may be the major way in which I come to construct a concept of myself as an object in the world (Mead 1934; Tomasello, in press). In combination with human capacities for pretense and representation, however, I might also simulate the point of view of a "virtual other" looking at my behavior or cognition. In this case, I am not simulating a real perspective of another person, but simply "looking back" at some behavior just produced or at some cognitive organization already constructed *as if* I were another person looking at it. Thus, as Piaget has argued, basic mathematical concepts are most probably derived from subjects' reflections on their own actions on objects, such things as placing objects in groups based on perceptual or functional characteristics, ordering them in terms of some physical characteristic, or mapping them onto culturally provided counting systems. Tomasello (1992a) has argued similarly that children construct their early grammars as they reflect on their productive use of individual linguistic symbols, especially those with inherently relational content (e.g., verbs) that can serve as raw material for the construction of the basic grammatical categories that underlie the productivity of language as a communicative system.

Our speculation is thus that the evolutionary adaptations aimed at the ability of human beings to coordinate their social behavior with one another might also underlie the ability of human beings to reflect on their own behavior (cf. Humphrey 1983); the human system-making ability is, in Gould's (1982) terms, an "exaptation" from human social-cognitive abilities. And there may even be further cognitive manifestations of these basic social-cognitive processes. For example, the ability to consider simultaneously more than one perspective on a situation or object is a key human ability in many school-age skills such as conservation, seriation, and hierarchical classification. Perret-Clermont and Brossard (1985) have speculated that the crucial ability in these skills, at least in some derivative sense, may be social as well, in the sense that the children are taking multiple perspectives on things as if they were different people looking at them from different vantage points. This ability too, then, may be an exaptation of a social-cognitive process for more strictly cognitive purposes.

The overall point is that what are manifestly not social or social-cognitive domains of human intellect or activity may still be seen as emanating from a process that, in some sense at least, has its origins in social and social-cognitive adaptations. Human perception works very much like the perception of other primates, and in many ways the most basic processes of human categorization do as well (Oden et al. 1990). Where humans display their unique and most powerful cognitive abilities is in learning from others, in taking multiple perspectives on a situation, or in building cognitive systems based on self-reflection, and all of these rely, *ex hypothesis*, on the fundamentally social-cognitive process of taking the perspective of other persons and learning from that perspective-taking. This conjecture may thus be viewed as a kind of biological extension of Vygotsky's original hypothesis of the social origin of all of the "higher" human psychological functions. Whereas Vygotsky focused on the important role of the tools provided by the culture in the development of many human skills, we are focusing on the fact that individuals bring to ontogeny very powerful social-cognitive capacities that allow them not only to acquire those skills, but also to take multiple perspectives on things, including their own behavior and cognition.

We conclude, therefore, with a plea for more attention to the social and cultural dimensions of human cognition and learning. In the field of developmental psychology this is mostly preaching to the converted, as life after Piaget reflects a growing consensus that the social-cultural dimensions of human cognition cannot be ignored. But, with a few exceptions (e.g., Neisser 1991), most of the nondevelopmental theories of human cognitive psychology do not explicitly recognize social cognition in any but the most trivial ways. It is our view, however, that theories ignoring social cognition and focusing solely on "information processing" will never be able to account for the truly unique characteristics of human cognition and cognitive development, including the acquisition of language (Tomasello 1992b). It is to be hoped that a corrective force will soon be supplied by the emerging paradigm of cultural psychology. The theoretical accounts in this new approach have so far been very general, however, and have mostly focused on the deficiencies of accounts that ignore the contributions of culture and social context. Our attempt in this target article has been to give a more positive and specific account emphasizing the kinds of learning that are involved in the ontogenetic processes whereby individual human beings become members of cultures. We have thus focused more on the psychological side of the paradigm and less on the cultural side. It is noteworthy that our attempt is also relevant in the broader context of the behavioral biology of primates. We hope we are contributing to a Zeitgeist.

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NOTES

1. All of these terms carry theoretical baggage, but we should make clear that by perspective-taking we do not mean to refer specifically to the spatial perspective-taking of the Piagetian three-mountains task or to the conceptual perspective-taking of referential communication tasks, but more broadly to all the attempts of one person to understand or perceive a situation in the way that another person understands or perceives it. By intersubjectivity we mean the situation in which this takes place in both directions – but without the implication of Trevarthen (1979) that this occurs any time after birth that two human beings look at one another.

2. As Vygotsky has pointed out, if a mimicked behavior is responded to in certain ways by others it may acquire the function of the behavior originally observed. This would constitute a different route to the acquisition of a cultural skill: mimicking plus individual learning (see Pepperberg 1990 for an account of this type of learning).

3. Another way of viewing what is happening here is to say that the child is imitatively learning the instructor's instructions, and the use of those instructions at a later time is simply a case of deferred imitation. We would not quarrel with this interpretation, but would merely point out that what is special here is that the child must not only direct those instructions to himself, but he must also compare the perspective embodied in those instructions with his own perspective on the situation on a moment-by-moment basis as his engagement with the task proceeds. This requires social-cognitive skills beyond mere imitative learning.

4. Several theorists have speculated that certain cultural tasks are best acquired through instruction and others through collaboration (e.g., Damon 1984; Rogoff 1990). The key factor seems to be whether the task is a straightforward "skill," for which instruction seems best suited, or a task that requires a shift of perspective, in which case collaborative interaction seems most effective. This is an issue that needs further research, however.

5. We do not wish to embroil ourselves in the controversy over what should be considered a representation versus a metarepresentation or, what comes to the same thing, what "order" are the various types of social cognition. We would simply like to adopt the more conservative views of Perner (1988) in which first-order intentional states do not begin until the child attributes a mental state to another person; second order is thus the attribution to others of first-order mental states that happen to concern other mental states.

6. The use of modeling as a training technique for autistic children has enjoyed some success (e.g., Charlop et al. 1983), but the tasks used in these studies are in all cases very simple ones in which the child merely reproduces a known behavior.

7. A careful reading of the primary sources reveals that this same analysis also applies to the well-known example of the group hunting of wolves (Murie 1942).

8. The most impressive pedagogical performance of animals in their natural habitats is that of various cat species who bring to their offspring half-dead prey for them to chase and kill; this does seem to be intentional instruction in some form because mothers persist in this behavior until their youngster has acquired the target skill (Caro 1980). It is unclear in such cases of nonverbal instruction, however, what the learner takes away from the learning situation. See Caro and Hauser (1991) for a more generous interpretation of animal teaching.

9. It is interesting to note that the most convincing cases of chimpanzee imitation in the wild all involve behaviors not used in an instrumental way. Mimicking thus remains a very real possibility in all these cases – and mimicking may be based on much simpler learning mechanisms than imitative learning of behaviors directed toward some outside goal.

10. We clearly recognize the anthropocentric bias in all of this. Cultural learning and its three subtypes were taken directly from an analysis of human ontogeny; there are undoubtedly other social and cognitive skills nonhuman primates have that humans do not. All we can say is that the bias results from our primary interest with human beings in this target article. We are using other primates for comparison in order to understand

the human case more clearly. This strategy is becoming more widely accepted in the study of cognitive ethology (see, e.g., the papers in Parker & Gibson 1990). [See also Parker & Gibson, "A Development Model for the Evolution of Language and Intelligence in Early Hominids" *BBS* 2(3) 1979; and Chevalier-Skolnikoff, "Spontaneous Tool Use and Sensorimotor Intelligence in *Cebus* Compared with Other Monkeys and Apes" *BBS* 12(3) 1989.]

11. We have left out of account here the institutionalization of many human practices. It is often the institutionalized structure that the developing child encounters and the adult relies on. Unfortunately, this is a dimension of the problem that would take us far beyond our current aims.

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A developmental theory requires developmental data

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One of the strengths of the cultural learning hypothesis is the developmental perspective. Developmental changes in social learning and in perspective-taking are detailed for humans. Age simply ceases to be considered, however, when comparing "normal humans" to other subjects. In apparent zeal to confirm their theoretical stance, Tomasello et al. seem to apply a double standard. In fact, if all the human subjects were 4 years of age or less, the target article's title would not refer to cultural learning. It is a double standard to consider primarily 4-year-old chimpanzee subjects and conclude that chimpanzees do not have cultural learning.

The study of cooperation in pulling together to obtain a box was conducted with five chimpanzee subjects, all less than 6 years of age (Crawford 1937). Contrary to the view presented, all the chimpanzee subjects did learn how to cooperate. Moreover, four subjects, without tuition, watched their partner and modified their behavior in response to that of their partner. Two subjects indicated their knowledge of the necessary role of the partner by spontaneously soliciting action from them. The example of cooperation in a symbolic request task, with two chimpanzees, aged 3.5 and 4.5 years, also documented cooperation, but Tomasello et al. objected to the training.

The human infant is enmeshed in a teaching environment. From its birth, parents imitate the infant's actions and vice versa (Meltzoff & Moore 1977), and provide tutorial feedback (Papousek & Papousek 1987), attributing intentional communication before the infant communicates intentionally (e.g., Bard 1992a). These interactions must be recognized as the intensive teaching experiences they truly are. When a behavior occurs as a result of a program designed to provide learning experiences to chimpanzees, it is totally inappropriate to conclude that the chimpanzees' behavior is a product of extensive training whereas comparable behavior in humans is spontaneously learned. Chimpanzee infants rarely receive as much training as human infants. Although it is true that the social environment, more than species membership, influences neonatal orientation (Bard 1992b), it is equally important to learn how chimpanzees become enculturated into chimpanzee society. The double standard applied by Tomasello et al. reflects their indefensible position that humans are unique. The comparative developmental evolutionary perspective (e.g., Parker & Gibson 1990; see also Parker and Gibson "A Developmental Model for the Evolution of Language and Intelligence in Early Hominids" *BBS* 1(3) 1979) concludes that differences between human and chimpanzee subjects are of degree rather than of kind. Just for the record, chimpanzees are neither mentally retarded nor autistic.

In addition, Tomasello et al.'s conclusions from the chimpanzee literature differ markedly from those of the cited studies. To begin with collaborative learning, it is appropriate that the search begin with adult chimpanzee behavior. The level of collaboration among chimpanzees of the Tai Forest was evaluated by Boesch and Boesch (1989). Individuals adjusted their behavior in time and with spatial orientation to others. Almost 70% of the time, individuals adjusted their behavior in relation to the others' role. Individuals took roles that were complementary to the roles of others (the definitive characteristic of collaborative hunts and of collaborative learning according to Tomasello et al.). The hunting behavior of chimpanzees therefore qualifies as a true instance of collaborative learning.

It is interesting to reread Menzel's experiments on leadership in 4- to 6-year-old chimpanzees. In these descriptions, one can see how perspective-taking abilities develop and thus how collaborative learning can emerge in a chimpanzee group. An individual led the group to a goal, sometimes in competition with another who knew of a goal in a different location. Menzel concluded that sophisticated and subtle information was communicated in order for the group to end at the "better" goal. The leader monitored the behavior of others and changed his own behavior according to their behavior, indicting knowledge of the complementary role of the followers. These experiments clearly highlight the 4- to 6-year-old chimpanzee subjects' ability to attribute knowledge to others: The followers knew that the leader(s) knew the location of the food. Moreover, the leader was able to compare "the perspectives of two mental agents (one of whom is the self) with differing perspectives on the same situation," the defining characteristic of instructed learning according to Tomasello et al. Further evidence of chimpanzees' ability to coordinate perspectives, equivalent to that of 4-year-old humans, was found in these chimpanzees' ability to deceive. Repeated observations of "lying" were the "clearest evidence that the chimpanzees know what effect their own behavior was having on others (and varied it accordingly)" (Menzel 1974, p. 134). [See also Whiten & Byrne: "Tactical Deception in Primates" *BBS* 11(2) 1988.]

The second main point I wish to take issue with concerns instructed learning. It is *not* true that chimpanzees do not actively instruct their young. Goodall (1968), Plooij (1984), and Rijt-Plooij and Plooij (1987) all describe chimpanzee mothers teaching their infants the meaning of a communicative signal. The most detailed account of the mother's active teaching of a communication signal is the following:

> FD was walking on a rock (about 50 cm high) while FF was sitting out of contact but within arm's reach. Then FF stood up slowly, turned her back towards him and approached him while flexing her knees slightly and looking back at him with her lowered back closest to him. FD did not cling immediately and FF waited motionless while looking at him. Finally, he clung and FF walked a few paces to turn around and come back to the same rock to return him to the rock. Over and over she started travel in this way and when FD did not walk onto the rock himself, she placed him there. Finally, FD clung immediately whenever FF "signalled" by flexing her knees and looking back.

> Next, FF started the whole procedure again, with FD on the ground. She lowered her back by crouching onto the ground in front of him while looking back at him over her shoulder. Whenever FD seemed not to be looking at FF she would wait and, ultimately, gain his attention by touching him. When touched in this way he always responded by clinging immediately. "Signalling" in this context was also repeated several times and gradually slight variations were made. (Rijt-Plooij & Plooij 1987, p. 25)

Observations of Washoe engaging in "very subtle tutorial activity" (Fouts et al. 1982, p. 183) illustrate exactly the same adult chimpanzee capacity for instructed learning. The difference is that Washoe was teaching the ASL sign rather than the behavioral signal.

> For example, when Loulis was first introduced to Washoe, Washoe would sign "come" to Loulis and then physically retrieve him. Three days later, she would sign "come" and approach him but not retrieve him and finally, 5 days later she would sign "come" while looking and orienting towards him without approaching him (Fouts et al. 1982, pp. 183–84)

The cultural learning hypothesis integrates information from two theoretical perspectives, social learning and theory of mind. When applied as a developmental theory it appears to be quite powerful. There is a necessary requirement, however, that the developmental application be considered equally important for equally long-living species, such as chimpanzee and human.

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Are children with autism acultural?

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Tomasello, Kruger & Ratner open their target article with the provocative statement: "Many animal species live in complex social groups; only humans live in cultures," and repeat the claim at the end of their article (sect. 5). They define "culture" as having certain characteristic products (material artefacts, social institutions, behavioural traditions, and languages) that accumulate modifications over time and across generations. They call such modifications the "ratchet effect," arguing that "cultural learning" is necessary to live in a culture and that cultural learning requires degrees of mindreading or "theory of mind" ability, the developmentally earliest expression of which would be in joint attention. In section 3, they review some of the evidence that children with autism illustrate the cognitive links between early joint-attention skills and later, more sophisticated, theory of mind abilities, these children being impaired in both. This leads them to the claim that children with autism "show little or no evidence of cultural learning." The implication from their argument is that children with autism therefore do not live in cultures; they are, in Loveland's (1991) phrase, "acultural." I devote my commentary to this claim.

It is important to discuss this claim because, if it is true, it may teach us a great deal about the cognitive (and ultimately, the biological) prerequisites of the capacity to be cultural. If it is false, then we had better expose it as false, before it causes further upset to the long-suffering parents of children with autism. Let us begin, then, by considering evidence that appears to support the claim that children with autism are acultural.

Evidence in support of the claim.

(a) Children with autism do not spontaneously establish joint attention (Baron-Cohen 1989; Loveland & Landry 1986; Sigman et al. 1986). Indeed, when Scaife and Bruner's (1975) paradigm is used, the majority of children with autism do not follow an experimenter's direction of gaze (Leekam et al. 1993). They mostly do not succeed in establishing a common topic on which to comment, either nonverbally or verbally (Baron-Cohen 1988) – presumably a prerequisite for the transmission of culture.

(b) From my own observations, the majority of children with autism neither invent nor acquire nor continue traditional playground games and folklore, unlike even normal 4- to 5-year-olds (Opie & Opie 1969). In this sense, they show no signs of peer-appropriate transmission of culture.

(c) Clinical descriptions suggest that children with autism are oblivious to the pressure to conform to cultural norms (Kanner 1943). Although they may insist on *routines* being adhered to, these are arguably different from cultural norms. Reports of teenagers with autism undressing in public or shouting in church, and so on, with no signs of embarrassment, are examples of such "norm-blindness."

(d) There are no reports providing convincing evidence of spontaneous *collaborative* interaction by children with autism, which Tomasello et al. suggest is one important component of what it is to be cultural.

(e) The interests of most children with autism tend to be highly idiosyncratic (e.g., collecting types of bottle-tops) rather than shared.

(f) Finally, they tend not to check whether their speech is actually succeeding at communicating, nor do they show any curiosity as to why a dialogue has broken down (Baron-Cohen 1988; Tager-Flusberg 1993). Such pragmatic deficits are presumed to reflect deficits in their theory of mind, specifically in their possession of the concept of (mis)understanding (Baron-Cohen 1993).

We could continue this list of evidence in support of the notion that such children are acultural, but I think the point is clear from the examples above.

Evidence against the claim. What evidence is there against the claim that children with autism are acultural?

(a) Children with autism do produce material artefacts, such as drawings, music, and poems (e.g., Selfe 1977). However, closer examination suggests that these are usually not designed for an audience. As such, these may not in fact count as cultural.

(b) Approximately 50% of children with autism acquire language which, on the face of it, should be a sign of an impressive cultural achievement. However, again, a close examination of their language shows that although syntactic and semantic development may proceed normally, pragmatic development is markedly abnormal (Baron-Cohen 1988; Tager-Flusberg 1993). Since the pragmatics of language encodes the cultural use of language (consider the differences in pragmatics between English spoken in London, New York, and Melbourne), language acquisition in autism may actually be evidence for insensitivity to cultural norms.

(c) One very able man with autism (a graduate, now working as a research assistant) told me that he viewed people with autism as a subculture akin to any other minority, to which the dominant culture had as yet failed to extend full civil liberties: to tolerate their right to be different. The analogy that springs to mind is the deaf community, which has all the hallmarks of being a subculture in its own right. Although I'm sure that this young man was right that people with autism have less than their full rights, from the preceding list the evidence that people with autism comprise a cultural community seems thin.

Exceptions. The evidence presented here weighs in support of the notion that children with autism are indeed acultural. However, there may be some exceptions to this.

(a) Some adolescents with autism do begin to show an interest in fashions (e.g., girls wearing lipstick, etc.), suggesting a partial awareness of some cultural norms and a desire to conform to these (Schopler & Mesibov 1986). I say "partial," in that these same individuals may still show a blindness to many other cultural norms, for example, the appropriate distance to stand from someone else so that their "personal space" is not invaded, or the appropriate use of eye contact (Argyle & Cook 1976; Baron-Cohen et al. 1993; Mirenda et al. 1983).

(b) Some adults with autism develop hobbies that lead them into special interest groups, which may have their own cultural norms (e.g., chess clubs, etc.). Such cases of apparent cultural participation would merit closer investigation.

(c) If children with autism really were acultural then one would expect to see few if any cross-cultural differences in behaviour between children with autism in, say, India, and those in, say, France. The relevant cross-cultural studies remain to be done.

In summary, autism may provide a model of what is needed in order to be cultural. Tomasello et al. suggest that this requires the capacity for cultural learning, for which a theory of mind seems to be the main prerequisite. As they point out, this probably has its origins in joint attention (Baron-Cohen 1989; 1991). The biological basis of joint attention and theory of mind may therefore hold the key to the biological basis of the capacity to be cultural.

Sharing a perspective precedes the understanding of that perspective

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In their target article, Tomasello et al. identify three processes of cultural learning (imitative, instructed, and collaborative) which are linked to three concepts of agency that appear developmentally at 9 months, 4 years, and 6 years (i.e., intentional agent, mental agent, and reflective agent, respectively). In the present commentary we focus on the relationship between cultural learning processes and the concepts of agency and suggest that although Tomasello et al. have provided a generally accurate characterization of the different types of cultural learning and the social-cognitive concepts of agency, they have misconstrued the relationship between these two components of the model. In brief, Tomasello et al. assert that each of the identified levels of cultural learning relies on a social capacity to share a perspective with another individual, usually of the same species. They further assume that in order to share a perspective, one must understand that the other is the type of agent that can have such a perspective. It is this latter assumption that we believe is unnecessary and mistaken. In what follows we suggest that the formation of a concept of person as intentional, mental, and reflective follows as a consequence of sharing a perspective at these three levels, but that it is the formation of the concept of agency at one level that allows the child to *become* an agent at the next level and thereby come to share perspectives at that level.

At the first level of cultural learning, the 9-month-old child may be capable of sharing an intentional perspective with another individual, through imitation, for example. However, such sharing does not require a concept of a person as an intentional agent. All that is required is that the infant be able to enter into intentional relations with objects and that, through the imitative process, the infant be capable of adopting the same intentional relation as the other. For example, the infant can share a visual perspective with another, by imitating the action of the other in looking in a particular direction and then noting the object that is found in that direction. For such sharing to occur, the infant need not be aware that a perspective is being shared (Moore & Corkum 1992).

Empirically, a concept of an intentional agent can only be said to be unambiguously in place when the child is able to recognize that the other is in a different state from the self and vice versa, or, in other words, that diversity is possible in the intentional relations of self and other. We suggest that this concept is not fully acquired until around 18–24 months. It is only at this time that infants can distinguish their own intentional attitudes toward objects from the attitudes of others and learn to respond differentially to the attitudes of others. For example, it is at about 18 months that infants know that another may see an object that they cannot see because it is behind them (Butterworth & Cochran 1980). Infants can also recognize differences in emotional attitudes toward objects at this time and can respond with sympathy to others, whereas earlier in development infants share, through contagion, the same emotion as the other (Hoffman 1977). Self-recognition with a mirror also occurs at this time, providing evidence that infants have developed a concept of self as an object of the same kind as other individuals (Lewis et al. 1989). Together, these phenomena suggest that the infant's concept of intentional agent, which can be applied equally to self and other, first appears at 18–24 months, not, as Tomasello et al. claim, at 9 months.

We believe that a similar developmental sequence occurs for the age 4 transition involving the concept of mental agent. The results reviewed by Tomasello et al. (e.g., on false belief, Wimmer & Perner 1983) indicate that the concept of mental agent occurs at about 4 years, because it is at this point that the child understands the possibility of diversity among mental states. We also agree with Tomasello et al. that instructed learning requires the child to have the capacity to enter into shared mental relations. However, in this case we differ about when instructed learning involving the sharing of a mental attitude first begins. In our view, once children have formed a concept of an intentional agent, they have then in effect become a mental agent, that is, they can think about the intentional activity of an agent. The 2- or 3-year-old child is in a position to share a mental attitude with an instructor; otherwise, the instructions of the other could not regulate behaviour. As in the case of sharing a perspective at the earlier level, however, the child need not yet have a concept of a mental agent. All that is required is the ability to adopt the mental relation of the other. Hence we again contend that the sharing of perspective precedes the appearance of the concept.

The formation of a concept of a mental agent at about 4 years allows the child to become a reflective agent in the sense described by Tomasello et al. At this level the child can share a perspective. In this case, what is shared is a reflective awareness of the mental activity of an agent, whether it be about self or another. Collaborative learning requires this sharing of perspective. However, at this stage the child merely acts as a reflective agent. It is only later, at about 6 to 7 years, that the child can form a concept of the activity of a reflective agent.

In sum, our view is that the sharing of perspectives is a precursor to the formation of the concept of a person as an agent having a perspective of that kind, and that this applies to all three of the levels described by Tomasello et al. Furthermore, we claim that there is a reason for this sequence. To develop a concept of a particular type of agency that can be applied uniformly to self and others, it is necessary to appreciate the equivalence of two qualitatively distinct types of information of the agency, namely, the information of the agency from a first-

person perspective and the information of the agency from a third-person perspective (Barresi & Moore 1992; Moore & Barresi 1993). Without a sharing of perspective at a particular level of agency between self and other, the individual could not come to appreciate the equivalence of the perspective of self and other at that level of agency. It is the cases where a pair of agents share an instance of a perspective at a certain level that provide the concurrent source of self and other information that can be integrated to grasp conceptually that level of perspective. Such conceptualization therefore only follows the sharing of perspective, as one becomes aware of similarity and diversity of perspective between self and other.

Towards a new image of culture in wild chimpanzees?

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Tomasello et al.'s three levels of cultural learning are presented as strictly human because captive chimpanzees do not perform them in tests. "Encultured" chimpanzees are recognized as capable of imitation and the authors propose that human language training has allowed new dormant abilities to be expressed. Besides noting the impossibility of explaining how such abilities could have been favoured by natural selection if they have no use, I suggest that we could just as convincingly propose that captive chimpanzees live in strongly impoverished conditions. Any enrichment is badly needed and so the language training that some captive individuals were lucky to get improved their cognitive development along lines similar to those occurring in human populations; the higher the educational level, the more complete the cognitive development (Dasen & Heron 1981). I suggest that wild chimpanzees live in a permanent training condition where survival and reproductive success are the teachers and I would expect them to be more intelligent than their captive counterparts.

Contrary to what Tomasello et al. suggest, the teaching instances in Taï chimpanzees were performed by mothers who changed their behaviour when they noticed their infant's difficulties (they were not cracking nuts themselves at the time), specifically performing in front of their infant an action that was directly related to the technical problems faced (they did not merely slow down their tool use, as Tomasello et al. state), letting the infant crack further while they waited nearby. In at least one instance it was clear that the infant learned from the mother's demonstration (Boesch 1991). Thus, Taï chimpanzees are capable of instructed learning.

I have not yet published detailed observations of the collaborative hunting in Taï chimpanzees but I can confirm here that some hunters do precisely monitor both the actions of other hunters and their effect on the movement of the prey. This is especially obvious with hunters closing an encirclement; this can only be done after such monitoring because they must anticipate the other movements in order to reach the strategic position in time. Thus, collaborative learning is at work in Taï chimpanzee hunting behaviours.

Tomasello et al. hypothesize that human cultural learning can only occur if imitative, instructed, or collaborative learning is at work. However, everyone can think of a typical cultural behaviour in humans that does not require the acquisition of a new behaviour (which is part of their definition of imitation). For example, hand shaking, embracing, or hat lifting to greet somebody in some cultures does not require the acquisition of any movement that cannot be seen being used by young children when playing. It is the *context* in which this behaviour is produced that is new and could be learned through social facilitation (or local enhancement). I do not deny that imitation plays a role in human cultures but I wish to emphasize that lower forms of social learning are also part of cultural transmission processes in humans. Thus, Tomasello et al.'s presentation of the three essential characteristics of human culture (sect. 5) are more relevant than the more limited scope of the analysis of some of the transmission mechanisms.

These characteristics are that cultural behaviour should be performed by all group members, that its form should be a faithful reproduction of that of the model, and that an accumulation of modifications must exist. These points are very important and deserve a fair review of the knowledge on chimpanzee traditions. First, besides termite fishing, activities such as ant dipping, nut cracking, leaf clipping, leaf grooming, and others have been proposed to be cultural. I shall discuss here the behaviours I have observed myself. In Taï chimpanzees, the nut-cracking behaviour was performed by all group members over 2 years of age (N = 99 chimpanzees), the only exception being one juvenile female whose hands were both badly impaired and unable to hold a hammer. Similarly, the leaf-clipping was for years performed by all adult males, and only them, because it was a component of the drumming display performed completely only by adult males (Boesch, in preparation). Ant dipping was observed in 4 males out of 7 and 17 females out of 22. This is a rare behaviour but on all occasions the females present dipped for ants whereas males tended to take them directly with the hand. The differential use of ant dipping represents a sex difference in feeding on ants (Boesch & Boesch 1990). Thus, in Taï chimpanzees cultural behaviours are learned by virtually all group members.

Concerning the second point, it is important to realize that this is a question of the level at which one compares interindividual performances. At a general level, all French people shake hands in a very similar and standardized way but if one looks at a finer level it would probably be difficult to find two individuals that present the hand, press the other's hand, and let go afterward in exactly the same way. Obviously, if one looks at the finest details, Taï chimpanzees show individual variations in nut cracking, such as the positions of the fingers holding the hammer, but at a higher level of comparison the most striking feature is that all group members crack nuts exactly the same way, holding the hammer in the same way, hitting with the same part of the hammer, and so on. Even throughout ontogeny I rarely observed young chimpanzees attempting to crack nuts with another movement, or trying other material or positions, or hitting the nuts with some part of the body or even throwing them against a hard surface. This standardization in form is also observed in ant dipping; in this case this is important because the form of ant dipping is different in the two chimpanzee populations performing it (Gombe and Taï) but the same within each one (Boesch & Boesch 1990). Similarly, leaf clipping is performed by all males exactly in the same way (Boesch, in preparation). Thus, *copying the precise movement of the model* is very strong in the cultural behaviours of Taï chimpanzees.

The third point is a very important one: Do chimpanzees have fashions like humans that spread rapidly in the group and appear independently of any ecological stimuli? Recently two appearances of fashion-like behaviour have been observed. The leaf clipping that was used for years only by males in the drumming context started within a month to be used in an additional and new context – resting. Not only did all males do it but other age/sex classes also started to perform leaf clipping for the first time in this new context (Boesch, in preparation). Second, in Gombe chimpanzees the leaf grooming was for years performed as a kind of redirected behaviour without any specific purpose (Goodall 1986). Lately, I observed that all group members I saw performing it (N = 24) did so in order to squash small ectoparasites before eating them (Boesch, in preparation). These observations not only show that chimpanzees can accumulate modifications over generations but that the function of some of these behaviours are pure social conventions: Leaf clipping in

Taï is part of the drumming display, whereas it is part of the courtship display in Mahale chimpanzees (Nishida 1987). Ectoparasites are squashed on leaves in Gombe, whereas Taï chimpanzees squash them on their forearms.

Thus, some of the cultural behaviours known in wild chimpanzees do fulfil all three criteria for human culture proposed by Tomasello et al.

Social-emotional and auto-operational roots of cultural (peer) learning

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In approaches to cognitive development and enculturation there has been a gap between those who assume with Piaget the autonomy of the individual mind, and those who assume with Mead and Vygotsky the priority of interpersonal mediation. Tomasello et al. are to be congratulated for bridging part of that gap. The target article does not specify, however, how cultural learning depends on prior primitive capacities in the learner, even though they are partly implied by the rich comparative evidence offered. I shall indicate how capacities for (i) immediate affective engagement in others and for (ii) auto-enclosed self-engagement discriminate between chimpanzees and autistic children and permit an added form of symmetric learning in peer interaction before the age of 6.

Capacity (i) for social-emotional engagement. The capacity to engage feelings with others in a direct, nonreflective sense is manifest in early infancy. Normal human infants engage activity and effortlessly in mutually attuned affective contact with adults (Stern 1985; Trevarthen 1990a). Even in peer contact, when opportunity arises, 3-month-olds have been found to engage in reciprocal gazing, smiling, vocalization, and sometimes reaching for each other (Field 1990).

The formation of the means for perspective-taking in representational mediacy appears to be nurtured by prior direct perception of others, in which the other's perspective is felt in presentational immediacy (Braten 1988; Neisser 1988; Trevarthen 1990b). Learners will not succeed in imitative learning if they have to divide their effort between attending to the model activity and attempting to get "inside" the other's perspective. Since the latter, however, is immediately felt in virtue of (i), no divided attention need interfere with the process.

Capacity (ii) for auto-enclosed self-engagement. The capacity to self-engage in coherent operational cycles upon disengagement from others is manifested in perturbed infant-adult contact. Upon disengagement from the adult, 2-month-olds turn to themselves in a coherent, auto-enclosed manner (Murray 1991; Trevarthen 1990b). Later in ontogeny, infants self-engage in "dialogue" with some bodily part or "transitional object" (Braten 1992a; Stern 1985; Winnicott 1986). Thus, rudimentary proto-instances of self-dialogical cycles, which in more advanced form characterize self-regulated (instructed) learning, appear to be manifested during the first year.

Chimpanzees and autistic children. Chimpanzees are capable of (i), but apparently not (ii). They can relate emotionally to others, even to the trainer, who may experience differences in rapport with the various trainees. Verbal praise sometimes suffices as a reward (Custance et al. 1992). Their capacity for (i) facilitates imitative learning.

In spite of difficulties in this respect, about one in two autistic children somehow learn to talk, even if deviantly. Why? They appear capable of (ii), but deficient or impaired with respect to (i), that is, their internal auto-enclosed cycles in self-talk operate without the social-emotional nurture of others' perspectives. Such auto-enclosed cycles appear to be manifested even when autistic children go into ecstatic states, "floating off" and reaching out their arms (Trevarthen 1990a), whereas they fail to lift their arms when offered to be lifted by others. Preconceptual forms of affectively toned communication in felt immediacy are profoundly aberrant in autism (Hobson 1990). Hence, the auto-enclosed operational cycles in the autistic child do not give rise to what Neisser (1988) terms an "interpersonal self," and cannot evolve into a self-regulative dialogue that involves actual others' perspectives as taken in virtue of having been felt.

Symmetric peer learning. Unlike encultured chimpanzees and autistic children, the normal child brings both (i) and (ii) to bear on processes of peer interaction. Tomasello et al. imply that symmetric (collaborative) learning does not occur before the age of 6. Before that age, however, children bring products of imitative or instructed learning to bear on processes of peer interaction in which neither is model or instructor. For example, when two 4-year-olds sing a song or dance together, or play mother and father, or doctor and patient, or even Batman and his adversary, they symmetrically constitute a cocreative dyad in which they are mutually attuned. This is not just delayed imitation or self-regulated instruction reenacted after the original learning situation. Even if learning is not mediated by a reflective agency concept of "person," something new in a cultural sense is cocreated and acquired in such symmetric peer interaction that adds to the products of asymmetric learning situations. A recursive kind of intersubjectivity, albeit in an immediate sense in virtue of (i), is involved in such situations of joint imitation or reenactment by peers, which permits new cultural acquisitions to be yielded before the age stipulated for collaborative learning.

The learner's virtual other. Such symmetric peer learning depends on the ability to mutually complement each other in a dialogue in which children can engage directly in each other's perspectives "from inside the other's perspective, as it were" (sect. 1, para. 3). Elsewhere, this has been accounted for in terms of the child's primary self-other organization with a "virtual other,"[1] a virtual companion perspective which invites and permits fulfillment by actual companion perspectives (Braten 1988; 1992a; 1992b). Having the operational efficiency of an actual other, the learner's virtual other later in ontogeny serves *inter alia* the inner observing function described in the target article conclusion (sect. 6, para. 3). But equally relevant, posited as inherent, not constructed, it permits the learning mind to recreate and transform itself in the form of the dialogical, whether in (i) affectively tuned engagement with actual others, or (ii) in self-engagement (with the virtual other). This, I propose, is the common base for the social-cognitive capacities for cultural learning examined in the target article.

NOTE

1. Proposed in my talk at The Gordon Research Conference on Cybernetics of Cognition, 1986 (Braten 1986/1988).

Do we "acquire" culture or vice versa?

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I am cheered and, indeed, much enlightened by Tomasello et al. Their theory of the processes involved in the "acquisition" of human culture provides needed psychological underpinning for the argument that human cognitive capacities evolved in response to the demands of an evolving social-political way of life in the primate order rather than, say, as a spin-off from the evolution of tool use. The authors present a strong case for the view that a powerful mediating process in this evolution was the emergence of cognitive means for registering and representing the intentions and mental states of conspecifics (Whiten

1991). The three forms of cultural learning that such a system of representation makes possible – imitative, instructed, and collaborative learning – are rich and detailed enough to stimulate a decade of research on how culture gives shape to mind, both phylogenetically and ontogenetically. Tomasello et al.'s hypotheses might even sharpen our understanding of the nature of human culture itself. I propose to offer some elaboration of that in the comments following.

Let me begin by explaining the scare quotes around "acquisition" in the preceding paragraph. It is an encumbering word inherited from old-fashioned learning theory (rats acquired habits, etc.), a term deeply rooted in the individualistic account of "social learning" that Tomasello et al. are trying to go beyond. Only in the most banal sense does one "acquire" culture: One *enters* it or is *enabled* by it or, to borrow Geertz's (1973) term, is *constituted* by it. Culture is not a set of responses to be mastered, but a way of knowing, of construing the world and others. To enter culture is not to *add* some element to one's "natural" repertory, but to be transformed. Obviously, such readiness to be transformed is dependent upon the requisite biological capacities, as Edelman (1990) and others argue, but it also depends upon social transactions that are accessible only to those who have, as it were, already crossed the divide into culture – who can, for example, construe others as intentional agents, mental agents, or reflective agents. Once they can do any or all of those things, the culture literally provides them a vast, readily accessible toolkit of devices for elaborating their mental powers and their effectiveness: enriched exchange arrangements, obligated allies and mentors, politically useful mates, instructive narratives of possibility, and the like. All of which leads in turn to situating the participant's cognitive life in an institutional network that, as Seeley-Brown et al. (1988) have noted, makes human intelligence "supra-organic" in Kroeber's (1952) sense.

That culture situates and amplifies cognitive life is a matter that Tomasello et al. note in passing; they as much as offer a promissory note for later return. For it is through cultural institutionalization that the most enduring "ratchet effect" is assured. Without such institutionalization, Kawamura's (1959) Japanese macaques do not pass on potato washing as a culture-wide tradition; it could easily disappear in a generation. For traditional cultural transmission requires not only an appreciation of "other minds." It also requires such intrapsychic support as guilt and shame for noncompliance, as well as such putatively external ones as the compulsion of legal systems, the unavoidability of rites of passage assuring universal participation (e.g., van Gennep 1960), incest taboos, and so forth.

I am concerned that such crucial matters as these may get overlooked in implementing and elaborating the Tomasello et al. account. For theirs is (in spite of their valiant efforts) too individualistic an account, too caught up in the problem of individual conceptual "acquisitions." Far more needs to be said about how collectivities of people operate to empower, sustain, pattern, and enforce these acquisitions. An example: Tomasello et al. acknowledge that human mothers become enormously diligent and skillful in "teaching the culture," as illustrated in their management of imitative, instructed, and collaborative activity in their children's language acquisition (e.g., Ninio & Bruner 1978). But Tomasello et al. tend to ignore the fact that mothers also impose strong normative expectations on their children in the process. What "should" be done or said becomes as important in the child's conception of agency as the act itself. Felicity conditions are usually imposed more rigorously than syntactical rectitude. The representation of the intentions and beliefs of others is as deontic as it is epistemic: full of oughts, musts, and notions like "good manners" and "helpfulness" (e.g., Dunn 1988). Of course, these reflect institutional demands as well: what society "decrees." Not surprising, then, that narratives, embodying the drama of deontic violations, early become such an important vehicle of cultural transmission (Bruner 1990), for they carry the message not only of agentivity but of what is normatively canonical. A deficit in narrative ability may even account for some of the difficulty experienced by autistic children in entering culture (Bruner et al. 1993).

So, although Tomasello et al. are compelling as far as they go, I sorely miss a discussion of the normative, deontic side of participating in human culture. What "ratchets" culture is not only that others are seen to intend and have thoughts and reflections on thoughts, but that they are *expected* to have them, or else. Such canonical expectations are justified to the child from the start by reference (more implicit than explicit, more micro- than macro-) to the institutional structure of the culture. These are matters that are in no way in conflict with the Tomasello et al. account. Indeed, they are offered in the spirit of buttressing it, for their target article represents a real step ahead in the effort to create a cultural psychology.

Hierarchical levels of imitation

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Compared with any premodern human societies, animal behavior shows relative uniformity between populations of the same species. When carefully examined, those population differences that do occur usually turn out to be consequences of subtle differences in ecology. Even in the well-studied and widely distributed common chimpanzee (*Pan troglodytes*), behavioral variations deserving the name "cultural" are slight (see McGrew 1992) and unlikely to leave traces in fossil forms, whereas many of the cultural differences between premodern peoples would be detectable in their debris. To judge from fossil evidence, this sort of cultural variation is rather new: Australopithecines, *Homo habilis*, *Homo erectus*, and even the Neanderthals give no convincing evidence of it. The question of which attribute of modern humans gives rise to cultural variation is an important one and is not yet settled.

Tomasello et al. offer a package of three candidate skills as an answer and argue that no animal untutored by humans shows any of them. The latest skill to emerge in children's development, collaborative learning, is not a method that serves to pass on behavioral variations to other generations, so in fact we are left with instructed and imitative learning as real possibilities for the source of culture. However, instructed learning as the authors define it can only safely be identified by the reenactment in the child of the adult's earlier instructions. This leaves little scope for nonverbal animals, and indeed Tomasello et al. do not accept any evidence of such instruction by animals. (They thus place considerable faith in verbal reports of young children as evidence of mental process, whereas the literature on verbal reports of adults would suggest caution; see Byrne 1983; Nisbett & Wilson 1977). The use of verbal instruction may of course be a unique and sufficient reason why premodern human societies show cultural variation and animals do not; this would accord neatly with the lack of evidence for culture in Neanderthals, if they also lacked modern speech, as argued by Lieberman (1984). Tomasello et al. go further, however, in advocating the cultural importance of an ability to learn imitatively, denying any true imitative ability is found in wild animals.

In order to differentiate true imitation from individual learning aided by a social environment, it is necessary to adopt strict criteria (see Galef 1988). Tomasello et al. do so, requiring behavior that (a) is novel for the imitator, (b) reproduces the actual behavioral strategies of the model, and (c) is directed toward the same goal as was the model's. Proviso (a) ensures that responses already in the repertoire are not simply brought forth

by seeing another using them; this was originally called "social facilitation" by Spence (1937), but "response facilitation" may be a better term now, as social facilitation has been used in at least two other senses since (Byrne, in press). Proviso (b) rules out the kind of social learning that is so important in animals, individual learning efficiently channeled toward just the crucial environmental features by the sight of a companion's behavior ("stimulus enhancement," Spence 1937); it also excludes an additional possibility of learning the "affordances" of objects and situations by observation, which Tomasello et al. describe as "emulation," but which could be seen as learning the correlational structure of the environment by classical conditioning (Dickinson 1980). Proviso (c) excludes what the authors call "mimicking" — new behavior for the sake of novelty alone – which parrots and myna birds are so good at in the vocal modality. I believe Tomasello et al. should be commended for this careful adherence to strict criteria. However, I think that proviso (b) brings additional problems in its wake and I would like to suggest a way of looking at imitation that may help to avoid them.

Behavior is hierarchically organized (Dawkins 1976a; Lashley 1951; Miller et al. 1960). The very simplest sorts of behavior can be adequately approximated by the one-level descriptions of S-R psychology and the ethology of "sign stimuli" and "fixed action patterns." Most behavioral sequences, however, and certainly those complex enough to need imitation for efficient acquisition, have clear hierarchical structure and can be described with equal validity at several levels.

Consider a manual task. A low level of description might specify the muscle groups that operate to move hands or fingers, a temporal patterning as detailed as a symphony's score; at a level above that in the hierarchy would be a specification of whether a grip was precision or power, whether right or left hand was used, and whether a movement was slow or fast; higher still, only the sequence of movements achieved, such as opening a hatch or pulling a lever would be explicit; and at the very highest imaginable level, the behavior would be coded as a single entity. Which of these levels is "best" for describing behavior depends largely on whether the animal can permute and modify elements at a given level; if not, a higher level is sufficient. If no modification at all is possible, the behavior really is a "fixed action pattern," and only a physiologist would need to dissect the fine detail.

It is much easier to *identify* imitation that occurs at a very low level in a hierarchy: The preservation in the learner's behavior of idiosyncratic details of the model's grip-type, hand used, and precise movements is a dead giveaway. But that is not necessarily the most useful or "intelligent" level at which to imitate. We humans are not proud of having to imitate at low hierarchical levels, describing this as "slavish," "plodding," and "mindless." It therefore cannot be assumed that this is the only level at which animals would imitate, if they can. Indeed, we have found rapid acquisition of complex, multistage techniques of plant feeding in wild mountain gorillas (*Gorilla g. beringei;* Byrne & Byrne 1991), and these techniques are idiosyncratic at low hierarchical levels of detail but standardized at a more organizational, "program-level" (Byrne & Byrne, in press). This leads me to suspect that dismissing the imitative capability of "uneducated" apes may be premature.

Whence the motive for collaboration?

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In the target article, Tomasello, Kruger & Ratner argue that collaborative learning is a peculiarly human characteristic. Their argument focuses on the capacity for collaborative learning, which depends on other capacities that must develop prior to the capacity for collaboration, in particular, the capacity to recognise other humans as subjects. The authors do not, however, consider either how the capacity for collaborative learning evolved or how it is motivated. Consideration of these issues can shed some light on why collaboration is a human trait and how it came to be. The evolutionary origins of collaboration and certain similarities between reproductive strategies of humans and other primate species suggest that collaboration might not be as unique as the target article claims.

There are certainly many people who could gain from collaborative learning but prefer to learn alone. The capacity for collaboration is not sufficient for collaborative learning; the will to collaborate must be there as well. One possibility is that the will to collaborate has social origins and is otherwise a consequence of general curiosity and intelligence. This aetiology is doubtful, however, since the rewards of collaboration can be experienced only after the complex task of collaboration has been performed. We still need an explanation of why collaboration should occur in the first place. It can be maintained by social forces, but they cannot explain its origin.

One common explanation of the development of collaboration makes it an adaptation for hunting. Certainly collaboration in hunting has the potential to make hunting more successful. The main problem with this explanation is that it is unlikely that hunting played a major role in the diet of early hominids. Aside from lack of evidence that early hominids hunted, bipedality is not well adapted to hunting unless a fairly complex technology is utilised (Lovejoy 1981). Early artefacts do not appear to be hunting implements. Even later hominids did not gain much of their food from hunting (although this minimal contribution may have been critical), so it is unclear that hunting had a strong adaptive value. If hunting underlies collaboration, then collaboration would probably have been a late adaptation. Furthermore, success at hunting would have been greatly enhanced by collaboration, especially among relatively inefficient bipeds. This suggests that the capacity and motives for collaboration appeared prior to the adoption of hunting.

A rather different origin for collaboration is suggested by primate reproductive strategies. Primates, especially the Pongidae, have a long gestation period and an especially long period of infancy and subadulthood. This trend is most marked in humans. Infants and subadults require considerable care and socialisation; reproduction is a major project, involving five or more years in chimpanzees, and fifteen or more years in humans. Chimpanzees and a number of other primates form matrilineal groupings in which related females cooperate in child rearing (though I know of no solid evidence that this cooperation is collaboration in the sense of the target article). Things are somewhat more complicated than this because of competition among females in the group carried out with the framework of an inherited (but not genetically inherited) dominance network. Nonetheless, the sharing of nurturing tasks is widespread, including features like adoption and foster care.

With the particularly long prereproductive phase in humans, reproductive capacity can be greatly enhanced by having males contribute directly to child care. This is likely only if the male can be reasonably sure of parenthood. This likelihood is increased by monogamy. Lovejoy (1981) suggests that human sexual dimorphism, which is distinct from that of other characteristics, is an adaptation for monogamy. Pair bonding would enhance the survival of offspring, given the huge investment of care required. This investment is immediately profitable in terms of fitness, and Lovejoy suggests that uniquely human characteristics are largely due to human reproductive strategy. It is reasonable to assume that cooperation between females for the nurturing of offspring became refocused into cooperative behaviour between mates. Even in lower primates males are capable of extraordinary acts of infant care. Hrdy (1981) describes a case of a male baboon who rescued an infant baboon

being born on a ledge who would otherwise have fallen to its doom. More commonly, however, the male contribution to child care among primates is restricted to a protective role.

There is a distinct advantage in flexibility of nurturing behaviour in a species that must nurture their young over many years. The problem that protohuman pairs faced was to engage over many years in a joint project whose requirements cannot be specified completely in advance. Clearly, there would be a major advantage to those who could maintain flexibility at the same time as major commitment to the project. I suggest that humans have developed the capacity to take on mutual projects that transcend their self-interests, identifying with the project, and thereby being able to see their own role in perspective. In short, it seems likely that collaborative learning, whether unique to humans or not (and it is certainly unique in its degree), has its origins in human reproductive strategy. Nonetheless, its roots can be found in similar species. More recent evidence suggests that the human reproductive strategy is not as unique as Lovejoy believed (Hrdy 1981, pp. 136ff). If my hypothesis is correct, we can expect to find a correlation between the length and degree of nurturing behaviour on one hand and the amount of nonspecific collaboration on the other.

What is the difference between cognitive and sociocultural psychology?

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If the aim of the target article by Tomasello, Kruger & Ratner is "to understand social learning in terms of the most recent research and theory on children's social cognition" (Introduction), then they have attained this goal to my satisfaction. Their integration of theory and research across a broad range of disciplines manages to make a convincing case for the interrelations between cultural learning processes, social-cognitive abilities and concepts, and cognitive representations. If their goal is instead to argue for "more attention to the social and cultural dimensions of human cognition and learning" (sect. 6, para. 6) then I am less satisfied that this goal has been accomplished. In citing recent work in sociocultural theory (either Vygotskian psychology or cultural psychology) as their theoretical framework, Tomasello et al. force us to ask whether they advocate a fundamental reconceptualization of the interrelations between cultural institutions, practices and tools, communication, and cognition. My comparison of their model of cultural learning with sociocultural theory is based in part on a metatheoretical argument by Lave (1991). The purpose of this comparison will be to show that cultural learning is closer to cognitive psychology than it is to sociocultural psychology.

Lave has identified three different versions of cultural theories of learning: the "cognition plus" view, the "interpretive" view, and the "situated social practice" view. In the cognition plus version, social interaction and everyday activities are recognized as having an important influence upon the process of thinking but not upon its result. Social and nonsocial cognition are also distinguished in this version. For example, the solitary individual engaged in self-reflection would *not* be using social cognition.

In Lave's interpretive version, thinking involves the negotiation of meaning in the context of sociocultural activity. There is no objective world "out there" to be understood. Instead, this approach focuses on explicating the temporary understandings of intentional agents about the intersubjective world. All cognition is seen as fundamentally social and cultural; learning is a communicative process through which children and adults co-construct a shared task definition. Consistent with Vygotskian theory,[1] changes in semiotically mediated social interaction are viewed as the source of individual developmental change (Forman 1989; Stone 1993; Wertsch 1985b).

In the third version, situated social practice, learning is an emergent property of people's participation in communities of practice. Lave uses examples drawn from studies of apprenticeship and Alcoholics Anonymous to illustrate how changes in social participation patterns index changes in knowledge of the skills valued by a particular community of practice (see also Lave & Wenger 1991). In this version, all cognition is socially and culturally specific.

Lave's situated social practice category seems closest to Shweder's (1990) characterization of cultural psychology. Cultural psychology attempts to go beyond Platonic approaches to understanding cultural learning where the content of actual social activity is regarded as noise and framed out of the theoretical models. "Indeed, in the land of cultural psychology all of the action is in the noise. And the so-called noise is not really noises at all; it is the message" (Shweder 1990, p. 24).

Which of these three theoretical versions does the Tomasello et al. article approximate? Their position seems farthest from the situated social practice approach articulated by Lave and Shweder. Tomasello et al. have taken an abstract, decontextualized perspective on social interaction and thought. For example, their typology of cultural learning processes, social-cognitive abilities, and cognitive representations (Table 1) is an instance of the kind of Platonism that Shweder sees as typical of a psychology which reduces the actual content of specific cultural practices to abstractions.

It seems to me that Tomasello et al. would like to be characterized as interpretive in their approach. For example, they argue that "the cognitive representation resulting from cultural learning includes something of the perspective of the interactional partner, and this perspective continues to guide the learner even after the original learning experience is over" (sect. 1). Thus, they seem to feel that even self-reflection by a solitary individual can be characterized as social cognition.

Nevertheless, there are at least two reasons Tomasello et al.'s perspective does not go beyond the "cognition plus" position. First, they take a restricted view of the role of semiotic mediation in cognitive development. The causal mechanism in their model is perspective-taking or intersubjectivity, not semiotically mediated communication.[2] They also ignore the essential similarities and differences between cultural tools and signs. Both tools and signs, according to Vygotsky (1978), are cultural inventions that mediate activity. When tools are directed internally, they become signs that enable humans to reflect upon and control their own behavior. Thus, the social-cognitive skills that Tomasello et al. discuss in detail would be reconceptualized by Vygotskians in terms of semiotic mediation (Stone 1993; Wertsch 1991).

Second, Tomasello et al. view changes in cognition as causing changes in sociocultural practices and not vice versa. For example, "these processes of social cognition then led humans to the species-specific ways of learning from one another that we call cultural learning, which then kicked off the evolutionary and historical processes that led to the species-specific form of social organization known as human cultures" (sect. 5, para. 9). In contrast, Vygotskian theory holds that changes in thinking (intrapsychological regulation) begin with changes in social practices (interpsychological regulation; Vygotsky 1978; Wertsch 1985b). This does not imply sociocultural determinism, however, because, as Shweder puts it, "psyche and culture . . . dynamically, dialectically, and jointly make each other up" (1990, p. 1).

Thus, I am forced to conclude that Tomasello et al. have been arguing for a more prominent role for social factors in learning and development but not for a fundamental change in the way we conceptualize culture, communication, and cognition. I find

it difficult to see how one can omit semiotically mediated communication or specific cultural practices from one's model and still end up with a theory of cultural learning in which culture is taken seriously. Perhaps an integration of two or more of the theoretical positions in Lave's typology is possible. Unfortunately, the model of cultural learning presented by Tomasello et al. has not accomplished this task.

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NOTES

1. Vygotsky's theory, especially the aspects of it that have been further developed as activity theory by Leont'ev and others, could also be characterized as Lave's (1991) situated social practice approach. In brief, sociocultural theorists who are closer to Lave's interpretive view emphasize semiotic mediation and individual psychological processes (reasoning, motives, goals), whereas those closer to the situated social practice view emphasize cultural praxis. Recent writings by sociocultural theorists further articulate these two aspects of Vygotsky's original framework (Forman et al. 1993; Rogoff 1990; Wertsch 1981; 1985a).

2. Tomasello et al. refer to "voice" (sect. 1, para. 4) when discussing the internalization of the perspective of the other. Yet they do not appear to view voice as an example of semiotic mediation, as Wertsch (1991) does.

Cultural learning as the transmission mechanism in an evolutionary process

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A central thesis of the target article is that (a) individuals must view each other as intentional agents and be able to adopt one another's perspective for cultural learning to take place, and (b) cultural learning is necessary for the emergence of cultural evolution, wherein the cultural products or memes (Dawkins 1976b) "accumulate modifications over time" and exhibit the ratchet effect. Tomasello et al. argue that cultural learning and cultural evolution are uniquely human and that this is because we alone are capable of intersubjectivity. To illustrate a possible flaw in this argument, consider the evolution of an understanding of the relationship between the phases of the moon and the height of the tides. (This example is borrowed from Hutchins and Hazelhurst 1992). Some individuals look at the moon night after night, chart the rise and fall of the tides and explore the notion that the two are correlated – they learn directly by assimilating observations of the natural world. They pass this knowledge on to others. However, if the individuals that initiate the cultural evolutionary process do not necessarily need to conceive of the source of *their* knowledge as an intentional agent, why must their students think of *them* in this way? Tomasello et al. present convincing evidence that intersubjectivity *facilitates* learning, but it should be pointed out that it is possible for complex information to be learned without it. Furthermore, there is no theoretical reason why intersubjectivity is necessary for cultural evolution; genetic evolution proceeds nicely without it. Evolution simply requires (1) imperfectly replicated patterns and (2) selection (differential reproduction of patterns according to their fitness in the current environment). In a computer model of cultural evolution that I have devised (Gabora 1992) a society of neural networks store, exchange, and embellish memes. These "meme hosts" cannot yet develop models of one another – they do not adopt one another's perspective, etc. – but their interactions give rise to the emergence of complex memes, and the dynamics of the system has much in common with human cultural evolution.

Tomasello et al. make two claims that appear to contradict one another. The first is that cultures are most clearly distinguished from other forms of social organization by the nature of their products, a critical feature of which is the *accumulation of modifications* over time. The second is the claim that humans transmit information *with higher fidelity* than any other species, and that this, in combination with inventiveness, forms the basis for cultural evolution. The first claim suggests that it is the susceptibility of human memes to mutation that enables them to evolve, whereas the second suggests the opposite, that it is resistance to mutation that permits their evolution. This apparent contradiction can perhaps be reconciled with a clarification: The rate at which human memes mutate is high enough to bring about diversity (the raw material of evolution) but low enough to safeguard against excessive disintegration of the information content.

A second thesis of the target article is that there is an ontogenetic progression from imitative to instructed to collaborative learning. The distinction between these forms of learning is insightful; however, instead of three categories we might just as well have two: imitative and collaborative. The goal of the first is to produce a copy of the original meme, the goal of the second is to produce a new meme, and instruction can play a role in either. In discussing the role of instruction, I am not convinced that the rather vague notion of intersubjectivity need be brought in. With simple imitative learning the meme fits readily into the learner's conceptual framework, whereas with instructed learning it does not; the necessary "precursor memes" must first be put in place. (It is useless to attempt to teach matrix algebra to someone who does not know how to multiply, much as it is useless to insert into an organism's DNA the genes that code for the manufacture of the last enzyme in a pathway until it possesses genes that code for the other enzymes.)

The authors' suggestion that children progress from imitative to collaborative learning parallels the progression from nonsexual to sexual reproduction in genetic evolution. In each case, there is a transition from a conservative mode of pattern replication in which accidental mutation is the only source of variation, to a more exploratory mode, involving not only mutation but the combination of relatively successful patterns to create novel ones. This transition is generally beneficial because it produces a creamier "cream of the crop"; we can leap across the fitness landscape and find optima more quickly. In genetic evolution, the cream is creamier because there is more variation to choose from. In cultural evolution, the cream is creamier because we use background knowledge to guide our combining of memes, biasing the outcome in favor of potentially fruitful combinations. Thus it makes sense that collaborative learning appears later in life than other forms of learning, when a knowledge base has been built up. The exploratory mode of reproduction is useful to both contributors only when their contributions are approximately equally fit, otherwise the less fit pattern merely dilutes the fitter pattern. Hence, from an optimization standpoint, the authors' claim that collaborative learning takes place when the participant's level of expertise is symmetrical also makes perfect sense.

In summary, the target article presents an interesting analysis of cultural learning, which can be enriched by viewing cultural learning as the transmission mechanism in an evolutionary process. Since intersubjectivity is not a prerequisite to evolution, its role in cultural evolution should be viewed as facilitative only. The distinction between imitative and collaborative learning is useful and makes sense in the context of optimization.

Learning stages and person conceptions

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As a staunch defender of the role that perspective-taking, or simulation, plays in interpreting the mental states of others (Goldman 1989; 1992a; 1992b; 1993), I am perhaps predisposed to sympathize with any attempt to apply this phenomenon in various domains. Still, I don't think my fascination with Tomasello, Kruger & Ratner's conjecture can be chalked up entirely to a prior interest in the simulation theory. They make a convincing case for the thesis that human cultural learning is a distinctive kind of learning, and they marshall an impressive range of evidence in support of the proposal that simulation, or perspective-taking, plays a critical role in this learning. Their tripartite division of types of cultural learning, however, is not entirely persuasive, and their precise characterization of this division has some conceptual problems.

One problem concerns the distinction between imitative and instructed learning. In the imitative learning stage, according to Tomasello et al., the child conceives of the adult as an *intentional* agent, that is, an agent who has perceptions and intentions. By contrast, at the instructed learning stage, the child conceives of adults as *mental* agents, who also have thoughts and beliefs, which may be compared and contrasted with the child's own thoughts and beliefs.

What critical difference distinguishes intentional and mental agents? Are thoughts and beliefs more mentalistic than perceptions and intentions, or somehow different in kind? In the philosophical literature, thoughts and beliefs are not regarded as more mentalistic than perceptions and intentions. Intentions can also be misdirected at the world in roughly the same way as beliefs. For example, one might intend to move an object from place X to place Y although the object is not initially at place X at all. So what is the significant difference between persons conceived as intentional agents and as mental agents?

Perhaps the crucial contrast is not between perceptions and intentions, on the one hand, and thoughts and beliefs, on the other, but lies in the fact that at the later stage the child compares or relates the adult's perspective to his own. If this interpretation is right, however, what justifies the claim that two different "conceptions of a person" characterize the first two stages or types of cultural learning?

The relation between the second and third types of learning stages is not problematic in the same way. The view of a person associated with collaborative learning is that of a reflective agent who engages in second-order mental states such as "thinking that I think John is cute." This recursive thinking is clearly a different type of phenomenon from first-order mental states, but why it is essential for collaborative learning? Why wouldn't a mere dialogue of the sort Tomasello et al. associate with instructed learning suffice for the coconstruction process characteristic of collaborative learning? The authors say that in collaborative learning children must be able to criticize another child's criticism of their previous suggestion. This shows that the child must recall the contents of the respective proposals and must be able to compare and contrast them, as in the instructed learning stage. But why is second-order thinking essential? Why must a child represent the other as having a recursive mentalistic representation?

Another feature of the collaborative learning process Tomasello et al. emphasize is that neither interactant is an authority or expert. They work together as peers, arriving jointly at a solution that neither has at the beginning. This feature suggests a difference along a further dimension: a willingness on the part of each child to think of himself as an independent contributor to the knowledge construction process, ready to come into sociocognitive conflict with his partner. This seems quite distinct from the recursive dimension. If the authors mean to identify two entirely different elements as distinctive of the collaborative form of learning, well and good. Their discussion suggests, however, that the two elements are necessarily connected with each other, and that has not been persuasively argued.

On a different point, Tomasello et al. try to guard the simulation approach against the implication that children must first understand their own intentional states before they may use them to simulate the perspective of others. They cite Gopnik (1993) in support of the claim that, empirically, this implication does not appear to hold. They accordingly endorse the Vygotskian view that an understanding of other persons through social interaction underlies the understanding of the self. But if the understanding of another's mental states consists (primarily) of projecting states of your own into their situation, don't you need some prior and independent grasp of those states? Otherwise, how could you even represent them as being in the other person? So the simulation approach does invite the idea that one understands mental state concepts "from one's own case" (Goldman 1989). This position, however, may well comport with the current empirical evidence, contrary to what Tomasello et al. assert. For example, Cassidy (1993) cites studies of Smiley and Huttenlocher (1989) and Povinelli and deBlois (1992) in support of the hypothesis that self-application of mental state concepts (or words) comes first, or is easier than application of these concepts to others.

Although I have raised a few problems for the target article, these are comparatively minor worries or disagreements about a generally quite attractive set of ideas.

Agents, intentions and enculturated apes

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The target article is a source of mixed feelings to anyone engaged in comparative research involving humans and anthropoids. A first feeling is of satisfaction to see a general framework – in this case Tomasello et al.'s cultural learning theory – where so many things can be put together and compared. The other feeling, however, is of frustration, even disappointment, to realize that so many gaps and uncertainties emerge from the picture. Is the target article a premature attempt at a synthesis? I had this feeling at several points. But this feeling was countered by another, namely, that a first attempt at a synthesis may help to highlight the gaps that need to be filled. In what follows I try to offer a contribution on two points addressed by the target article: the concept of "enculturated ape," and the "person concept."

What is an enculturated ape? My first comment has to do with the authors' concept of "educated" or "enculturated" ape. They seem to suggest that any anthropoid infant reared by humans should be included in the category. Tomasello et al., therefore, seem to equate "hand-reared" and "enculturated." For example, they refer to the subject of my study on joint attention (Gómez 1990; 1991) as an "enculturated gorilla." I find it difficult, however, to identify my subject as enculturated in the same sense that famous anthropoids such as Washoe, Sarah, Koko, or Kanzi can be said to be encultured. I think it is important to distinguish between educated or enculturated apes, who have been subjected to symbolic training or have been reared in an experimental environment specially designed to enhance integration with humans, and merely hand-reared apes, who have been reared in contact with people but without receiving formal "education."

For example, my own subject, a female gorilla called Muni, whose joint-attentional skills are mentioned by Tomasello et al., showed this joint-attentional ability *before* receiving any formal

training in symbol use (Gómez 1990; 1991).[1] She had been hand-reared in a zoo nursery environment in contact with humans and a monkey partner for a year (when she was about one year old). From the second year, her contact with humans became more restricted when she was integrated with three other gorillas. It is true that at first she was bottle-fed, wore nappies for a time, and had access to a variety of human objects and companions for about 10–12 hours a day during her first year in the zoo. Perhaps that experience with humans was enough to "socialize her attention" (whatever this process involves) to some human degree; but is this enough to consider her to be enculturated in the same sense as apes subject to long-term home-rearing and symbol-teaching conditions?

I do not think the term "enculturated" represents adequately the status of merely hand-reared apes – especially if they are hand-reared in zoo nurseries. Even if it is clear that their infant experiences differ in important ways from those of the typical zoo-born gorillas raised by their mothers (not to mention the typical gorilla infancy in the wild), I don't think their experience can be equated with that of Washoe, Sarah, Koko, or Kanzi. I think the distinction between hand-reared and educated or enculturated is an important one. As Tomasello et al. point out in the target article, evidence about the sociocognitive abilities of captive apes (including both hand-reared and educated) is scarce and difficult to evaluate. Even so, I think there are cues that point to possible important differences between symbol-trained anthropoids and (merely) hand-reared ones. For example, Premack and Premack (1983) report differences in problem-solving abilities between both kinds of chimpanzees. I suggest that the distinction between hand-reared and enculturated apes will prove to be useful in the comparative assessment of their sociocognitive abilities.

Person concepts. The other point upon which I will comment concerns "person concept." I will concentrate on the person concept that appears at around 9–12 months in human children – what Tomasello et al. call the "intentional agent" concept. I think there may be a problem with the use of the term "intentional." It is necessary to distinguish between understanding intentions and understanding goal-directedness.[2]

Understanding an organism as goal-directed involves seeing it as capable not only of self-propulsion but also of directing its movements toward particular targets. A goal-directed agent can be understood in terms of movements, without reference to internal or mental states. However, one can also understand that the goal is represented by the organism, and this would properly be an understanding of the *intention* held by the other. But note that this understanding would already imply some reference to the mental life of the other, thereby qualifying as an understanding of persons as mental agents. Probably this is only a terminological problem, but it would be interesting to try to further clarify what is meant by understanding others as intentional agents.

In this connection, another possible problem has to do with the characterization of the intentional agent concept as "0 order." I assume – but perhaps my assumption is wrong – that the authors refer to something similar to Dennett's orders of intentionality (Dennett 1983). However, in Dennett's scheme, considering the other as an intentional agent would qualify at least as first-order intentionality, if not as second-order (after all, this level involves the ability to understand other people's behavior as intentional). I do not mean that Tomasello et al. should adopt Dennett's conceptions and terminology, but perhaps it would be wise to clarify a potential source of misunderstanding.

Finally, I would like to call Tomasello et al.'s attention to an important dissociation found in the development of preverbal intentional communication in normal human infants, autistic children, and hand-reared apes. Our studies (Gómez et al. 1993) have shown an important difference between the spontaneous joint-attentional skills of gorillas and those of normal human infants. Briefly, human infants at around 12 months of age are capable of using gestures both to request things from people and to point out things to people apparently for the sake of sharing with them the attention on that particular object. These two kinds of gestures have come to be known as protoimperatives and protodeclaratives, respectively (Bates 1976). A study conducted on a hand-reared gorilla (Gómez 1992; Gómez et al. 1993) has shown that although this animal developed complex joint-attentional skills in request situations, she never engaged in protodeclarative gesturing (she never showed objects to her human caretakers unless she wanted them to perform something with them).[3] The absence of protodeclarative behaviors has also been reported or suggested in chimpanzees (Savage-Rumbaugh et al. 1983). On the other hand, several studies have demonstrated that in autistic children there is an absence of protodeclarative gesturing too, whereas they seem to be able to engage in request behaviors by means of gestures (see Gómez et al. 1993, for a summary of results). It is interesting to note that protodeclarative behaviors have been related to later theory-of-mind abilities. Furthermore, there is at least one study demonstrating a correlation between protodeclaratives and imitative skills (Sarriá & Rivière 1991). One interesting question that immediately comes to mind concerns whether enculturated chimpanzees and gorillas develop protodeclarative gestures as a consequence of their "education," as well as they seem to develop more elaborate imitative skills. This pattern of dissociation between communicative behaviors involving joint-attentional skills suggests that the concept of person identified by Tomasello et al. as "intentional agent" may have different components that could relate differently to cultural learning.

NOTES

1. Our gorilla eventually received a limited amount of experimental sign-learning sessions when she was about 3–4 years old. The training sessions were very restricted in scope and frequency and far from the thorough and massive education reported in most ape language experiments. Not surprisingly, she never achieved the results reported in proper language training experiments (e.g., Patterson 1978).

2. It was Simon Baron-Cohen who first alerted me to the need to keep this difference in mind.

3. See Gómez (1992) for a discussion of some candidates for protodeclarative-like behaviors in this subject. Even these examples seem to be far from full-fledged protodeclarative behaviors as described in humans.

Imitation, cultural learning and the origins of "theory of mind"

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This target article argues for a connection between two aspects of development: cultural learning and cognitive conceptions of the person. Tomasello et al.'s presentation of this connection is novel and interesting and we think they are right that these two areas of development are related. However, it is not clear to us exactly what developmental story Tomasello et al. are proposing. It could be that there are general underlying changes that allow both the development of new social-cognitive skills and new forms of cultural learning. Alternatively, the independent development of the social-cognitive skills could underlie the new forms of cultural learning. Tomasello et al. also write in some places as if it were the cultural learning abilities themselves that allowed the new understanding of social cognition (this is implicit, for example, in their discussion of the data on enculturated chimpanzees, and their endorsement of "cultural

psychology"). In short, although Tomasello et al. have admirably sketched a plausible connection between two areas of development, we need to develop a clearer account of the causal and developmental relations that underpin this connection.

These problems are not unique to Tomasello et al., of course. Our interactions with children and even young infants have a richness and intimacy that seems to require interpersonal understanding, and at a broad ecological level we can identify the sorts of general changes that Tomasello et al. describe. Yet it is difficult to find any single behavior that justifies those impressions, or to imagine just what cognitive mechanisms could sustain them. The developmental problem is even more acute. What kinds of mechanisms are responsible for the changes in understanding that Tomasello et al. describe?

We think part of the answer to the developmental question may lie in a sort of reversal of Tomasello et al.'s argument. They see the social-cognitive abilities as the underpinning for cultural learning, particularly imitative abilities. We suggest that this relation may be reversed, that is, imitation itself may serve as a mechanism driving our ability to understand the mental states of others. In combination with strong theory-formation abilities, imitation may serve as a motor for social-cognitive development.

The unique feature of imitation, as Tomasello et al. note, is that it both requires and instantiates a mapping from the actions of one person to those of another. More significantly, even the earliest forms of imitations, the imitation of facial gestures like tongue protrusion and mouth opening, also involve a mapping from the visually perceived behavior of the other to internal sensations and to a plan of action that is formulated in the mind of the self. For example, imitating tongue protrusion requires that the infant map the visually perceived movement of another person onto his own movements, known only through internal kinesthetic sensations, and formulate a plan to execute those movements. Infants demonstrate these imitative abilities even when they are only a few hours old (Meltzoff & Moore 1977; 1983). Moreover, recent studies show that this behavior is not a simple reflex (Meltzoff & Moore 1992).

The fact that infants imitate the facial gestures of others at birth is relevant to a basic psychological and philosophical puzzle. How do we ever come to map our experience of ourselves onto our experience of others at all? The sensory information we have about ourselves seems to consist of a stream of internal sensations, thoughts, feelings, and intentions, the occasional waving hand or foot, and a blurry edge of nose, whereas our sensory information about others is of a bag of skin moving over the ground. And yet the identification of ourselves and others as similar beings seems effortless. This identification is a prerequisite for any of the conceptions of the person Tomasello et al. discuss, as well as for other accounts of the child's theory of mind.

A number of authors have suggested that infants have some innate "intersubjectivity" (cf. Stern 1985; Trevarthen 1980), but the evidence for these claims has been unclear. Trevarthen and Stern point to the infant's "conversational dances": the elaborate play of eye contact, vocalization, and gesture between infant and mother. But why should these temporal coordinations require the sense that the other person is "like me" in fundamental ways? The fact of newborn imitation suggests a deeper identification between the self and the other. To imitate, infants must somehow assign the same representation to perceived movements of others and their own internal kinesthetic sensations. This is apparently an innate ability.

This innate bridge between the self and the other accounts for the basic fact that the behaviors of others are automatically construed as relevant to my own behaviors, intentions, and plans. More significantly, however, imitation can also serve as a source for more elaborated understandings of the person. By 9 months infants imitate not only gestures but also actions on objects, in the way Tomasello et al. describes; they also recognize when their own actions on objects are being imitated by others (Meltzoff 1990). We suggest, however, that this ability is an elaboration of the earlier more foundational ability to identify the self and others in the first place. We have suggested, for example, that the mutual imitation games between infant and mother that are commonly found in infancy may serve as a sort of theory-of-mind tutorial, specifying for the infant what his own relations and attitudes to objects and persons ought to be (Meltzoff & Gopnik 1993).

This example raises an important point about the developmental continuities between various early conceptions of the person. Imitation, by itself, has seemed to many, including Tomasello et al., to be limited to rather superficial behavioral mimicry. Now combine the impulse to imitate, and the identification of self and other that underlies it, with highly powerful theory-formation abilities. Suppose the child is simultaneously trying to understand people and to be like them. For example, as the child begins to understand relations between people and objects at 9 months, the relevant units, as it were, for imitation turn into actions on objects rather than actions per se. The basic mechanism, namely, the identification of the behavior of others with our own intentions and internal states, is the same but the construal of what the behavior of others is, and therefore what our own internal states are, has become far more sophisticated. The child's behavior starts to look less like imitation and more like attribution.

Now suppose that the child makes some even more sophisticated theory-like generalizations about behavior, say, those generalizations that are involved in a new understanding of beliefs at about age 4. Several investigators have argued that such generalizations are responsible for the changes in false-belief performance at around this age (Gopnik & Wellman 1992). It is crucial for Tomasello et al.'s arguments about cultural learning that children not only make this generalization but apply it equally to themselves and others; and indeed the empirical evidence suggests this is the case (Gopnik 1993). But why would children apply these generalizations to themselves? It sounds odd to say that children "imitate" beliefs or desires in the way that they imitate actions, but we think the basic mechanism may be the same. Children develop a more sophisticated and abstract conception of human behavior, which includes "theoretical entities" like belief and desire. Given the fundamental and innate identification between the behavior of others and the internal states of the self, the child attributes these states to both the self and other. As a consequence, when children have an inaccurate view of others, their view of themselves is similarly inaccurate. For example, children who fail to understand the false beliefs of others also fail to understand their own false beliefs (Gopnik 1993).

This combination of theory formation and imitation may itself lead to some of the unique and puzzling features of human culture. When we develop knowledge about objects, we feel no impulse to extend that knowledge to ourselves or to regulate our actions in accord with it. When we develop similar knowledge about persons, on the other hand, especially the persons closest to us, we do indeed attribute similar states of mind to ourselves, and act in accord with them. This fairly simple story might provide a basis for the mysterious "internalization" that Vygotsky (1962), representatives of the psychoanalytic tradition, and others have postulated. It would also help to explain the cultural "racheting" that Tomasello et al. describe so well.

We suggest, then, that imitation and the identification of self and other that underlies it is more than just one more form of cultural learning. It may lie very near to the heart of the astonishing ability of human beings to understand the minds of their conspecifics and to attribute similar mental states to themselves and others. As humans, we use our extraordinary theory-creating abilities to construct ever more elaborate and abstract accounts of the behavior of others. It is, however, our basic identification with others, manifested first in imitation, that leads us to treat these theoretical constructions not only as

cold generalizations about the behavior of others, but as descriptions of the deepest and most fundamental aspects of our own being.

Child development and theories of culture: A historical perspective

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One of the most intriguing aspects of Tomasello et al.'s formulation is their synthesis of two historically disparate lines of inquiry in cross-cultural child development: (a) grounding in an evolutionary model, and (b) explicit identification with more interpretive approaches to culture.

Evolutionary/adaptationist approaches. Historically, both anthropology and developmental psychology emerged from the progressive developmental paradigm that we today associate with such nineteenth-century evolutionist thinkers as Spencer, Haeckel, Romanes, Morgan, and Tylor (Morss 1990; Stocking 1984). Based on non-Darwinian evolutionary speculation, as well as on a misreading of Darwin himself, this paradigm maintained that development consists of an orderly sequence of changes that are parallel across the individual, the history of civilization, and the course of evolution itself.

This paradigm ceased to be dominant in cultural anthropology early in the twentieth century, due in part to post-World War I disillusionment with the presumed superiority of Western civilization, and in part to the rise of the structural/functionalist approaches of Radcliffe-Brown and Malinowski. Child psychology, on the other hand, took a different course in that the search for universal, sequential stages of development remained a more paradigmatically dominant concern (e.g., Baldwin, Freud, Piaget).

The *cultural* study of the child, however, did not emerge from within developmental psychology, but instead from Malinowskian functionalism in anthropology. Ruth Benedict and Margaret Mead, students of Malinowski, are generally credited with founding the culture and personality movement – a movement whose dominance in cross-cultural child psychology is still felt (e.g., Segall et al. 1990). In the late 1950s, culture and personality incorporated the ecosystem concept in anthropology (Steward 1955) to form what Keesing (1981) terms "cultural adaptationism." According to this view, the socializing context of the child is an ecosystem in which the physical environment, modes of production, social organization, and belief systems are all viewed as functionally interdependent and coexisting in an adaptive equilibrium. Culture itself is ultimately defined as socially transmitted behaviors that are adaptive to an environment common to a group of people. Adult personality plays a functional role in relation to a society's economy and the goal of child training is to produce personality traits that are adaptive to a society's economic needs (Whiting & Whiting 1975).

To this day, when developmental psychologists choose a theory, it is usually an heir to the progressive developmental paradigm, with its search for an orderly and universal sequence of change across the lifespan. Concomitantly, when child psychologists reach for a theory of *culture,* it is generally some variant of cultural adaptationism. However, cultural adaptationism has fallen into disfavor among both cultural anthropologists and cultural psychologists. First, its inherent functionalism has been heavily criticized for confusing the genesis of practices with their current use (Little 1991). Second, scholars have questioned the assumption that ecosystems exist as isolable units (Drummond 1980). Third, the failure to find lawful relations between environmental variables and particular attitudes and behaviors has called into question the notion that all aspects of an ecosystem exist in a necessary interrelationship (Super & Harkness 1986). Fourth, increased disillusionment with the idea that researchers can identify stable characteristics of individuals apart from situational determinants (Mischel 1968) has challenged the notion of personality itself. Finally, the cognitive revolution in psychology has brought with it greater interest in the cognitive processing of social demands, a perspective that necessitates a more fluid, contextualized approach than that suggested by a notion of generalized adaptive tendencies (Laboratory of Comparative Human Cognition 1983). Interest in cognition has in turn paved the way for more *interpretive* approaches to the study of culture.

Interpretive approaches. Although diverse in their particulars, interpretive approaches generally share two central concepts: (a) Human beings construct meaning through their cultural symbol systems, with language being one of culture's most powerful symbol systems; and (b) this construction occurs within a matrix of social interaction. Interpretive approaches within the social sciences have included: symbolic interactionism (Mead 1934); sociolinguistics (Gumperz & Hymes 1986); postmodern cultural anthropology (Clifford 1986); social constructionism (Shweder 1990); sociohistorical approaches (Vygotsky 1978); and Ochs and Schieffelin's (1986) interactional view of socialization.

According to interpretive approaches, through the process of socialization individuals acquire "stock knowledge" for use in constructing and interpreting contexts; through participation in social activities with culturally competent interactants, individuals internalize interactional norms and gain performative competencies. The child is thus viewed as an active organizer of the rule-governed understandings to be abstracted from the speech acts of everyday social interactions. Although this has led to increasingly popular narrative/linguistic studies of socialization (see Garvey 1992), interpretive approaches have generally been considered too "soft" and "murky" for child psychologists seeking universal laws of human nature; the latter have tended to look instead to evolutionary/adaptationist models (e.g., Segall et al. 1990) for explanatory mechanisms.

Cultural learning. The theory of cultural learning offered by Tomasello et al. clearly shares some aspects of the evolutionary/adaptationist approach outlined above. First, it contains elements of a comparative model with its appeal to research on chimpanzees and autistic children. Second, it outlines an orderly, presumably universal sequence of developmental stages. Finally, it is clearly influenced by Boyd and Richerson's (1985) dual-inheritance theory, a processual approach within contemporary anthropology which seeks to explain how biological evolution led to the capacity for culture and its diversity.

Tomasello et al., however, upset the status quo of cultural approaches to the study of child development by combining their theory's evolutionary grounding with key aspects of the interpretive approach: the central role of human cognition, the significance of language as a symbolic system, the importance of the social context in the internalization of the "voice" of the other, and a stated commitment to "the emerging paradigm of Cultural Psychology" as articulated by Shweder (1990). Many researchers may find that this model lacks some of the defining characteristics of a fully interpretive approach (e.g., emphases on the coconstruction of a worldview, the arbitrariness of most aspects of culture, the importance and variability of cultural meaning systems, and the extent to which individuals' perceptions are shaped by those meaning systems). Nonetheless, Tomasello et al.'s cultural learning model represents an attempt at and an opportunity for rapprochement between two historically disparate and deeply entrenched schools of thought. Such a rapprochement may be essential to further progress in the field of cross-cultural child psychology.

Cultural learning: Are there functional consequences?

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Two problems commonly surface when scientists attempt to provide evolutionary accounts of human cognition. First, proximate causation (i.e., mechanism) is often viewed as an alternative to ultimate causation (i.e., adaptive function). It is not. Second, performance on a task is equated with cognitive ability. This is only sometimes true.

In this commentary I raise two objections. I claim that a more complete evolutionary account of human culture will require the integration of a more explicit functional stance, exploring the fitness consequences of the different mechanisms of information transmission in the social arena. This claim is important for the second point, which is that current assessments of the "special" nature of human cognition depend on the reliability, robustness, and interpretation of current work on nonhuman animal cognition. I believe this is a weak foundation for building *evolutionary* theories of cognition.

Tomasello, Kruger & Ratner believe that cultural learning and the products it generates are the result of cognitive processes whose origins are within the hominid line rather than within the more ancient hominoid or even primate line. This claim is difficult to defend because it relies completely on the strength of experiments with extant nonhuman primates. As the history of research on animal intelligence warns us, we must be careful to distinguish between ability and performance. Because so few controlled experiments have been conducted to assess the cognitive abilities of our closest relatives (and I would include all of the nonhuman primates, not just chimpanzees), I don't believe that current performance is actually indicative of ability. I suppose that in this sense, I am a closet MacPhailian who believes that it takes considerable work to demonstrate the *lack* of an ability. We are a long way off from claims regarding the representations, beliefs, and intentions of monkeys and apes.

Tomasello et al. want to rule out some of the observations of chimpanzee culture and imitation as bona fide examples because they do not meet some of the stringent criteria that have been set up. I found, however, that their discussion underestimated the potential importance of nonhuman animal work and in particular underemphasized the necessity of considering the function of different mechanisms of transmission and the evolutionary consequences they bring. Consider for the moment the data on putative teaching in wild chimpanzees (Boesch 1991). Tomasello et al. state that, in two cases, mothers appeared to "slow down their tool use when infants were watching." This is completely inaccurate. In one case the mother reoriented the way in which her infant was holding the tool (i.e., a hammer used to open nuts), and in the second case a mother reoriented the position of the nut on the anvil to increase the probability of a successful hit. This direct intervention on the part of the mother suggests both that she recognized how things should be done and that she recognized a deficiency in her infant with regard to the requisite motor task. More important, as Caro and Hauser (1992) have argued in a review paper on teaching in nonhuman animals, *instructive* interactions do not require the ability to attribute mental states to others. This is because from a functional perspective what counts is whether the interaction leads to significant fitness consequences. And in many recent cases of socially mediated learning, there are clear fitness consequences such as increased survivorship (e.g., Aisner & Terkell 1992; Hauser, in press). Although Tomasello et al. cite our paper as providing a "more generous interpretation of animal teaching," it has nothing to do with generosity. Rather, our view reflects an emphasis on the adaptive function of teaching as opposed to the mechanisms of teaching. Thus, to summarize my first point, if an evolutionary account of human cognition is desirable, as Tomasello et al. clearly seem to suggest, then it is absolutely essential for the theory to consider the function of different mechanisms of transmission and thus why the hominid line developed its own special breed of cognitive abilities – if it did.

My second point concerns the claim that nonhuman primates lack the appropriate cognitive capacities to engage in cultural learning. We now know from the work of several neuropsychologists that nonhuman primates have the ability to represent, over fairly long periods of time, complex visual and auditory information. Among the key neural players are the prefrontal cortex, amygdala, and hippocampus. The strong claim of the target article by Tomasello et al. is that nonhuman primates, in particular chimpanzees, lack the ability to take the perspective of others and thus lack the ability to make use of intentional instruction or to engage in intentional collaborations. I would like to suggest that our nonhuman primate relatives have the neural machinery to engage in the sorts of cultural learning discussed by Tomasello et al. and that there are in fact cases that are at least as suggestive as those described for preverbal human infants. For example, Stammbach (1988) has shown that when a subordinate individual is trained to perform a task that yields extremely valuable goods (i.e., food) and no other group member is capable of performing the task, the subordinate's status in the group changes. Specifically, although dominant individuals would normally supplant a subordinate from food, the subordinate individual is now allowed to keep some of the goods as long as he continues to perform the task. In this example, there is clearly collaboration and, although the individuals involved may be basing their actions on the behavior of others rather than on their mental states, it implies a level of sophistication that I believe Tomasello et al. fail to consider. And, in the case involved, there are clearly functional consequences to the collaborative effort.

In conclusion, although I would very much like to see Tomasello et al. place their framework in a more functionally based perspective, I applaud them on their effective integration of issues in the cognitive sciences, developmental psychology, and behavioral biology. They have certainly provided those of us working on nonhuman animals with some theoretical targets to shoot at and for.

Imitation without perspective-taking

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Tomasello et al. offer a hypothesis to explain the unique characteristics of human traditions. They have identified features that distinguish human and nonhuman traditions with unusual clarity and their hypothesis is intriguing, but the target article leaves me unconvinced that social-cognitive abilities such as perspective-taking play "a vital role" in cultural learning.

My doubts about the relationship between social-cognitive abilities and cultural learning were aroused principally by Tomasello et al.'s discussion of imitation. They suggested both that perspective-taking is logically necessary for imitation and that there is convincing empirical evidence of a link between the two. Both these propositions are, I shall argue, false and their cooccurrence is a sign of confusion. If imitation implied perspective-taking then it would be unnecessary to seek empirical evidence that the capacities for imitation and perspective-taking coincide. Instead of opting to rest their case on one claim or the other, Tomasello et al. have, I suspect, allowed false preconceptions about the psychological processes underlying

imitation to guide their interpretation of the empirical evidence.

Tomasello et al. suggest that perspective-taking is logically necessary for imitation in section 2.2: "Reproducing an adult's novel behavior in both its form and appropriate function (i.e., imitative learning) clearly requires some understanding of what the adult is perceiving and intending because without such understanding the child cannot know which aspects of the adult's behavior are relevant or irrelevant." There are in fact at least two ways in which an individual could achieve form and function or action and outcome reproduction without perspective-taking (Heyes 1992). First, if individuals observe a model executing several different action-outcome sequences (e.g., see a ball being thrown underarm and overarm and landing in different places), then they might learn that certain, observable features of the action are predictive of certain, observable outcomes, and selectively reproduce those features that are predictive of the outcome that is desired. This process may be described as action-outcome contingency learning by observation. Second, an individual could "mimic" a model's behaviour, that is, reproduce the action without expectations about its outcome, let alone any apprehension of the model's goal (if any) in performing the action. Tomasello et al. acknowledge the possibility of mimicry without saying how, in general, it may be distinguished empirically from imitation; and they overlook the possibility of action-outcome contingency learning altogether.

Tomasello et al.'s case for empirical rather than a logical link between imitation and perspective-taking is also unconvincing, for at least two reasons. First, it dismisses without proper justification evidence of imitation in creatures that are thought to be incapable of perspective-taking. For example, the capacity of newborns to imitate facial movements and head turnings (Meltzoff & Moore 1989) is discounted on the grounds that it does not involve "the acquisition of novel behaviors," but it is not clear why this fact might protect Tomasello et al.'s hypothesis from disconfirmation by Meltzoff & Moore's (1989) data. The requirement that a behaviour be novel in order to qualify as evidence of imitation was imposed when researchers could not think of another reliable means of distinguishing imitation from the chance occurrence of matching behaviour (e.g., Thorpe 1956). Now that the possibility of chance or coincidental matching can be eliminated using, for example, Meltzoff and Moore's (1989) "cross-target" procedure, continued adherence to the novelty rule requires explanation. Tomasello et al. might explain their adherence by pointing out that the reproduction of behaviours already in an individual's repertoire is unlikely to effect behaviour transmission. This argument, however, would make Tomasello et al.'s claim that imitation is a form of cultural learning rather vacuous. If imitation were defined, in part, as a learning process that effects behaviour transmission, and if the potential to effect behaviour transmission were judged to be sufficient to make a learning process "cultural," then imitation would inevitably count as a form of "cultural learning." (Because "cultural accumulation" is likely to depend at least as much on processes of information retention as on mechanisms of information acquisition, I would also contest the second premise above, but that's another story – Heyes 1992).

Second, Tomasello et al.'s review of the literature is too narrow to take account of the fact that when imitation is defined as the reproduction of the form and function of a model's novel behaviour there is evidence that both budgerigars and rats can imitate. Budgerigars that have observed a conspecific using either its beak or its feet to lift a flat cover from the top of a food cup tend to use the same appendage as their model to lift the cover (Galef et al. 1986). Rats that have observed a conspecific pushing a joystick in one of two directions for food reward tend subsequently to push the joystick in the same direction (relative to the actor's body) as their model (Heyes & Dawson 1990; Heyes et al. 1992). As far as I know, no one has tried to find out whether budgerigars and rats can attribute intentions; hence these experiments cannot be said to indicate with certainty that perspective-taking is not necessary for imitation. However, since our reasoning about vermin and budgies may be freer of anthropomorphic bias than our reasoning about children and chimpanzees, they are a reminder that the link between imitation and perspective-taking is a bold, largely unsupported hypothesis rather than a necessary truth.

Turning finally from imitation to "cultural learning" more generally, I found Tomasello et al.'s remarks about "enculturated" and "nonenculturated" chimpanzees inconsistent with their claim that social-cognitive abilities such as perspective-taking are required for imitative, instructive, and collaborative learning. If their suggestion were valid then how could a "nonenculturated" chimpanzee deficient in the relevant social-cognitive abilities become an "enculturated" chimpanzee that had sufficient social-cognitive ability to be capable of cultural learning? Tomasello et al.'s concession that such a transformation may occur implies either that social-cognitive abilities result from, rather than give rise to, imitative, instructive, and collaborative learning, or that there is some other variety of cultural learning that does not require social-cognitive ability. Thus, far from providing convergent evidence that certain social-cognitive abilities are necessary for cultural learning, Tomasello et al.'s interpretation of the chimpanzee data apparently contradicts that conclusion.

On acquiring the concept of "persons"

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In their description of cultural learning, Tomasello, Kruger & Ratner offer a timely and persuasive account of the emergence of certain forms of perspective-taking that are unique to human beings. The developmental story is couched in terms of the child's growth in understanding about the nature of "persons." I believe there is much to be said for adopting such an approach. Tomasello et al. suggest that in successive stages of development, a young child operates with different "concepts" or "constructs" of the person: the intentional agent, the mental agent, and the reflective agent. I shall concentrate on the first of these categories.

The initial stage of cultural learning corresponds with the infant's ability to learn through imitation of another person. Such behavior appears towards the end of the first year of life and requires that "the child must understand the demonstrator in terms of his intentions toward things (i.e., as an intentional agent) in order to distinguish the relevant and irrelevant aspects of the demonstrator's behavior" (sect. 2.4, para. 5). In this regard, Tomasello et al. emphasize the child's understanding of what the adult is perceiving and intending. At several points they also state that cultural learning occurs when the child attempts to understand or perceive a situation in the way that another person understands or perceives it.

Two questions arise. First, what is the *kind* of "understanding" these infants have attained? Second, how is such understanding acquired?

I am doubtful whether it is appropriate to talk about the infant's "concept" of persons at this early period. I say this, even though I strongly agree that this is an important stage in the acquisition of such a concept. Tomasello et al. seem to suggest that in early imitation, infants themselves have the goal of approximating their own actions *and intentions* to those of another person, conceptualized as such. They are supposed to have a concept of persons and a sophisticated degree of self-reflective awareness, so that they can knowingly adopt or try to adopt the psychological stance of someone else. I doubt whether

this is a correct description of the 12-month-old. I agree that infants are trying to act in correspondence with perceived actions. For this to occur, "actions" have to be perceived *as* actions and thus infants must have some awareness of the nature of other persons. This having been said, infants may not have the goal of adopting the other person's psychological perspective, even if this is an outcome of what they *are* attempting to achieve. I would suggest that, on the contrary, it is partly through imitating others' actions that infants come to experience and in due course understand what it means to assume another person's viewpoint. Only with such insight will they have acquired the *concept* of a person as "someone in whose place I can put myself" (Bosch 1970, p. 89), and only then will they be in a position to "attempt" to adopt alternative perspectives *as* alternative perspectives. This seems to occur around the middle of the second year of life.

Just now I suggested that it is "partly" through imitating actions that a child comes to understand what it means to adopt someone else's psychological orientation. What else might be involved? I believe that Tomasello et al. are overly restrictive and perhaps somewhat misleading in the way they characterize the content of the child's interpersonal understanding at the end of the first year of life. Here I shall need to supplement as well as comment upon their ideas. The important thing to add is that the infant apprehends other persons as having subjective orientations and attitudes as well as intentions-in-acting. Such outwardly directed mental states are "intentional" in Brentano's (1874/1973) sense of this word, but only a subgroup are intentional in the sense of "intending-to-X" (and note that I am not claiming the infant conceptualizes any of this). So, for example, Tomasello et al. suggest that an understanding of another "in terms of his intentions toward things (i.e., as an intentional agent) . . . would also seem to underlie the child's early attempt to make social reference, to engage in joint attention, and to communicate intentionally with others" (sect. 2.4, para. 5). If the authors meant that the "intentional agent" was construed as a person who has psychological *attitudes* towards the world, then the terms would be defensible, at least in a qualified way; however, it is not clear that this is what they mean. They do not consider the processes by which an infant comes to perceive, react to, and sometimes assume the psychological orientations (as opposed to the actions) of others, nor do they analyze how the child becomes aware of the "intentionality of mind" behind "intending."

I think Tomasello et al. overlook certain important "noninferential" mechanisms that come into play here – mechanisms that may be specifically abnormal in autism. These mechanisms have much to do with the "direct" perception of and responsiveness to what we might broadly call the affective expressions and conduct of others. They are mechanisms that draw the child into states of mind that are coordinated with the mental states of others – and are so registered. They establish the earliest forms of shared experience and thus of communication between the infant and others, and they account for much though not all of joint attention and social referencing. According to this account, normal 12-month-olds perceive rather than conceive person-related "meanings," which induce corresponding feelings and motivational propensities in themselves, including dispositions to imitate. Concepts will come later, built on these very nonconceptual foundations.

I would also make one comment on the next phase in the scheme of Tomasello et al. This is when the child acquires the concept of a mental agent, around the age of 4. It is questionable whether the expression "mental agent" should be reserved to characterize this relatively late stage of interpersonal understanding. As the authors appreciate, it is not a matter of children understanding how there can be different subjective orientations on the same situation, something they achieve during the second year of life, but rather that around age 4 children acquire an understanding of the way that different people may hold different views (and convictions) concerning what is truly the case. It will need some further fleshing out to explain why this is critical for instructed learning.

There is a great deal of value in the concept of cultural learning. I agree with Tomasello et al. that this perspective is of fundamental importance in understanding the cognitive deficits that characterize autism. The authors have highlighted and begun to characterize a central feature of human cognitive development.

A social anthropological view

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Writing as a social anthropologist rather than a psychologist, I can only welcome this target article's call for an approach to processes of cultural transmission that is sensitive to their embeddedness in contexts of social relations. It would be invidious to suggest that psychologists are at last discovering what anthropologists knew all along, for psychology's erstwhile neglect of the social and cultural dimensions of human experience has been matched by an equally shameful neglect, on the part of anthropology, of children and their development. A decade ago, Theodore Schwartz told us of his "sudden and belated realization . . . that anthropology had ignored children in culture while developmental psychologists had ignored culture in children." The result, he observed, "is ignorance of the process and content of the child's emerging competence as a member of a culture" (Schwartz 1981, p. 4).

Not much has changed in the intervening years, though there are signs that anthropologists are at last waking up to the fact that a large proportion of the people in the societies they study are children (just as a while ago they woke up to the fact that half of them are women). And on the part of psychology, we have the evidence of Tomasello et al.'s paper, and other work cited therein, for a redirection of attention towards culture and social context. There are grounds for optimism that practitioners of the two fields will eventually realize that mind and culture are not separate entities, lying on either side of a dichotomy between individual and society, but are rather mutually implicated in the processes by which human beings make their way in the world. In their attempts to understand these processes, anthropologists and psychologists have (or should have) the same objectives.

Many hurdles to disciplinary integration remain, however. One of these is that we are heirs to a conceptual vocabulary that is ill-suited to current concerns. This vocabulary includes such key terms as mind, culture, individual, and society. Let me begin with a word about culture. It seems that the concept of culture is currently making its entry into psychological theorising in a sense that more and more anthropologists would now regard as virtually obsolete. Few would any longer subscribe to the idea, apparently endorsed by Tomasello et al., that cultures exist "out there" as things that human beings might be said to live in: each one a neatly bounded, perfectly shared, and historically cumulative body of acquired tradition. It would be more in accord with present anthropological thinking to say that people live culturally rather than living in cultures, and that cultural life consists in a medley of multiple voices, as often discordant as in unison, characterised by an imperfect sharing of knowledge, founded as much on misunderstanding as on common understanding, and perpetuated through an improvisatory, often playful and always creative, dissembling of convention. People, in their everyday lives, encounter and engage both with other people and with a range of nonhuman agencies and entities in their environments, in diverse situations and con-

texts. But no one has ever encountered a culture. There must be some question, therefore, about whether it is possible to distinguish cultural learning from the total process of cultural life in which all of us participate all the time – a process otherwise known as history.

Quite apart from what we might mean by culture, the terms of the distinction Tomasello et al. draw between social and cultural learning are bound to cause confusion. This is apparent from the observation that for the authors, social learning is essentially individual whereas cultural learning is essentially social. Part of the problem goes back to the thoroughly unsatisfactory nature of the classical distinction between individual and social learning, a distinction that effectively divorces the learners' interactions with conspecifics from the contexts of their practical involvement with other components of the environment. Anthropological thinking, too, has been plagued by a pervasive dichotomy between the individual and the social; its consequence has been to split off the development of human beings as *organisms*, endowed with capacities common to the species, from their development as *persons*, equipped with the particular attributes required to function as members of this or that social group. This, in turn, lies behind classical anthropological theories of socialization and enculturation, according to which the human organism is the passive recipient of social and cultural forms that are imposed upon it from outside, and that mould its ways of acting, thinking, and feeling into conformity with prevailing normative standards.

I believe that this individual/social dichotomy is also responsible for the unfortunate separation, noted earlier, between the psychological study of child development and the anthropological study of culture and social life. For the implication is that only as fully socialised or enculturated beings do humans properly participate (as persons) in the life of society: the processes of socialisation and enculturation that prepare the child for personhood thus form no part of that life, and to study them is to study not the dynamics of social life but the psychodynamics of acquisition, by immature individuals, of the sociocultural schemata that enable them to enter into it. However, recent studies in both anthropology and psychology, including the present target article, demonstrate convincingly that this position is untenable (see Ingold 1991; Lave 1990; Toren 1990 for some relevant anthropological discussions). They show that from the start the infant is caught up within a nexus of social relations and that its own individuality, far from being given in advance as a biological datum, emerges as these relations unfold in the course of development.

Certain implications follow, however, which are not so easily reconciled with Tomasello et al.'s position. The first is that it is precisely in those so-called learning processes wherein children actively and creatively engage with others in their surroundings, recognizing them as persons who attend to them, that history is being made. The authors claim that it is thanks to cultural learning that humans have history, yet with the possible exception of collaborative learning, they separate the learning from the history, the former providing a route of induction into the latter. As intimated above, I would question that separation. Situations of learning do not provide a prelude, in the life cycles of individuals, for their entry onto the historical stage; rather, they are the sites from which history unfolds. And by the same token, I would be inclined to seek the conditions of learning in historically formed asymmetries in the social distribution of knowledge (and concomitantly in the structuring of social power), rather than in universal stages of individual ontogeny. To put it crudely, trajectories of learning will depend upon the power relations obtaining between adults and children, and these relations are historically variable.

Second, I would query the authors' consistent emphasis on the acquisition of *cognitive representations*, and along with this, their frequent resort to the notion of learning as a process of *internalisation*. This amounts to positing the individual, right from the start, as a bounded, self-contained entity vis-à-vis an "outside world" that must be internally represented in consciousness prior to any attempt at engagement. As regards the representation of other persons, it is precisely this cognitivist premise that has underwritten the dichotomy between individual and society, whose damaging consequences I have already outlined. I would be more inclined to treat learning as an attunement of the perceptual system constituted by virtue of novices' active, bodily immersion in their surroundings. What learners acquire, then, are skills of *attending* to the world (including skills of reflexively attending to their own and others' attentiveness), rather than schemata for *representing* it within their several minds. With Gibson (1979, p. 254), I would thus regard learning as an "education of attention," a matter of enskillment rather than enculturation (Ingold 1991, p. 371).

This brings me to the third of my reservations about the position taken in this target article, which concerns the concept of the person. The authors claim that children operate, in successive stages of development, with a concept of the person as intentional agent, as mental agent, and as reflective agent. These concepts, it is supposed, enable the child to understand the behaviour of other persons by referring it back to preexisting "intentional," "mental states" or "beliefs" located in the minds of agents. This claim, it seems to me, is problematic on two levels: ethnographic and ontological. First, it attributes to children everywhere a model of agency that is in fact of peculiarly Western provenance (and for that reason, of course, deeply embedded in mainstream psychological thought). By and large, people in non-Western societies do not subscribe to this model, and look to the sphere of a person's involvement in wider fields of relationship, rather than invoking interior mental states, to discover the generative source of social action. Second, it assumes that the child's apprehension of *actual* persons in its environment is always, and necessarily, mediated by concepts. In other words there can be no *direct*, mutual involvement of self and other: Intersubjectivity is possible only on the level of shared representations. This is to accord ontological primacy to the Western model of agency, and once again to perpetuate the dichotomy between individual and society.

In their target article, Tomasello et al. take a major step towards "socializing" the theory of learning, but they make it only halfway. To complete the passage, it will be necessary to jettison the conceptual baggage of cognitivism, whose effect is to remove persons and relationships from the lived-in world, only to reinscribe them on the plane of its mental representation. What remain are isolated, asocial individuals, opaque to one another. Human beings are indeed perspective-takers, but their perspectives are taken from positions *within* the world, and the very taking of a perspective is itself an aspect of social action.

The primate behavioral continuum: What are its limits?

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Even those of us who embrace the notion of a continuum as the best way to describe primate behavior – and who thus reject strict behavioral dichotomies in cognition and communication between humans and other primates – recognize that the continuum has its limits. Nonhuman primates do not, for example, show evidence of religious ideology, complex trade networks, or the ability to express their thoughts in writing. Species-specific adaptations and evidence for human uniqueness, then, sometimes overlap in a meaningful way, that is, it surely must *matter* that humans behave in ways qualitatively different from their closest relatives.

One might ask, though, whether all species-specific differences are meaningful. In some cases, might there be a difference between noting that "behavior X is species-specific to humans" and claiming that "behavior X is qualitatively different from behaviors shown by other primates and thus makes humans unique in a meaningful way"? My remarks are intended to address this question plus the related issue of whether Tomasello et al.'s conclusions about human uniqueness are shaped primarily by data, primarily by assumptions, or by a mix of each.

That my commentary is topically restricted to suggesting an alternative perspective on some of the assumptions and conclusions is a credit to the authors. The target article is well argued and stimulating, as is the research of Tomasello and his colleagues reported in it; comparison of data from apes and children is particularly welcome. Indeed, on quite a few points, Tomasello et al. are convincing. From their account, collaborative learning and the complex perspective-taking on which it depends do seem to be unique to humans, with important consequences for the mode of cultural transmission (and the ratchet effect) found in human societies. When it comes to imitative learning and particularly to instructed learning, though, the case seems less clear, for two reasons – the anthropocentric assumptions of the authors and the lack of sufficient data from nonhuman primates on the issues raised.

In note 10, section 4, Tomasello et al. recognize their anthropocentric bias and justify it by noting their primary interest in humans. It seems to me that their primary interest is in *differentiating humans* from other primates. Adopting definitions with an admittedly anthropocentric bias is not the best way to achieve this goal – or even to understand humans alone – because it does not allow for the possibility that a different type of species-typical adaptation might accomplish the same end as human-specific behavior (see Cartmill 1990). Tomasello et al. do not ask what monkeys and apes do so much as ask whether monkeys and apes do what humans do. These questions are quite different and might well produce divergent answers. In section 5 they say that nonhuman primate traditions such as termite fishing by chimpanzees are not cultural, "at least not in the human sense of that term." True enough, but why would we expect *chimpanzees* to show culture in the *human* sense?

Elsewhere (King 1991a), I have suggested that theories by anthropologists and other scholars about the origins of speech or language tend to fall into three categories. In the first (e.g., Burling 1993), communication skills of humans and other primates are strictly dichotomized, with human skills seen as vastly superior. In the second (e.g., Lieberman 1991), no strict dichotomization is attempted, but modern human speech and language are used as standards against which all other abilities are judged, with the clear assumption that these abilities are the most complex and efficient. In the third (e.g., Gibson 1990), behavioral change over time is modelled to suggest how and why change occurs gradually along the continuum of communication abilities in primates. It is possible, naturally, to show bias toward any of these categories (I am probably biased toward the third). I only want to suggest that Tomasello et al. fall into an analog of the second category, and that their conclusions are influenced by that fact.

The authors state in section 4, for example, that chimpanzees in the wild do not actively instruct their young, but only prevent certain behaviors and facilitate others. From another perspective, King (1991b) suggests that although instruction is indeed rare in nonhuman primates, evidence exists for (1) behavior that meets logical, nonanthropocentric criteria for active instruction, and (2) a continuum exists in active information transfer across primates. I agree with Tomasello et al. that there is no evidence that young chimpanzees internalize anything social or intersubjective from their interactions with adults, but that lack of evidence does not seem to justify claims for no active instruction – which brings us back to questions of definition.

Some questions to consider are: Should the Boesch (1991) report of teaching in wild chimpanzees be dismissed as Tomasello et al. suggest, because the adults do not "persist in their behaviors until the youngster has reached a criterial level of performance"? According to Boesch, mothers adjust their behavior to the skill level of infants; if these data are confirmed, I see no point in excluding this behavior by definition from active instruction (these data may also have significant consequences for understanding perspective-taking in *adult* chimpanzees). If, as Tomasello et al. admit in section 2.2, there may be no clear testable differences between instructed learning, as they define it, and scaffolding, it is also not clear that the definition of instructed learning should always include the child learning about the adult as well as about the task. Perhaps the instructed learning described by Tomasello et al. is just the human species-typical version rather than the only possible kind of instructed learning. What evidence would be needed, in any case, to claim that young chimps learn about adults as well as the task? What is meant specifically by "cognitive self-monitoring" in this context? In section 4, the authors comment that it is unclear how an unenculturated chimp would demonstrate understanding of others as reflective agents, and the point applies throughout. In the absence of clear testable predictions for distinguishing among behaviors, the requisite evidence cannot be sought, and claims for human uniqueness are premature.

Consider next the description from section 5 used to discuss three posited differences between traditional behavior of nonhuman primates and cultural behavior of humans. The authors state that human children learn "concrete tasks," such as hoeing, "in the way they have been shown . . . with perhaps some individual idiosyncrasies." With human social-conventional behaviors such as linguistic symbols or religious rituals, idiosyncratic use is not viable. By contrast, "many keen observers have noted that individual chimpanzees often use their own idiosyncratic techniques in all kinds of 'cultural' behaviors." Assuming that the appropriate comparison to chimpanzee termite fishing is with concrete tasks such as hoeing (and not with linguistic symbols or religious rituals), isn't the reported difference one of degree only?

In sum, Tomasello et al. are on the right track in arguing that differences in perspective-taking abilities between humans and other primates have meaningful consequences for cultural transmission across species. Others of their conclusions, however, are rooted as much in assumptions as in data.

Moving forward on cultural learning

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Tomasello, Kruger & Ratner make the very interesting and valid point that the transmission of culture must depend on understanding others' minds. Culture is shared among a people and is passed on to progeny. The sharing of culture implies that the purpose of (and therefore the meaning behind) any given cultural element (behavioral tradition, word, or artifact) is understood. Because meaning or purpose emanates from minds, something about others' minds must be understood in order to truly learn some element of a culture. It thus makes sense that cultural learning should depend on social-cognitive skills. But what exactly is cultural learning?

There are two rival interpretations of the term cultural learning. In the first, one would define a given type of cultural learning by the type of social-cognitive skill it entails. For example, imitative learning would be defined as any learning of a cultural element in which another's goals or intentions are taken into account. This definition of cultural learning, however,

would force Tomasello et al.'s argument into a circle: Imitative learning relies on this social-cognitive skill because imitative learning is defined as learning that relies on this social-cognitive skill. Such a circular definition does not do their argument justice.

The alternative interpretation requires that any given type of cultural learning be defined separately from the skills used to engage in it. This calls for a focus on the cultural elements themselves. Exactly what elements of a culture are learned via a given type of cultural learning?

The clearest example is language, learned in Tomasello et al.'s scheme via imitation. Imitative learning involves taking the other's perspective where the other is conceptualized as an intentional agent. Language acquisition entails imitative learning because in order to understand that words refer, children must understand adults as intending to refer when they use words. In this case, then, Tomasello et al. specify an element of culture (language) and discuss how certain social-cognitive skills allow its transmission. The main problem with their line of argument in this domain is the age at which they claim it occurs: 9 months. Joint attention and social referencing behaviors are given as evidence that 9-month-olds understand that adults attend and refer to objects. The evidence that 9-month-olds actually have this understanding is controversial. Reductive explanations can be made for early instances of joint attention. For example, children might have learned that when they look where an adult looks they see an interesting sight, or perhaps it just feels good to look where others look. And although some recent work suggests that social referencing is engaged in by older infants (Baldwin, personal communication), effects that have been attributed to younger infants might be explained as the child's associating a feeling elicited by the mother's voice with a given toy (Mumme, personal communication). Hence the skills necessary for understanding reference might not be there at 9 months. The best evidence of infants' seeming to understand *something* about others' intent to refer is probably Baldwin (1991), in which infants 16–19 months old did not apply new word labels to a novel toy that an adult was not attending to even when the children themselves were attending to the toy. Yet it is unclear exactly how to characterize even these older infants' knowledge of the mind. Early word use, on the other hand, could be explained by association or other low-level principles rather than by understanding attention. In short, the jury is still out on what infants understand about others' minds, and Tomasello et al.'s claim of an ability to understand others' intentions at 9 months is too generous based on current evidence. Language is a good example of cultural learning, however, and imitative learning, with its underlying social-cognitive skill of understanding others' goals and intentions, does seem necessary to learn a language.

Tomasello et al. are less clear about what aspects of culture are learned through instructional learning. Self-regulating speech is their main line of evidence that it has occurred, and presumably any cultural domain in which direct instruction is given can qualify. The problem with this as evidence for social-cognitive knowledge is provided by Tomasello et al. in their note 3: A child repeating an adult's instructions at a later time could simply be deferred imitation. There is no evidence that children are comparing their own perspective with that of the instructor as they do this. (Indeed, there is also no evidence that they are not doing so in Tomasello et al.'s counterexamples. When the children say "No!" when they are about to touch the electrical outlet, they could be enacting the adult's perspective and comparing it to their own.) Furthermore, the fact that high-functioning autistic children can learn to use tools quite well suggests that it does not require any insight into the mind of the teacher. If one were to respond to this by claiming that cultural learning occurs only when the learning is accompanied by insight into the mind of the teacher then we have run into the circular argument outlined and dismissed above. How do we know when a child has internalized the perspective of an adult as opposed to simply imitating the adult's directions? When has a child learned the meaning behind a religious custom as opposed to only the behaviors? It seems likely that children understand the perspectives of others at different times in different domains. Future work needs to determine more precisely and in different domains when true cultural learning rather than its poorer cousin (a reductive/behavioral counterpart) has occurred.

The same problems arise with regard to collaborative learning. One example of collaborative learning is that of the hammer evolving over the years. To make modifications to the hammer, however, it is not necessary to understand the intentions of the previous hammer-alterer. One need only know one's own requirements for the hammer and improve it accordingly. Regarding scientific collaboration, the partner need only respond to the words of the other, one need not conceptualize the other as having beliefs about one's own beliefs. The examples given of children solving conservation problems together are open to the same interpretation. Hence, with the examples of collaborative learning given by Tomasello et al., recursive understanding is unnecessary. Again, one might wish to define collaborative learning as only those cases in which one does simulate another's perspective on one's own mental state, but if this is the case then we are faced with the circular argument.

In sum, there is no strong evidence supporting Tomasello et al.'s position that the given social-cognitive skills are needed for the instances of instructional and collaborative learning that they use as examples. The most promising case is for imitative learning in acquiring word labels: It seems that to truly acquire language (as opposed to simply imitating sounds in response to certain stimuli), children must understand something about speaker intent. However, the evidence that children can engage in such learning is weak at 9 months; stronger evidence exists for 14- to 18-month-olds. Despite the lack of evidence, there is a strong logical appeal to their thesis: Human culture is endowed with meaning, and meaning entails minds, so the ability to understand minds should be integral to the true transmission of culture. Future work needs to examine specific cultural learning events and analyze how understanding the mind is entailed. An interesting test case might be the kinds of cultural transmission that occur to and among autistic individuals, who lack an understanding of beliefs, and therefore also of reflective thought. Such cases must not be explainable by the autistic person's lack of desire to be in a social group, as are the autism examples currently given by Tomasello et al.

Cultural transmission is more than cultural learning

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Tomasello, Kruger & Ratner have proposed a model of human cultural learning and innovation based on a transfer mechanism they claim is unique to humans. Cultural (as contrasted with social) transfer is based on taking or modeling the perspective of another, a uniquely human interaction that accounts for the stability and directional development ("ratchet effect") of human culture. Based on this interaction, the authors conclude that human culture is qualitatively different from the socially transmitted knowledge bases of birds and nonhuman mammals.

The evidence that Tomasello et al. provide suggests that transmission based on shared perceptions and intentional models of social partners are a unique feature of human culture. The developmental evidence, however, could be parsi-

moniously interpreted as resulting from processes that lead to shared perspective and the modeling of others as intentional agents rather than the final outcome of these processes. The authors are properly skeptical of claims of mental modeling in animals, but pushing such modeling earlier into human development is equally subject to skepticism. To take the best-developed example, tracking the gaze of adults and later signs of joint attention are interpreted as indicating that the child is responding to the parent as an intentional agent. Might the data just as well indicate the operation of a preintentional mechanism that causes the tracking of direction of gaze and other behaviors when interacting with conspecific adults? Such a mechanism might be a prerequisite to the child's developing an intentional model of others.

If Tomasello et al. are right in their conclusion that modeling others as intentional agents is absent in other primates then identifying the developmental precursors to perspective-sharing would be an important step in uncovering the underlying causes of human uniqueness. If linguistically trained apes, given the best training that 5 million years of selection for interactive instruction can provide, fail to model others well enough to pass culture through one generation, then the bottleneck must be in the appearance of modeling in infants. Perhaps the behaviors the authors take as evidence of shared perspective (e.g., the infant alternating gaze between mother and the focus of her gaze) started as a novel mechanism for offspring to retain or reestablish contact with the mother. This noncognitive mechanism would begin operating during the period when infants were just starting to move independently and risk separation.

Although sharing perspectives in social interactions may characterize human culture, it is unreasonable to assume that the social learning processes found in other animals do not continue to operate and play a part in transmission in humans. Although human culture may not be homologous in the sense intended by Galef (1992), processes homologous to animal transmission do operate. Besides the types of teaching, reported in animals, that Tomasello et al. categorize as "scaffolding," processes of facilitation and enhancement continue to operate in humans, as even the authors admit in their discussion of early development. In cases where intersubjective instruction may be impossible (because the model on which the behavior is based is beyond the capacity of the child) or too expensive in time or attention resources at the moment, other instructional tactics such as scaffolding or conditioning can be used (e.g., talking during a religious service). Although primates, as a group, are adept at social interactions, other groups (e.g., birds such as columbids, Lefebvre & Palameta 1990) have demonstrated a stronger inclination to social learning. Even among relatively primitively social birds such as Florida scrub jays (Woolfenden & Fitzpatrick 1984) enhancement plays a significant role in the learning of foraging by juveniles (personal observation).

In light of the foregoing, it is reasonable to consider the possibility of differences in transmission between cultures. Most of the studies cited deal with interactions of Western adults with children. Cultures certainly vary in the uses to which perspective-sharing is put. They might well vary in the emphasis placed on different types of transmission, ranging from a rigid conditioning to highly interactive teaching to "looser" cultures where trial-and-error learning directed by enhancement might prevail.

Finally, whether or not a uniquely human form of cultural transmission exists, pursuit of the role of culture (or social information exchange) in shaping cognition should not be limited to human cultural psychology. It would be shortsighted to assume that social transmission in animals does not affect their cognition in a manner at least analogous to the effect in humans.

Kinesthetic-visual matching, perspective-taking and reflective self-awareness in cultural learning

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Tomasello, Kruger & Ratner deserve congratulations for their well-reasoned ideas on the development of cultural learning. Their arguments are generally convincing, perhaps because their distinctions and developmental relations among types of cultural learning and agency mirror concepts of my own.

In trying to explain mirror-self-recognition I developed the idea, following Guillaume (1926/1971), that an organism could recognize itself in the mirror if it had an ability for matching its kinesthetic feelings with a visual representation of those feelings. An organism with such kinesthetic-visual matching could (quasivisually) imagine itself acting within situations that it could then reproduce because it could translate from its imaginings (mental plans) to its body movements in real space and vice versa and also know what its actions look like. According to this theory, kinesthetic-visual matching is present not only in mirror-recognition but in the imitation of others, in recognition of others' imitations of oneself, in pretense of others, and in planning (Mitchell 1990; 1992; 1993a; 1993b; 1993c). Thus, an organism with kinesthetic-visual matching would have self-awareness, in the sense of imagining itself and knowing what it looks like (cf. Gallup 1985).

This form of self-awareness seemed different from that of mature humans, as exemplified in responses to mirrors. Mature humans use mirrors to create an image of themselves which is satisfying to themselves or others, and very young humans and apes do not. I suggested that, unlike young humans and apes, mature humans incorporate their perspective of the other into their own self-image; we create a self which satisfies (or reacts against) the perspectives of others that we have internalized. Although apes exhibit an awareness of the other's perspective in some of their deceptions, pretenses, and imitations, they fail to exhibit reflective self-awareness (Mitchell 1986; 1987; 1990; 1992; 1993a; 1993b; 1993c).

Thus, my approach distinguished three types of awareness relevant to the concerns of Tomasello et al.: the self-awareness present in kinesthetic-visual matching (their "intentional agency"); the awareness of others' perspectives present in some acts of deception and communication ("mental agency"); and the reflective self-awareness present in thinking about ourselves and others in terms of others' and our own perspectives ("reflective agency"). Reflective self-awareness allows humans to think about their mental states in terms of multiple perspectives, to experience tremendous conflict when going against their internalized perspectives of others, and to experience emotions about themselves which result from their interpretation of others' perspectives on themselves (Lewis et al. 1989).

These ideas suggest that perspective-taking develops from the imitative learning of organisms rather than the opposite as Tomasello et al. suggest in relation to autistic people and chimpanzees. These ideas also suggest that, although children may not fully understand their own mental states until they understand those of others, they clearly *experience* mental states before they understand that others have mental states that are different from their own. Thus, although I agree with Tomasello et al. that understanding of others and of (some aspects of) self requires social interaction, I think some self-understanding exists prior to awareness of the perspective of others.

Tomasello et al.'s skepticism toward imitative learning and deception in chimpanzees is understandable but it forces us to avoid developing coherent theories of chimpanzee behavior;

each instance of imitation and deception must accordingly be approached ad hoc (see de Waal 1986). To create an experimental situation for nonenculturated chimpanzees similar to that used to exhibit human-reared chimpanzees' imitational skills is difficult in that it calls for chimpanzee modelers (or perhaps humans dressed as chimpanzees and trained to act as chimpanzees) because nonenculturated chimpanzees are selectively responsive to chimpanzees, not humans. Thus, the apparent distinction in imitative learning between nonenculturated and enculturated chimps is inadequately supported. Although Tomasello et al. deny that techniques used by chimpanzees are cultural because these can be idiosyncratic, they fail to note that human beings use a variety of idiosyncratic techniques in food shopping and preparation, hair combing and decoration, toothbrushing and early morning bathroom rituals, yet we do not deny that these are cultural techniques. The implied difference seems to reside in some measure of how similar the activities are within the groups to be compared, yet no such absolute measure of similarity is available. Tomasello et al.'s claim that adult chimpanzees fail to exhibit instructed learning because they do not continue to teach until their youngster reaches an adequate performance suggests, given the state of understanding in undergraduates, that many human teachers fail to exhibit instructed learning.

Although Tomasello et al. apply their ideas specifically to task learning, their range can be extended. Collaborative learning seems implicit in mature sexual encounters between people, who create their sexual excitement in terms of the other's sexual excitement about their own sexual excitement (Nagel 1969/1979). The instructed learning parents teach their children about interpersonal relations need not be explicit and can be used in other interactions, as shown by transference in psychotherapy. And people's imitating the behaviors, peccadillos, or mannerisms of those they esteem (Mussen 1967; Valentine 1930) suggests that imitative learning is present in more than just functional tasks, as well as that, contrary to Tomasello et al.'s assessment, perspective-taking and reproduction of both form and function need not be present in all forms of imitative learning.

For Tomasello et al., instructed learning requires understanding another's point of view and explicitly relating it to one's own, but much instructed learning involves merely internalizing another's instructions apparently without such perspective-taking and relating. For example, in teaching me how to drive, a friend informed me that when I go around curves I should turn into the curve in order to have better control. For many months following her teaching, as I drove around curves, in my head I heard my friend's voice saying "When you go around a curve, turn into the curve." Although there was an awareness that these were *her* instructions *I* was following, there was no awareness of a point of view different from my own or of an explicit relating of it to mine – I simply "heard" and followed her instructions. Now I think Tomasello et al. might believe that in following the instructions (or in first learning the instructions) I *was* understanding her perspective and relating it to my own. Although this belief seems unnecessarily cumbersome to some (see Millikan 1984), if correct it suggests that human perspective-taking is not always conscious or explicit. In any learned task that has been enacted repeatedly, consciousness of the component activities is diminished with repetition; in learning to type we become less and less conscious of our finger movements; and in learning about perspectives perhaps we develop to the point where perspective-taking is unconscious.

Although the idea that humans show an extrapolation of apparently social-cognitive adaptations to nonsocial domains is intriguing and reasonable, I wonder if in reality the opposite is true (see, e.g., Parker 1992). Sometimes the understanding of other minds seems to me just another problem-solving skill developed from kinesthetic-visual matching. But I'm not completely sure where to go from there.

Cultural learning and educational process

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Tomasello, Kruger & Ratner relate the evolution of social cognition – the understanding of others' minds – to the evolution of culture. Tomasello et al. conceive of the accumulation of culture as the product of cultural learning, a kind of learning dependent upon recognizing others' intentionality. They distinguish three levels of this recognition: of intention (what is x trying to do), of beliefs (what does x think about p), and of beliefs about beliefs (what does x think y thinks about p). They then tie these levels to three discrete forms of cultural learning – imitative, instructed, and collaborative – which children become capable of when they are 9 months, 4 years, and 6 years old respectively, at least in Western culture where relevant data are available.

We express two concerns about these proposals. First, Tomasello et al. attribute to the human species as a whole aspects of subjectivity that may be elaborated and exploited in particular cultures and embodied in the educational practices of those cultures. Second, they fail to distinguish the different understanding of minds required by the teacher as opposed to the learner in cultural learning. Teachers' assumptions about the child's understanding may be of more importance to the evolution of culture than the child's understanding itself. We show how these two issues are related.

Our first concern, then, is the relation between the capacity to recognize another's intentionality, which Tomasello et al. take as criterial for the human species, and the level of this capacity exploited in various ways by diverse human cultures and diverse pedagogies. Although all humans are presumably capable of understanding the actions, knowledge states, and beliefs of others – a form of competence required for any complex discourse or social interaction – the extent to which these understandings are embedded in explicit concepts and applied systematically in educational contexts varies greatly from culture to culture. Stages in the evolution of schooling are analogous to the stages of development described by Tomasello et al. Traditional societies, cultures without schools, pass on their cultural traditions via "apprenticeship," processes that rely heavily upon imitation, the first of Tomasello et al.'s levels. To cite one example, Bruner (1972) noted that among the !Kung Bushmen of the Kalahari there is a complete absence of "teaching" in the modern sense of that term. "Most of what we would call instruction is through showing. . . . Among the !Kung children there is very little 'telling'" (p. 11). More recent studies (Rogoff 1990) tend to confirm this view.

The more systematic educational attempts characteristic of "modern" societies place a great deal of emphasis on formal teaching. Formal schooling, at least until recent times, was based primarily upon instruction – the attempt to convey bodies of truth to ignorant learners with little regard for the beliefs and opinions of the learners themselves, Tomasello et al.'s second level. Modern schooling (we like to think) is based upon the assumption that children are not merely ignorant, but that they, too, have thoughts, which can be revised or extended through argument and evidence, a form of collaborative learning, Tomasello et al.'s third level. After all, it was only under the guidance of Dewey and Piaget in this century that educators began to take seriously the notion that children had conceptions and misconceptions; they were not merely ignorant. Although thinking recursively about others' beliefs and intentions may be far from modern in social life, using this way of thinking to educate children in school may be an essentially modern method of education.

Although Tomasello et al. may be right about the role that the recognition of intentionality played in the evolution of culture,

they may underestimate the role that culture has in understanding of mind. Children may come to see themselves as having minds because their culture sees them that way. It may be argued, as indeed it has been (Bruner 1983), that children come to see themselves as intentional creatures in part because parents and teacher ascribe intentionality to them. Furthermore, Tomasello et al. present some evidence along these lines. Enculturated chimpanzees, that is, chimps who have been reared by human beings, are much more able to engage in joint attention and to ascribe intentional states to others ("simulating the intentional states of others"). But if this is the case, it requires that we distinguish the understanding of mind held by the acculturated person, the teacher, and that held by the learner.

Let us spell out this as asymmetry between teacher and learner more fully. To learn through imitation, the learner must recognize the intentionality of the actor as Tomasello et al. suggest. But to deliberately provide a model for imitation, the teacher must have, in addition, a model of the learner's ability or inability, an understanding that the learner does not *know how to do x*, which the demonstration attempts to rectify. To instruct a learner, that is, to provide information, the teacher must recognize ignorance or false belief in a learner, that is, the learner does not *know that p*, an understanding not necessarily available to the learner. And finally, a recognition of what the learner thinks the teacher thinks is implicated only when the teacher recognizes the possibility of misinterpretation on the learner's part. Thus, the purveyors of culture must have a higher level of representation of mind than the learners they teach. And the learners in turn come to think about their intentional states in terms of the ascriptive and pedagogical practices of adults.

Put simply, the ability to teach is what is critical to cultural development, not the ability to learn. And that ability to teach – to understand inability and provide demonstrations, to understand ignorance and provide instruction, and to understand thinking and provide theoretical discourse – although premised on certain evolutionary properties of the mind, is the product itself of cultural evolution. Second, it is not the ability to imitate that provides the basis for the accumulation of human cultures but the ability to teach.

Cultural learning *and* teaching: Toward a nonreductionist theory of development

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The theory of cultural learning proposed by Tomasello, Kruger & Ratner exemplifies Vygotsky's methodological tenet that a complete understanding of human activity requires the investigation of phylogenesis, ontogenesis, microgenesis (small scale changes occurring during episodes of teaching and social interaction), and sociohistorical evolution. With regard to ontogenesis, Vygotsky distinguished conceptually between natural influences and cultural influences but he concluded that the two threads were indistinguishable, that is, they become woven into a single thread of sociobiological development for each individual because the cultural line of development interpenetrates and transforms the natural line (Kozulin 1990; Wertsch 1985b). Tomasello et al.'s theory of cultural learning is a sophisticated attempt to unpick this single ontogenetic thread.

Their endeavor reveals the inevitable tensions between various dualisms – learning and teaching, the individual and society, the psychological and the cultural, and the biological and the social. Psychology has been characterised by the reductionist tendency to explain human activity by reference to processes within the individual which have in turn been traced back to biological roots. The theory of cultural learning proposed by Tomasello et al. exemplifies this reductionist tendency. They suggest that cultural learning – the uniquely human form of learning – is based on the social-cognitive capacity to take the perspective of other persons. This cognitive capacity is in turn described as unfolding according to an age-determined maturational schedule that the authors imply is driven biologically. The implication regarding the biological cause was inferred from the following statement in their target article:

> And all of these [uniquely human cognitive capacities] rely, *ex hypothesis*, on the fundamentally social-cognitive process of taking the perspective of other persons and learning from that perspective-taking. This conjecture may thus be viewed as a kind of biological extension of Vygotsky's original hypothesis of the social origin of all of the "higher" human psychological functions." (sect. 6, para. 5)

There is no attempt in the paper to explain why social-cognitive capacities should develop on a biologically based maturational age schedule, in contrast to other aspects of higher mental functioning that they propose are derived from increasingly complex forms of cultural learning. The recent "theory-of-mind" research that is used to formulate aspects of the theory of cultural learning is an elaboration and extension of Piaget's genetic epistemology. There is no support from Piaget, however, for a maturational explanation of social-cognitive development. All aspects of cognitive development were explained by Piaget through the interaction of four factors: biological maturation, experience, social interaction, and the internal regulatory process of equilibrium. In examining the synchrony in development between levels of logical thought and levels of reciprocity in social interaction, Piaget (1926, p. 72) suggested that there was "perpetual interaction between these two factors of evolution." Social interaction could not in itself cause cognitive change but particular types of interaction could either retard (relations of heteronomy) or foster (relations of equality) the conditions conducive to restructuring the cognitive system. This reciprocal and dynamic model of the relation between forms of social interaction and levels of cognitive development avoids the problem of locating one aspect of cognition (social-cognitive capacity) outside the explanatory framework that applies to all other aspects of cognition.

The reductionist tendency in the theory of cultural learning is also present in the preference for the individually focussed terms of *learning* and *perspective-taking* over the socially focussed terms of *teaching* and *intersubjectivity*. The result is that the actions of the social agents (parent, peer, carer) in coconstructing the contexts of learning with the child are largely ignored. For example, Tomasello et al. note that language is acquired in "highly contextualized, often routinized, mutually understood (i.e., intersubjective), nonlinguistic formats such as the feeding situation, diaper changing, book reading, taking a walk, or playing a game of peek-a-boo." This contextualist theory of language acquisition and usage, however, undermines Tomasello et al.'s current formulation of the theory. Clearly the contexts of language acquisition are not given in nature. The social agent and the child create the contexts by their interactions. In particular, the actions of the adult in interpreting the child's incomplete, rudimentary, and perhaps unintended gestures and vocalisations *as if* they were infused with specific meaning and significance is crucial in enabling the child to become a progressively more competent partner in the interaction (Bruner 1983). As the contexts acquire shared meaning for the adult and child the child has in a real sense come to see the situation through the eyes of the adult. For example, in supporting very young children's participation in the shared book format, the adult infuses the book-reading activity with specific cultural meanings that might be represented as "one looks at and points to the pictures and 'labels' the pictures and turns the page and repeats the actions until all the pages have been turned." Obviously adults have multiplied and sophisticated representa-

tions of books and reading that are not instantiated in their interactions with children, but in order to move the children away from their perhaps preferred sensorimotor representation of books ("books are to be sucked, pulled apart, stacked, and thrown") toward the shared reading format, the adults adjust their actions in order to create the possibility of a shared understanding of the situation. I would interpret the shared book interaction as an unambiguous instance of "instructed learning" in the terms of Tomasello et al.'s theory. They appear to interpret these events as instances of "adult task simplification," which they call "scaffolding." To quote:

> Instructed learning as we define it involves more than the child's learning by means of adult task simplification. Whereas in scaffolded learning *children learn about the task* [emphasis added], with the adult in the background providing help, in instructed learning children learn about the adult specifically, about the adult's understanding of the task and how that compares with their own understanding. (sect. 2.2, para. 2)

What is problematic in this quote is the absence of a coherent theory of meaning. The notion that the child can learn about the task directly suggests an empiricist epistemology in which meanings exist in the outside world waiting to be discovered. The contextualist approach that Tomasello et al. invoke suggests, in contrast, that meanings are constructed in communicative exchanges that necessarily involve intersubjectivity. This incoherence in the underlying theory of meaning needs to be addressed in future formulations of the theory.

Tomasello et al.'s attempt to unpick the development thread has many more features to it (e.g., phylogenetic analysis) than I have been able to address here. With regard to human ontogenesis, a focus on the concepts of intersubjectivity and teaching within a theory of language discourse (e.g., Bruner 1990; Wertsch 1991) may provide the basis for formulating a theory of cultural learning without reductionist tendencies.

Questioning assumptions about culture and individuals

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This is a daring and provocative article that takes on the classic question of what makes humans human. It argues that cultural learning is the distinguishing feature, and proposes a distinction between three types of capacity for learning from others. However, this account of cultural learning seems to be based on unexamined and problematic assumptions about the nature of the relation between individual and cultural processes.

The approach taken by Tomasello et al. separates the roles of individual and culture, leading to questions about the "impact" of culture on individuals and how individuals "acquire" culture. It is not necessary, however, to assume a boundary between individual and cultural processes, and to do so, we argue, limits the ways scholars can understand how individual and cultural processes function. It is revealing that Tomasello et al. equate the concepts of internalization and their reading of the concept of appropriation as used by Rogoff (1990), where the concept of appropriation was introduced specifically to argue *against* the assumption system of internalization, which separates individual and culture.

Briefly, the internalization model assumes that individuals are separate elements that may be influenced by other people (also elements) and by cultures (also elements). Individual and culture are conceived as separate and inherently static collections of objects, so the approach requires positing ways that culture or social things "transmit" skills and knowledge to the individual (producing change from outside), or that the individual "acquires" social or cultural things (producing change from inside). Tomasello et al. take the latter approach, proposing that the mechanism is what they call "cultural learning" – a capacity (that some have and others do not) to take the perspective of social partners.

In contrast, the appropriation model does not separate individual from cultural processes as elements requiring links to relate them. Instead, the appropriation approach uses activity (rather than individual characteristics or moves) as the unit of analysis, arguing that individual, interpersonal, and sociocultural processes constitute each other and cannot be separated (see Rogoff, in press). As people participate in activities involving other people and cultural practices, they develop and their participation changes. In the appropriation model there is no boundary between the individual and the rest of the world, and there is no need to posit a link between elements; rather, the focus is on understanding processes of participation in shared activity.

The internalization model in which culture and individual are separated leads to problems at the level of cultural processes, interpersonal processes, and individual processes in Tomasello et al.'s account. The view of culture that is presented is a reduction of culture to societal tools and social partners, with no consideration of culture as human activity involving organized processes. There is little mention of communities or of institutions except in a footnote indicating that considering the institutionalization of human practices would take the authors far beyond their current aims.

The target article presents an ordered series of the kinds of social interaction the authors consider to be cultural.[1] However, all three kinds of "cultural" learning focus on separate individuals involved with another person. The progression begins with interaction in which the learner is active and the social world passive (imitative learning), to interaction in which a partner is active and the learner is passive (instructed learning), to interaction in which both are active but their roles are still separate efforts to take the perspective of the other (which the authors call collaborative learning). In none of the types do the authors consider social relations in which people contribute inseparable efforts to shared endeavors.

The ordering of certain forms of social interaction as more "cultural" than others reveals culturally bound assumptions about social interaction, evident in the primacy given to dyadic, intentionally instructional interaction and the exclusion of arrangements between people. Tomasello et al. explicitly exclude arrangements of the social environment as being cultural because they attribute responsibility for making sense of the environment to the individual when no explicit instruction occurs. Although individuals carry great responsibility for learning from social arrangements, it seems odd to exclude such arrangements from being cultural. We agree with Whiting's (1980) view that a primary cultural role of caregivers is deciding about the activities in which children participate and with whom. Tomasello et al.'s focus on instructional intent makes their system inapplicable to other cultural systems.

Their claims that instructional and focused interaction is the norm for children's learning overlook well-known observations to the contrary in many cultural communities. In many communities, individuals are embedded in cultural systems of activity; children's learning of cultural ways can occur (and often does) by means of observation and eavesdropping if cultural arrangements for children allow them to participate in the mature activities of their community (Heath 1983; Ochs 1988; Rogoff 1990; Rogoff et al., in press; Schieffelin 1991; Ward 1971).

We find Tomasello et al.'s characterization of learning through imitation to be particularly troubling, although they do make interesting distinctions between imitation, mimicking, and emulating. Their characterization of learning through imitation seems to portray learning through observation as a relatively unskilled interpersonal approach to learning. However, learning through observation seems to involve very skilled

management of attention by children as well as sophisticated and responsive support for children's efforts by adults and others in the group present (Rogoff 1990; Rogoff et al., in press).

To resolve the dilemma of how individuals internalize culture, the authors rely on children's "theory of mind" and "capacity" for perspective-taking to make the connection. They claim that cultural learning in its highest forms involves individuals "getting inside" the heads of others, so to speak, or at least making use of the words of others to regulate their own behavior and understanding.[2] Tomasello et al. regard use-of-other-people's-words-to-regulate-oneself as evidence of attention and understanding, but they do not seem to notice that it is only when people are having difficulty with a task that such talking to oneself is likely to occur. People who really understand a shared activity may simply begin to take on greater responsibility for managing the activity; if they resort to repeating others' instructions to them it may indicate that they attended but did not really understand the process.

We prefer an approach that examines how children's involvement in cultural activities changes with the developmental processes of the children, their partners, and their communities in shared activities, rather than an approach based on internalization of social or cultural objects. Nonetheless, we applaud Tomasello et al. for offering a provocative and far-ranging account.

NOTES

1. If there were space we would argue with the effort to put the different kinds of social interaction on any single, directional scale.
2. The authors attempt to include nonverbal symbols as regulators, but their effort draws attention to their reliance on symbols as somehow external to the shared activity, to be lifted and imported for the use of the individual.

Cultural learning is cultural

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Cultural learning in itself is not cultural; its forms and contents are universal: This is the implicit consequence of Tomasello et al.'s model. It thus seems coherent that they refer to Piaget (1985) and to Karmiloff-Smith (1986) – possibly his most interesting successor – to understand the way complex systems of "human cognition" like "the various systems of mathematics and the various grammars of human languages that have been created by human cultures" are constructed. Tomasello et al. in fact do no more than add a social component to the cognitive development saying: Pay attention to the fact that children need another person to construct their own cognitive mechanisms. This facilitates construction (this is the weak Piagetian formulation one can already find in the final remarks of Piaget and Inhelder's 1966, p. 123); or this is necessary for it (which is the social psychological version represented by authors like Doise and Mugny (1979) or Perret-Clermont and Brossard (1985) referenced by Tomasello et al.). From this point of view, the forms of interaction are universal and so are the contents of learning (look at the examples of collaborative learning given by Tomasello et al.: conservation tasks and abstract moral judgement tasks). Culture is in fact absent from this model of cultural learning. Note that this kind of cultural learning is easy prey for "information processing" approaches which can, by enlarging their scope to include some social aspects, easily integrate the purely formal interactions described by Tomasello et al.

The model presented, though bringing to the fore important general aspects of human learning compared to higher forms of animal learning, is insufficient to characterize real cultural learning, such as the *learning of culture in cultural forms*. The main reason lies in the choice of the *unit of analysis* which for the authors is "what the individual organism brings to the process of enculturation." Human beings do indeed have the highest learning potentials (Schneuwly, in press) for this process, the most important being precisely that the forms of learning are open and varied because the means and forms of enculturation are themselves results of enculturation and are not provided by organisms. This means that the unit of analysis for modeling cultural learning can in no case be the individual organism. It has to be a triangular structure that combines the learner (for instance the child), the contents to be learned (i.e., culturally constructed ways of behaving in and knowing reality) and the technical and psychological tools necessary to appropriate contents, mediated by teachers (parent, older child, sibling, or whatever else) and their practices.

Already in the stage where, according to Tomasello et al., imitation is its only manifestation, learning is cultural in the sense just described. As shown, for example, in Moro and Rodriguez's (1991) analysis of the baby-object-child triad in children aged 7 to 13 months, there is an intricate and changing relationship – between the contents (in this case the object signification of certain toys), the means created during interaction mainly by adults (*ad hoc* semiotic systems) and the actions and reactions of children – a relationship that can in no way be grasped in terms of the concept of imitation, all the less so as the specific form this complex interaction takes is in itself defined by cultural practices.

The higher forms of learning are even more dependent on cultural practices. Learning to write in a modern society is very different, for example, from learning in a more traditional medieval society (for a general history see Ludwig 1988) and this has important consequences for mental functioning. The forms of learning are dependent on the contents (e.g., writing for religious purposes or for use in some situations in daily life, Besnier 1991; or as an abstract tool for thinking, Olson et al. 1985), on the forms written texts take in history, which are the tools for mastering writing (Schneuwly 1992), and on the relationship students and teachers establish with each other and with writing in an institution such as public school compared to a traditional society where writing is completely embedded in the oral tradition (Clanchy 1979).

Cultural learning is itself a product of culture; its means and forms are constructed at the same time as culture; it can therefore only be analyzed by using the triadic structure as unit of analysis where culture is present in contents; in tools, and in teaching and learning practices. This does not mean there is a mechanical conditioning of development by teaching/learning; on the contrary, as Vygotsky puts it, "There is a process of teaching/learning; it has its own structure, its linking, its logic of development; and there is in the mind of each learner taken individually a sort of internal network of processes which, although they are provoked and put in motion during teaching/learning, have their own proper logic of development" (1985, p. 269; our translation). The relationship between these two logics is at the core of a psychology of cultural learning.

Predispositions to cultural learning in young infants

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Tomasello et al.'s theory of cultural learning and its origins has revolutionary implications for all human sciences. The authors, experts in ape communication and child language, show how human learning needs shared attention and "perspective-taking," a kind of intersubjectivity absent in apes and impaired in autism (Trevarthen 1989). Unfortunately, the authors do not

fully appreciate the unique ways in which young infants communicate their feelings and orientations and react to others' expressions. Any social learning theory has to have an idea, implicit or explicit, of prelinguistic communication, when knowledge is interpersonal and emotional and any factual reference must be to present reality (Trevarthen 1987; 1992; Trevarthen & Logotheti 1987).

A new conception of innate predispositions to culture has been gained in the past 20 years (Trevarthen 1983; 1987; 1992; Trevarthen & Logotheti 1987). The origin of active human intelligence is found in the patterns and controls of spontaneous mother-infant intersubjectivity in the 3 months preceding and following normal full-term birth (Trevarthen 1993a; 1993b). Premature infants join in protoconversation, fetuses learn to identify their own mothers' voice, neonates imitate expressive elements. In the 3 months after term, innate and growing sensibilities and expressive abilities, and rapid learning under intrinsic motivational control, transform the neonate into a skilled partner in nonverbal or paralinguistic play with a person (a subject or "object with mind"). At this age the infant is just beginning effectively to track, identify, grasp, and manipulate impersonal (physical) objects.

In the earliest human communication the infant is a discriminating perceiver and voluntary agent. In ordinary life, neonatal imitations are part of *reciprocal* conversational play (Kugimutzakis 1993). Parent "models" also imitate neonates. Kugimutzakis's films show that neonatal vocal imitations are parts of conversations, as are the hand gestures, "prespeech" oral movements, and facial expressions of "emotions" (or of histrionic display) imitated from visual models. (Note: I do *not*, as I am said to do by Tomasello et al., identify the primary intersubjectivity of protoconversation with "any time . . . that two human beings look at each other"; blind infants can protoconverse well, and premature infants use audition more than vision; Trevarthen 1993a).

The timing and melodic features of mothers' speech to infants transcend languages (Fernald 1989), and even neonates prefer this "intuitive motherese." Protoconversations contain matching and complementary emotions and reciprocating utterances, gestures, and expressions of attention and intention (Trevarthen 1993a). Whether positive and supportive or mismatched and disruptive, the involvement of mother and infant, though asymmetric, is mutual (Murray 1992). It is not "unidirectional imitation of intentions," a description that might apply in laboratory tests of the baby's capacity to imitate or discriminate.

After 3 months, infants' communication becomes more obviously "self-conscious" (monitored through others' reactions, metacommunicatively – by "emotional referencing" with respect to the self as "referent object"; Reddy 1990). Emotional negotiations of games, joking, and teasing lead to transfer of feelings to objects of contemplation or to objects of use, and objects are animated and validated in games that are rhythmic and repetitive. Six-month-olds are capable of participating in and learning a litany in poetic or musical form that lasts many seconds (Trevarthen 1987). They are equipped to learn in a dramatic or emotionally transforming narrative or performance. When they acquire referential content, such narratives become stories, the primary vehicle of linguistic learning that is so readily adapted to comment on and explain pragmatic tasks of culture, such as building a construction, making a meal, delivering a gift, dressing up, performing an act or a role, and so on. Before speech, communication becomes integrated in one shared space for orientations; it becomes cooperative and conventionalized and the infant displays "protosigns" (Trevarthen 1987; 1992; Trevarthen & Logotheti 1987). At the threshold of language play is richly imaginative, seeking expression in imitated and socially approved roles, attitudes, and humorous displays that other persons in the familiar community readily recognize and appreciate (Trevarthen 1992; Trevarthen & Logotheti 1987).

Developments over the first year show no discontinuity or innovation to justify denying the first period of human communication the dignity of the title "intersubjectivity" – if we mean the use of imitative and complementary expressions to establish mutual awareness of basic "mental states" – sharing mutually adjusted "points of view," interest, pleasure, surprise, confusion, purposefulness, thinking, and so on. The entrenched philosophical objection that such states are unobservable, or that they need verbal, problem-solving, empirical, reality-based rationalisation and practical efficiency, is responsible for a dark ages in our psychology of the personal, the prejudices of which have disallowed perception of an initial innate intersubjectivity and its adaptation to mental interplay between human subjects of any age, at least past 30 weeks postconception.

Human social learning occurs in relationships identifying individual others as distinct sources of psychological or intersubjective teaching, and of cooperative initiative. Correspondingly, a parent is more than a caregiver, protector, or scaffold for action. The infant seeks, in succession: an identified, emotionally available, and responsive partner in communication of basic motives and emotions; an opponent in affectionate play; a companion and guide in emotionally evaluated experience with objects and events; a helper in task-performance; an audience, admirer, and critic, whose feelings convey the value of shared experiences and provide guidance towards greater competence and facility (Rogoff 1990). The emotional aspect of this early communication and its growth is scarcely mentioned in the target article, but it is crucial for any psychobiological theory of how cultural awareness and its communication develop (Trevarthen 1993a).

We lose nothing by a more imaginative and accepting eye on the young human. We gain a responsibility: to integrate the theory into a developmental one that explains how linguistic and metalinguistic cognition are learned. Tomasello et al. review many critical observations and interpret them with skill and circumspection, but because they fail to comprehend the initial protoconversational state, they cannot explain how the steps to referential and symbolic consciousness and competence in social conventions, roles, belief systems, moral obligations, and so on are achieved.

Finally, in considering the link between speaking and thinking, which Vygotsky brilliantly observed with the insight that communication in the child's "zone of next learning" provides the foundations for socio-historic-cultural "evolution," Tomasello et al. refer, without acknowledgement, to the "virtual other." This important concept and term was introduced by the Norwegian sociologist and cybernetician Stein Braten (1988) to explain protoconversation and to examine how basic human communication through "dialogic closure" and "affect attunement" is used in teaching/learning and in therapeutic communication. The "virtual other" is a key component of the innate intersubjectivity out of which cultural learning grows. [See accompanying commentary by Braten.]

Interpersonal interaction as foundation for cultural learning

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In describing their conception of cultural learning, Tomasello, Kruger & Ratner differentiate social learning from cultural learning and assert that cultural learning relies on "uniquely powerful forms of social cognition," without saying very much about how these forms of social cognition come about during ontogenesis. I think it may be useful to examine the nature of social interaction in which human infants participate from the

earliest months of life in order to see how the social cognitive abilities necessary for cultural learning come into being.

As has been argued by the philosopher Macmurray (1961), human infants enter into social interactions *as persons* not when they conceive themselves or their caregivers to be persons, but when their caregivers engage them as persons, which seems to be quite soon after birth. Human infants are able to learn that their expressions and behaviors convey meaning because they are treated as meaningful during interpersonal interactions, even if not during all interactions with other people. There are many descriptions in the current literature of how meaning is imputed to infant behaviors from the earliest weeks of life in Western (e.g., Newson 1979; Snow 1977; Trevarthen 1979a) as well as non-Western societies (Morikawa et al. 1988). During this time, the infants are not learning culture in the sense of specific practices; they are learning to become cultural beings.

The occurrence of early imitation, which Tomasello et al. discount in regard to cultural learning because "nothing new is being learned," demonstrates one avenue for constructing an interpersonal space in which cultural learning can begin. Precisely because the acts being matched in these early imitative exchanges are familiar to the infants, their mutual enactment can result in a shared experience. Observational studies indicate that adults are the ones who initially match infant behaviors and thus enter a shared world with the infant (Papoušek & Papoušek 1977; Užgiris 1989). Within this world of shared meanings, infants can begin to differentiate another's distinct perspective from their own and begin to learn from the other's perspective. Thus, adult interaction with infants as persons, which is already culturally nuanced, seems to underlie the development of abilities that are necessary for the first type of cultural learning discussed by Tomasello et al.

In the discussion of engagements during which cultural learning takes place, Tomasello et al. focus more on the product of the learning than on the process, particularly when describing imitative learning. But a process of interchange over time is implied by each of the learning situations. Even imitative learning is rarely a single exposure encounter. To refer to the two domains mentioned by Tomasello et al., novel object uses and novel words, they are seldom learned from a single demonstration; in fact, first attempts often result in approximations, which are perfected through exchanges of demonstration and imitation (Užgiris 1991). Although many laboratory studies of infant imitation attempt to minimize the social relation between the model and the infant, there is evidence that the interchange still remains a social interaction for the infant. The interweaving of social experience with cognitive skills has been recognized even by theorists like Guillaume (1926/1971), who attempted to differentiate "pure" imitation from various precursor forms of matching. A focus on the process in each of the learning situations might show that the social-cognitive skills deemed prerequisites for each type of cultural learning are actually evolved and perfected during social interactions.

My highlighting of the interactive process during learning is not intended to negate the contribution of the individual's skills to the process. Tomasello et al.'s focus on "the individual capacity for acquiring culture" serves as an important counterweight to the recent emphasis on the sociocultural constitution of human activities. It just seems to me that a full understanding of the individual's contribution calls for an examination of the use and modification of individual skills in social interaction. The individual's cognitive understanding derives from participating in the total activity that is composed, whether individually or jointly, and, therefore, cognitive skills need not be viewed as arising in some other sphere, to be employed subsequently in social interactions. The issue is not whether individual cognitive skills are relevant to understanding the types of cultural learning that are possible, but whether involvement in various learning encounters still has to be individually assimilated and accommodated (or appropriated, to use Rogoff's [1990] term).

To put it another way, the arrows depicted in Figure 1 seem to overlook the envelope of bidirectional influences in a social interaction within which all three types of learning take place. Even with respect to the main motive force, the depiction seems to be especially wanting for the imitative learning case; when the repetitive nature of imitative attempts is taken into account, it seems clear that the model must consider the imitator's attempts at least as much as the learner considers the instructor's moves in the case of instructed learning. In all three cases, participation in the learning encounter is an opportunity for a change in cognitive understanding on the part of both participants, although proportionately the change may be greater for one than the other.

When considered within the framework of interpersonal interaction, the three types of cultural learning delineated by Tomasello et al. capture distinct types of learning situations that support children's induction into human cultures. Although their sequencing in ontogeny might be less clearcut than claimed by Tomasello et al. because the social-cognitive abilities involved in each type are themselves constructed in the context of interpersonal interaction, they will nevertheless function as useful anchors for grouping our knowledge of concrete learning engagements. It will be also useful to remember that all three types of learning remain possible for human adults and may be selectively used in specific contexts by particular societies.

Developing semiotic activity in cultural contexts

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A theory of cultural learning. One important question for a theory of cultural learning concerns how to account causally for the dynamics of the "ontogeny of learning." Unfortunately, in the target article no clear answer is given to this question. Tomasello et al. provide interesting evidence for the *correlation* between social cognition and cultural learning, but they do not propose a specific theory that can plausibly account for the psychological dynamics of the development in cultural learning. In this commentary I will argue that the Vygotskian approach has produced some concepts and empirical evidence for a theory as desired here. Before describing briefly some core concepts of this theory, I will put down a few critical remarks.

The context of learning. According to Vygotsky, learning can promote development when it is embedded in the child's zone of proximal development (ZPD). It is not the appropriate place here to discuss all the complexities of the ZPD concept. I will only draw attention to the fact that the ZPD is essentially related to "imitation," according to Vygotsky (e.g., 1982, p. 250). In this activity the child is not merely copying the adult's actions. There is a meaningful reconstruction of an already existing sociocultural activity, in cooperation with an adult or a more capable peer. The child's activity generally transcends the characteristics of the model that is imitated.

Cultural learning, then, is always embedded in sociocultural activity settings. The performance and learning of new actions within this activity are often generated and given meaning from this context. Significant others, for example, attribute meaning to the child's actions even before the child itself consciously knows this meaning. The child can recognize meanings from this concrete or symbolic context.

Recognition of the support the child gets from this social activity context is essential for the understanding of specific actions and learning. Actually, cultural learning processes cannot be studied apart from their sociocultural activity contexts. This is one of the shortcomings of the cultural learning theory of Tomasello et al. They try to conceptualize cultural learning

without devoting due attention to the activity contexts and their impact on the learning process. Consequently, they sometimes have to attribute qualities to the individual child that are probably just characteristics of the cooperation between the child and the (real or virtual) others in the activity setting. To give just one example, it is true that young children can gather from context what other people might mean, but it is far from evident that they actually rely on "understanding persons as intentional agents," as Tomasello et al. suggest. They offer only circumstantial evidence in favour of this option; they still seem to be committed too strongly to an *individualistic paradigm of learning*. In many of these cases it is more parsimonious and consistent (considering the Vygotskian starting point) to assume that at first children just rely on adults' understanding of persons (as intentional, mental, or reflective agents). Only after some context-bound and socially assisted learning can they interiorize such person concepts.

Collaboration in learning. This leads us into a new problem with respect to the target article. Learning always implies collaboration between the child and a more capable other. It is hard to see how the gradual learning of the person concept can take place without some sort of collaborative learning. According to the authors, collaborative learning requires an already highly developed concept of person. This apparent paradox can be resolved by assuming that the reflexivity (the concept of the reflective agent) is present from the beginning in the activity context of the learning child but that this reflexivity is "borrowed" from the adult, who takes care of this part of the sociocultural activity. Again, this requires that the individualistic style of conceptualizing children's learning processes be abolished.

It is impossible to provide a comprehensive account of my view of a Vygotskian theory of cultural learning here (see Van Oers, in press, for more details). The gist of my argument thus far has been that both the person concept and the forms of learning are codeveloping processes within common contexts of sociocultural activities. Many so-called prerequisites may not be available at the individual level, but they are always present in the common activity: At first they are socially represented. The question now arises, What is the dynamic basis (the "motor") behind this development?

Leading activities and the development of semiotic activity. Starting from Vygotsky and Leont'ev, the Russian psychologist D. B. El'konin offered a theory of child development that could account for some of the above-mentioned complexities (see for example El'konin 1972). On the basis of dominating motives in the child (manipulation, play, learning, etc.), he described different forms of leading activities that are indicators of stages in the child's development. As recent research has shown (see Lisina 1982), within every developmental period the child has different needs and, accordingly, it communicates and learns differently. There is a growing mass of empirical evidence from Russian researchers that shows the possibility of communicating with young children in a collaborative (play) context so that they learn to make sense of other persons and also acquire different strategies for learning and making meaning (or "semiotic activity" as I will call it). In this cooperative semiotic activity communication can be made to change from a primarily object-oriented to an ultimately more person-oriented form (see Lisina & Kapčel'ja 1987). In this context the initial forms of *learning in collaboration* can be transformed into real discursive learning, "imitating" the scientific learning process. The common basis of the development of person concepts as well as all other kinds of scholarly concepts is the semiotic activity the child learns to perform and improves in cooperation with others. In my opinion, a theory of cultural learning should be basically a theory of the cooperative improvement of children's semiotic activity in sociocultural contexts.

From intra- to interpsychological analysis of cognition: Cognitive science at a developmental crossroad

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The only thing I am really astonished about is why this paper appears only now. Indeed, the target article presents a much needed elaboration of ideas that have long been central to the basic problems of interdisciplinary research on human culture and cognition. Somehow the emerging paradigm of cultural psychology has heretofore avoided debate with mainstream cognitive psychology, although in many respects they are mutually exclusive. The impression of a peaceful coexistence of the paradigms was perhaps permitted by a profound ignorance on the mainstream side. Like several recent analyses of the phylogenesis of cognition (e.g., Donald 1991), Tomasello, Kruger & Ratner's article directly confronts the established views, even on such seemingly noncontroversial points as early language development and the intrapsychological character of our higher-order thought.

What could the results of this comparison of the paradigms be? Although biased in favour of hierarchical models and cultural-historical explanations, I nevertheless think a compromise is in order. There are no doubts on my part about the reality of the three developmental levels described by the authors. At the same time, these levels apparently represent only the tip of the cognitive iceberg and their functions can go beyond those of social cognition and cultural learning (Velichkovsky 1990).

Of course, the main problem here is the lack of reliable methods for the analysis of the interpersonal components. We need a kind of experimental (and not philosophical – cf. Fodor 1987) psychosemantics which could allow us to say, "Aha! Here we see this interpersonal character of a person's cognitive representations, reflecting many perspectives on a state of affairs, as if it were a stereoscopic view of a situation shared/coordinated with other actors ("generalised other," Ulric Neisser, Lev Vygotsky . . .)." Without such a methodology it will be difficult to argue against well-established explanations, for instance, those based upon reference to inborn genetic endowment. Vygotsky (1934/1962) himself tried to develop such a methodology; there were also some efforts in post-Vygotskian Soviet psychology that were based on the personal constructs approach (see, e.g., Shmeliov 1984).

Another problem is the lack of an in-depth logical analysis of the three stages. Tomasello et al. acknowledge that "the developmental ordering . . . results in some sense from the logical dependence of these concepts on one another" (sect. 2.4, para. 6). However, they do not really explore the implications of this claim. From the neo-Piagetian or information-processing viewpoint it could be precisely the growing logical complexity of underlying mental operations, for example, the emergence of the recursive use of propositional attitudes or embedded-rules, that will explain age changes in social-cognitive concepts and cultural learning (see Zelazo et al. 1992).

Although I enthusiastically support this attempt to address cultural mechanisms of cognitive development, I have some reservations about the range of its applicability. Tomasello et al. suppose that various cognitive systems like those of mathematics are based on explicit or at least implicit mechanisms of cultural learning (see especially sect. 6, para. 2). This may be true developmentally, but in general one's reasons for being involved in a type of activity are extremely dynamic. On what grounds does one choose mathematics as a profession? It may well be a personal affection for a school teacher or an especially rewarding cooperative atmosphere, but afterwards these con-

texts can lose their influence as one delves deeper into the problem domain proper. One of Vygotsky's coworkers, Leont'iev, called this transformation "the shift of motive to goal," a psychological phenomenon known also to Wundt and other founding fathers of psychology. Even at the advanced stages of a personal endeavor, our motives and success can depend crucially on other factors, such as our visual pattern-recognition ability (an ability we actually share with all other higher primates). Visual perception and aesthetics rather than interpersonal pragmatics may dominate some of our higher-order cognitive capacities (see also Bartlett 1932, pp. 230–33; Premack 1991). There is evidence of very early aesthetic influences in phylogenesis too: Stones that are simply beautiful are found in endocasts that are old even in comparison with the most primitive tools (Oakley 1981).

If cultural learning – in the social-psychological definition proposed by the authors of the target article – is the common denominator of all higher forms of intellectual activity then we should expect at least some positive correlation between expertise in social communication and in other domains, for example, mathematics or computer programming. But are experts in these fields relatively sophisticated in the sphere of interpersonal cognition and communications? I very much doubt it (Velichkovsky et al. 1992). Also, studies of autistic children (although we know how controversial these results and interpretations are) reveal deficiencies in the interpersonal components of competence whereas mechanical problem solving and even recursive use of such social tools as geographical maps remain relatively intact (Leslie 1991). In other words, cultural learning as defined in the target article seems to be the major, but not the only, gate to higher forms of cognitive development, which may bypass at least the higher stage of the Tomasello et al. hierarchy.

A minor historical remark is that Vygotsky (1934/1962) considered at length the problem of cultural learning with respect to its contribution to development and especially to reflective consciousness. His suggestion was to look more closely at the nature of scientific as opposed to spontaneous concepts, a strategy the utility of which is at least partially supported by later cross-cultural research (Scribner & Cole 1981). The notion of "appropriation" played a central role in the post-Vygotskian activity research in which definite proposals concerning the relationship between personality and cultural learning were also made (Leontiev 1975).

All in all, Tomasello et al.'s discussion of joint attention, instructional learning, and cooperative interpersonal interaction and their attempt to delineate the developmental sequence among these phenomena represent a major advance in our understanding of cognitive development. A clear consideration of the variability of paths of cognitive development, however, would relativise the current model somewhat and encourage further communication between cultural psychology and cognitive science.

Human enculturation, chimpanzee enculturation (?) and the nature of imitation

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The central tenet of Tomasello, Kruger & Ratner's analysis of cultural learning is that the form of an organism's cultural learning is shaped by its psychological model of those from whom it learns. This seems to me an insight that deserves a powerful influence in research efforts in several related fields, including developmental psychology, evolutionary anthropology, and comparative primatology. No less intriguing is the other side of the coin, that a crucial input to the construction of individuals' psychological models is provided by social experience – some, perhaps much, of which may itself involve cultural learning. In this respect the findings Tomasello et al. marshall regarding the nature of enculturation in chimpanzees and autistic children are, I suspect, particularly significant and I shall concentrate on these – although they are far from the only issues worthy of productive commentary.

Most comparative analyses of "cultural learning" in human and nonhuman primates have operated at a level where the question is whether the species has the capacity or not: For some species of monkey and ape the answer has been thought to be "yes, in some sense," and for humans "yes, certainly." This neglects an important possibility, however, namely, that levels of competence in cultural learning are themselves achieved only as a result of other crucial learning processes. This is what appears to be shown by the findings of Tomasello and colleagues comparing enculturated and nonenculturated chimpanzees. The former, raised with experiences inherent to those same human cultures that nurture the ultimate cultural learners – children – have shown cultural learning (i.e., imitative abilities) significantly superior to those without benefit of these rearing experiences. Tomasello et al. are right that most of the impressive records of spontaneous imitation in chimpanzees collated by Whiten and Ham (1992) are from such human-reared subjects: The extensive studies of wild ("nonenculturated") chimpanzees have indeed provided no data to match.

There are two problems, however, with this comparison as Tomasello et al. present it. First, what of the possibility that imitation as defined by Tomasello et al. indeed has to be a product of enculturation, but that for wild chimpanzees this is simply *chimpanzee enculturation?* For Tomasello et al. enculturation is equated with *human* enculturation: What I am suggesting is that the development of imitation in young chimpanzees may need a context in which early attempts at imitation are reinforced and that it can be elaborated upon through an extended interaction between the growth of imitative abilities and contexts which make these rewarding. This could be true in the wild where subsistence includes such tools as are used in termite fishing or nut cracking, for example. The reason imitation may be difficult to *detect* here by observation alone, as Whiten and Ham suggested, is that the actions involved will probably be just part of all chimpanzees' eventual repertoires, so acquisition through individual learning is difficult to rule out. By contrast, when these apes are reared in human homes, the copying of novel actions (particularly those like sweeping with a broom, which have no immediate function for the ape) cannot be explained away in this fashion. This may mean not that imitation is actually occurring only within human cultures, just that it is more easily identified. And is it not possible that the chimpanzees who have failed to exhibit imitation in experimental tests have been reared without the richness of normal human *or* chimpanzee enculturation?

Whatever may be the role of learning in the ontogeny of imitative abilities, I take issue with Tomasello et al.'s implication that chimpanzees are ordinarily not imitative, only becoming imitative as a result of human enculturation. Could a species for whom imitation is not part of their "nature" be got to imitate merely by being subjected to the circumstances which nurture the development of human imitative ability? Tomasello et al. and others (Heyes 1993; Whiten & Byrne 1991; Whiten & Ham 1992) agree that imitation rests on specialised cognitive abilities which transduce others' perspectives into self's. That a certain natural ability, along with certain experiences, may be necessary to generate imitation is suggested by the limitations on expression of imitation by both autistic people and certain hand-reared monkeys, despite their environment of human enculturation. It seems odd that chimpanzees should have evolved such a nature,

unless it is correlated with functional outcomes such as acquisition of tool use under natural conditions.

In fact, is there not a strange reversal in the logic of Tomasello et al.'s argument with respect to enculturation and imitation in the case of apes and autistic people? Chimpanzees, they argue, can be given a dose of (human) enculturation and can then (almost magically) imitate. Yet it seems to be argued that this is not true for autistic children (why?) and, indeed, that autistic children cannot get a dose of culture (they "are basically acultural" – sect. 3) because they lack imitative as well as more advanced social-cognitive abilities.

What is it that is so different about imitation? Two alternatives were distinguished by Whiten (1992), both being related to the types of "mindreading" abilities Tomasello et al. discuss: (a) To imitate certain acts imitators need to be able to recognise models' *purpose* in doing what they do; and (b) imitators need to be able to translate, in three-dimensional space, between the action performed from the other's point of view (seen from their own viewpoint) and what it is to perform it from their own point of view. Tomasello et al. appear to incorporate both of these in their imitative level, which includes "perspective-taking" as the social-cognitive ability, and "intentional agent" as the concept of person. They are quick to demote what they call mere "mimicking," in which actions are copied without an understanding of goals from their category of imitation. However, such mimicking would appear to face all the difficulties of perspective-taking described under (b) above. The experiments of Tomasello et al. are interpreted as supporting only emulation in "nonenculturated" chimpanzees, but would they claim that chimps can or cannot mimic? If they can, how do Tomasello et al. see this being done without some form of visual perspective taking? And if they are thought incapable of both mimicking and imitating, how does this square with recent studies championed by their authors as offering the best available evidence for animal imitation, in both rats (Heyes et al. 1992) and parrot (Moore 1993)?

Instructed and cooperative learning in human evolution

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Tomasello, Kruger & Ratner present a picture of human culture and cultural learning that can be checked against archaeological and anthropological evidence. Are instructed and cooperative learning essential to modern culture? Were they important in human cognitive evolution?

Archaeology may supply us with evidence of instructed learning, or at least its social-cognitive basis, fairly early in the evolution of the genus *Homo*. About 1.5 million years ago hominids (probably early *Homo erectus*) began producing standardized artifacts, known in archaeological literature as "bifaces." These stone tools were extensively modified, so that in most cases the original shape of the stone "blank" was altered. The amount and location of modification suggests that the resulting shape (usually almond-like or a pointed oval) was intentional. Moreover, this shape was repeated again and again – indeed over hundreds of millennia and millions of square kilometers. Obviously many, if not all, individuals knew how to make this artifact and they must have shared some idea of what shape was appropriate. How could such a shared idea of appropriate shape be learned? It is here that the concept of instructed learning may yield some insights. Perhaps *Homo erectus* could conceive "of other persons as mental agents who have . . . their own individual thoughts and beliefs that guide their behavior"? This seems to me to be precisely what was required for the production of standardized shapes. One hominid must have been able to represent not just what another saw, but what another believed or understood about what was acceptable and what was not. I do not think that imitation as described by Tomasello et al. would have been sufficient. In the absence of an ability to represent what another believed, one could not have acquired knowledge of the acceptable range of forms; the notion of "appropriate" is a belief, not a perception or even a simple intention. I agree with the authors that chimpanzees do not demonstrate these social-cognitive abilities. Moreover, stone tools that date to before the appearance of bifaces did not require them either; imitation would have been sufficient for these earlier tools, which have no intentional overall shape, let alone a shared standard. *Homo erectus* appears to have been the first hominid clearly to have employed a concept of mental agent.

I am reluctant to conclude, however, that *Homo erectus* must have learned biface technology through instructed learning. There is still the problem of language. Was it (and is it) necessary for intersubjectivity? Or could observational learning have been sufficient? Admittedly, reconstructing another's belief would have been easier through linguistic instruction, but it may not have been necessary. Certainly we cannot simply assume the presence of language in the behavioral repertoire of *Homo erectus*. Indeed, given the largely nonlinguistic way in which most technology is learned even today (Wynn 1991), language would seem to be an unnecessary ingredient. In other words, I think the archaeological record supports the presence of the social-cognitive underpinnings of instructed learning as early as *Homo erectus*, but not instructed learning proper, which had to await the acquisition of language.

In sum, when we apply Tomasello et al.'s concepts to the archaeological record of *Homo erectus* we can identify certain features that resemble human culture or at least clearly distinguish *Homo erectus* from chimpanzees. Here, at least, their scheme has supplied useful ideas for thinking about cultural evolution. But not all of their ideas are so useful.

Tomasello et al. argue that cooperative learning is a basic element in the creation of novelties in modern human culture and is also important to the "ratchet effect," in which cultural modifications accumulate over time. This is the least developed of their arguments and as an archaeologist I found it largely unfounded. My reservations are based primarily on the archaeological record itself but also on the anthropological literature that discusses cognition in apprenticeship.

Innovation and the ratchet effect are not cultural universals. The archaeological record of modern humans reveals vast spans of time (often thousands of years) during which the products of human culture (and specific human cultures) remained unchanged. Even in the relatively recent times of the Mediterranean Classical Age, change in cultural products was slow or nonexistent for the vast majority of people. Indeed, it was not until the industrial revolution that technological change occurred at a rate readily perceivable by an individual in a lifetime. The "ratchet effect" appears to be an outcome of the industrial revolution (and Basalla [1988], cited by Tomasello et al., clearly writes with a bias toward industrial society). It is a local phenomenon that is uncharacteristic of most modern human culture. Given the extragenerational rate of most modern human cultural change, it seems unlikely that cooperative learning could be a sufficient cause for innovation.

Of course, most technology is *not* learned through cooperative learning. Anthropological literature on apprenticeship (e.g., Gatewood 1985; Keller & Keller 1991) indicates that it is based largely on rote memorization and individual problem solving. There is much imitative learning and some instructed learning, but novices are rarely if ever allowed to muddle through a task together. Cooperative learning is simply not a component of apprenticeship or, indeed, most traditional forms

of instruction. And, it is interesting to note, apprenticeship in European technology often began at precisely the age (6–8) at which Tomasello et al. recognize cooperative learning.

These two reservations suggest to me that cooperative learning is not a human universal, but it may well be a true "cultural" cognition, in which the features are determined largely by the local cultural milieu. Cooperative learning may be very real and important in the Western classroom, but it is not a feature of learning in rural Africa and probably was not during the Upper Palaeolithic in Spain 19,000 years ago. It appears not to be a necessary component of modern human culture. However, its cognitive bases probably are. Understanding other individuals as reflective agents is almost certainly a feature of all adult social interaction and might well qualify as one of the defining features of modern behavior.

What is apparent to me from my consideration of instructed and cooperative learning is that the important developments in human cognitive evolution are the social-cognitive abilities like mental and reflective agency. These appear to be characteristic of the cognitive abilities of all modern humans; moreover, some can be recognized early in the human evolutionary record. However, although instructed and cooperative learning rely on these cognitive abilities, they themselves appear to be secondary phenomena that were unlikely to have been central players in human evolution.

Authors' Response

Culture, biology and human ontogeny

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Commentators on our target article come from at least three distinct scientific paradigms: cultural psychology, cognitive ethology/primatology, and developmental psychology. This diversity is a testament to the importance of issues of culture, intentionality, intersubjectivity, perspective-taking, imitation, instruction, collaboration, social learning, and theory of mind in the behavioral and brain sciences as a whole. Our attempt in the target article is to conceptualize these issues within the framework of one coherent model that allows for communication among all three of the paradigms. As can be seen from the commentaries, we are only partially successful in this attempt, but at least it can be said that a productive cross-disciplinary discussion has begun. We are tempted to point out in this connection that the diversity of perspectives from which the different commentators approach our article – and the affinities in many cases among commentators from within each of the three scientific paradigms – is strong evidence of human perspective-taking and cultural learning abilities. But it is enough to point out that the commentaries may be usefully grouped into three points of view representing, roughly, culture, biology, and human ontogeny.

R1. The view from culture. Almost all of the cultural psychologists who comment on our paper feel that our approach is too individualistic. Thus, **van Oers** expresses the opinion that we "attribute qualities to the individual child that are probably just characteristics of the cooperation between the child and . . . others in the activity setting" (para. 4), going on to say that all cultural learning is cooperative and that reflexivity is present from the beginning in the activity contexts of the learning child. **Schneuwly** claims something similar in stating that "the unit of analysis for modeling cultural learning can in no case be the individual organism" (para. 2). **Renshaw** attributes to us a "reductionist tendency," meaning a reduction of the sociocultural to the individual and biological. For **Rogoff, Chavajay & Matusov,** "individual, interpersonal, and sociocultural processes constitute each other and cannot be separated. . . . There is no boundary between the individual and the rest of the world. . . . The focus is on understanding processes of participation in shared activity" (para. 4). **Bruner** argues that human cultures have a deontic side in which children do not just learn tasks but are subject to normative expectations and to the strictures of cultural institutions. **Forman** believes that we have taken an "abstract, decontextualized perspective on social interaction and thought" (para. 6) that leaves out of account the specific cultural practices of specific cultural groups. **Ingold** charges that our article serves to perpetuate the "pervasive dichotomy between the individual and the social" (para. 4).

Our response to these charges is that we are, to some degree, guilty of them all: In its current formulation our theory focuses on the individual organism as it interacts with others; it leaves out of account the normative and institutional structure of cultures and it has little to say about the cultural contexts of specific cultural activities. But, in our defense, we would like to highlight two considerations that place these issues in context. First, in the paradigm of cultural psychology there is great variety, with perhaps the major dimension of difference being precisely the degree to which the focus of interest is the culture or the individual in the culture (cf. Cole 1989). The "purists" in the paradigm are those who are attempting to reformulate psychology – or formulate an alternative psychology – that does not take as its primary unit of analysis the individual human being, but rather the cultural collective. We and a number of others, on the other hand, believe that a cultural psychology can also focus usefully on the individual in its cultural context. And certainly for the questions we are interested in – children's acquisition of specific skills of language, memory, problem-solving, argumentation – we believe that the individual is the appropriate unit of analysis. In the words of Vygotsky (quoted by **Schneuwly**): "There is in the mind of each learner *taken individually* a sort of internal network of processes which, although they are provoked and put in motion during teaching/learning, have their own proper logic of development" (para. 5, our emphasis). This network of processes is precisely our focus. And although it is clearly important that the specific cultural practices of specific cultural groups be addressed in any theory of cultural learning (which could be done within our framework), we believe there are some human universals in terms of which these specific practices and their

deontic and institutional dimensions may be more fully understood.

The second consideration that helps to place our view of cultural learning in context is our concern with nonhuman primates. We believe that any adequate theory of human ontogeny, in any of its important aspects, must be grounded in an appreciation of human phylogeny. In looking at our evolutionary roots, it is apparent that not all animals, or even all primates, are social in a deep sense; thus it makes absolutely no sense to say in this context that individuals are constituted by cultures. Talk of that kind may make sense if we are discussing some types of human activities and thinking – especially those involving values, attitudes, and other psychological phenomena dependent on language and "cultural models" of the world. But there are other aspects of human development whose roots can be seen, sometimes more clearly than in the human case, in our nonhuman primate cousins, outside the human cultural context. From this perspective, we simply do not see how a human infant's imitation of an adult's tool use is collaborative or normative or reflective or anything other than the social learning of an individual organism. The learning involved is of a general type practiced by other primate species, but it also has species-specific qualities having to do with human perspective-taking, intention-reading, and the like, as we argue in our paper. The point is that if human social learning is conceived as always collaborative and normative and reflective – and individuals are not recognized except insofar as they are cultural beings – the possibility of cross-species comparisons is basically eliminated from the outset. We would like to make such comparisons, and thus **Harwood** is basically right in characterizing our paper as an attempt to combine an "evolutionary grounding with key aspects of the interpretive approach," thus attempting a "rapprochement between two historically disparate and highly entrenched schools of thought" (para. 9); so is **Velichkovsky,** when he credits us with attempting a "compromise."

R2. The view from biology. If the cultural psychologists think we reduce cultural learning to something more individualistic than is appropriate, a number of the more biologically oriented commentators think our characterization of cultural learning has remained all too human, so that nonhuman animals are left out almost by definition. **Gabora,** for example, thinks our use of perspective-taking and intersubjectivity as the social-cognitive basis for cultural learning is gratuitous, as complex information transfer and cultural evolution can take place without these sophisticated processes. **Midford** argues that social transmission in nonhuman animals affects their cognition in much the same way it affects human cognition. **King** points to some of our "anthropocentric assumptions" and argues that we do not ask what apes can do but only whether they can do what humans do. And **Bard** criticizes us for our "indefensible position that humans are unique" (para. 3).

Once again, we plead guilty, to a degree, but we would again like to point out the context and goals of our attempt, especially our explicitly comparative agenda and our primary focus on *Homo sapiens*. There is no doubt that in many nonhuman species information transfer occurs in very complex ways. The issue is whether we can make meaningful and accurate distinctions in the nature of the processes by which this is accomplished. To make such comparisons, there will have to be a standard set of definitions that can be applied to all of the species being compared. Recognizing the difficulty, if not impossibility, of making meaningful comparisons across widely divergent species, what we have attempted to do is to adopt a common set of definitions only for the family of primates, especially apes and humans (whose common ancestor lived relatively recently). This definitional set must of course be broad enough to include the range of behaviors exhibited by both apes and humans, and rich enough to capture the uniqueness of each species (and we would argue that every species, including humans is, by definition, unique). But, as we readily admitted in note 10, we are not attempting a totally "objective" comparison. Our primary attempt is to explain human culture within an evolutionary framework. If, to some eyes, ape social learning ends up looking "deficient" in this comparison, that is manifestly not our intention. It is just that, in our opinion, social learning of the type used by chimpanzees is not the kind that would support culture as it is manifest in human societies.

We must note that the latter opinion is not one that all of the commentators agree with. In particular, **Boesch** claims that even if our three criteria for a cultural tradition are accepted, chimpanzees still fit the bill. He reports that, unlike many of the other behaviors of chimpanzees that have been claimed as "cultural," nut cracking is exhibited by virtually all the Tai chimpanzees and leaf clipping is exhibited by virtually all the adult males of this group. Moreover, he claims that the techniques used by different chimpanzees are very similar. The problem in both these cases is that if there are ecological stimuli that evoke similar response tendencies in all animals, and if there is only one way (or a few) to perform the response given the sensorimotor capabilities of the organism, then similarity results through individual learning (cf. **Whiten**). This is why we do experiments such as those in which subjects are given problems that may be solved in more than one way. When such tasks are given to captive chimpanzees, they show no tendency to copy techniques. In interpreting these experiments, Boesch argues that the failure of the captive chimpanzees is probably a result of their impoverished rearing conditions. This is possible, of course, but until we test wild chimpanzees experimentally, the case is simply not proven in our eyes. Finally, as to the accumulation of modifications over time, we simply do not see that Boesch's two examples of a *change* in behavior over time in any sense consist in an *accumulation* of changes of behavior or product in the group.

Perhaps the most controversy was created by our analysis of imitative learning. **Whiten** agrees that there are no really convincing data on imitative learning by wild chimpanzees, but he argues that this might be either because, as **Boesch** argues, the captive chimpanzees of our experiments have grown up in impoverished conditions, or because imitative behavior is difficult to observe under natural conditions in which many of the behaviors engaged in are in the normal chimpanzee repertoire. Once again, we agree that these are possibilities, but given the experimental findings, we believe the jury is still out.

Heyes points out interesting data on rat and budgerigar imitation that would seem to undermine our view. To be convincing, however, the rat studies need an additional control, namely, a condition in which the joystick moves to one side or the other without another rat moving it; in other words, the rats may not be imitating another rat's behavior but rather seeing which way the stick moves preceding food. The budgerigar experiment by Galef et al. (1985) is more convincing, but it is very likely that these are not novel behaviors and therefore there is no learning occurring. Heyes questions the definitional requirement that imitative learning involve novel behaviors or strategies, but we believe it is important, for two reasons. First, if our interest is in culture and such things as the accumulation of modifications over time, we need to talk about animals acquiring new behaviors. Second, the process of having an established behavior evoked may be a very different process from learning a new behavior. It might be evoked by something like "response facilitation" (see **Byrne**), or it might arise from the fact that animals have a tendency to repeat behaviors and the performance of a behavior by another individual is just as likely to evoke repetition as performance by oneself (Piaget 1962). This reasoning underlies our dismissal of human neonatal (and other animal) mimicking as not truly imitative learning.

Several commentators discuss interesting theoretical alternatives to our analysis of imitative learning. First, **Heyes** questions the necessity of perspective-taking and the understanding of intentional agents for imitative learning. Thus, she proposes action-outcome contingency learning in which one animal simply sees another individual's action and its outcome and goes on to "selectively reproduce those features that are predictive of the outcome that is desired" (para. 3). This does not seem like a viable possibility to us because we do not believe that learners of any species can select out the relevant features of the model's behavior without knowing the model's goal. In some cases this may appear to be happening – as in the rat experiments – but this results from contingency learning about things in the environment that go together (e.g., stick movement and food – "learning the correlational structure of the environment by classical conditioning" in **Byrne's** formulation).

Byrne also posits his own theoretical alternative. Pointing out that the reproduction of behavior is never exact (see also **King**), he argues that since most complex behavior is hierarchically organized, the best way to look at imitative learning is as "program-level imitation," that is, behavior that reproduces not the fine details or the outcome of a behavior only, but the logic of the action at "the most useful or 'intelligent' level at which to imitate" (para. 6). This is clearly an important idea, one that is different from (although related to) emulation learning, in which a goal is reproduced with idiosyncratic means. We accept this level as imitative learning if it can be shown that the program level is still novel for the observer. Thus, in the Nagell et al. (in press) experiment we looked at the flipping of the tool and not at such things as which hand was used to flip it. We found no differences in our chimpanzees, and if Byrne has found differences in naturalistic observations of gorillas, we would encourage experimental controls so that other interpretations (that the materials evoke similar behaviors in all gorillas) can be ruled out.

Overall, **Whiten** points out that in our account imitative learning really requires two things: (i) a recognition of the model's purpose, and (ii) a translation of the model's action into the observer's action. We do not deny that many animals can do the second of these and that some animals can engage in individual learning that has the effect of reproducing the results of another's behavior (emulation learning), but we think that only humans perceive the actions of others as intentional ("the model's purpose") and that this makes true imitative learning possible.

Closely related is the issue of chimpanzee enculturation and what it leads to. **Whiten** is unhappy that we seem to equate enculturation with human enculturation. Our characterization is not meant to be confined to humans except that it requires instruction, attention encouragement, and reinforcement for imitation from others; if these are present in the adult behaviors of any species, there is the possibility for enculturation. We just do not think, as Whiten proposes, that reinforcement from the environment alone (e.g., by obtaining food) is enough for reproducing the behavior of another.

In a different critique of our notion of enculturation, **Heyes** wonders why we say that chimpanzees do not have certain social-cognitive capacities, given that chimpanzees do develop these capacities under human tutelage. Does that not mean that all chimpanzees in some sense have the capacity? Avoiding a philosophical discussion of the "potential" versus the "actual," we will simply follow Gottlieb (1992) in noting that many different phenotypes may be produced by the same genotype, especially in flexible animals such as mammals. Our argument is that in one environment chimpanzees develop in one way and in another they develop in another way. If one wants to say that they therefore all have the potential but only those who develop in certain environments realize that potential, that is fine. Our hypothesis, however, is that by the age at which enculturated chimpanzees begin engaging in joint attention and imitative learning, wild chimpanzees no longer have the potential to engage in these types of interactions.

It is certainly true, as **Gómez** points out, that we know very little about the enculturation process at this point. We do not agree with his view, however, that symbol learning and use is the key. The process of socialization-enculturation is the key, in our view, and symbol learning is simply one part of that process. The gorilla Muni was reared as an infant by humans, presumably with rich interactions involving instruction and reinforcements, and these conditions were essential, in our view, to the skills Muni developed. Gómez also points out that the social-cognitive bases of imitative learning may not be just any form of intentional agency, but rather the more detached form of sharing known as "protodeclarative communication," in which the infant simply points out a phenomenon to an adult with no immediately present instrumental goal. We agree that this is the clearest case, but believe that it does not change much in our account, because these types of communications emerge in human children at about the same time as their protoimperative counterparts.

With regard to instructed learning, **Hauser** (see also **King**) argues that instruction is much more prevalent than we believe if the focus is on adult behaviors that have the function (not just the intention) of supporting the learning of immatures. A focus on function is important because "what counts is whether the interaction leads to significant fitness consequences" (para. 4). We would argue that in many cases different proximate mechanisms may have the same fitness consequences and that it is therefore important to investigate proximate mechanisms as well. We do not know what the adaptive consequences of cultural learning are other than in the context of a broad "Just So" story about how useful it is to learn things from the experience of others.

Boesch and **Hauser** both point to what they believe is a misunderstanding on our part of what Boesch reported as teaching in the Tai chimpanzees, but we stand by our interpretation. In the first reported case in Boesch (1991), the mother could have been repositioning the nut in anticipation of her own attempt to crack (which did not materialize as the child then cracked it). In the second case the mother used what we presume to be her normal grip to pound some nuts; it is just that she both assumed the grip and then proceeded to pound the nuts more slowly than usual. The mothers in these cases may have been instructing, but then again they may have been cracking nuts somewhat differently from their usual way, which the infants observed. And we must reiterate, instruction by itself does not guarantee instructed learning.

With regard to collaboration, **Boesch** reports some unpublished observations in which chimpanzees actively monitor the actions of others in relation to the actions of the prey. These will be very interesting data to see with regard to the possibility that they are truly coordinating mental perspectives. And again, not to be obstinate, but collaborative learning is another thing still. We do not have a strong opinion on the adaptive origins of collaborative learning, but **Collier's** suggestion that it has its origins in human reproductive strategies is intriguing.

Bard's claim that in our analysis of the collaborative learning of chimpanzees we focus solely on immature animals is simply incorrect. The Boesch examples we discussed all involved adults. And the imitation experiments (about which she implies the same criticism) used chimpanzees of all ages including adults.

In a very interesting application of instructed and collaborative learning to current human societies and to human evolution, **Wynn** thinks the evidence supports neither the current universality of these forms of learning nor their necessity in the evolution of human culture. One reason for the claim about their marginal status in human evolution is that *Homo erectus* did not have a well-developed language. This may very well be the case, but the supposed absence of language at this point does not settle the issue; instructed learning can take place with no language (as we state at the end of sect. 2.2) or with forms of communication that are simpler than full linguistic communication. Wynn goes on to argue that the social-cognitive bases of instructed and collaborative learning – conceiving others as mental and reflective agents – are universal and important in human evolution and that the emergence of these abilities changes the nature of imitative learning. This dissociation between social-cognitive capacities and their deployment in learning situations is not something we have considered deeply, but it is a very interesting idea that may help to explain some of the differences in instructional strategies used in different cultures (as pointed out by **Rogoff et al.** and **Olson & Astington** – see below).

R3. The view from human ontogeny. The developmental psychologists who comment on the target article generally do not bring up either our reductionistic or our anthropocentric tendencies. They do, however, have a wide range of opinions on the capacities we attribute to children at different ages, ranging from **Trevarthen,** who believes we have missed much of the innate capacity for intersubjectivity that characterizes the human infant, to **Lillard,** who believes that in most cases we have overattributed social-cognitive capacities to young children. It is noteworthy that the focus of most commentators is on infancy.

For **Trevarthen** and **Braten** the human infant is born with innate intersubjectivity in the form of a "virtual other." Trevarthen cites evidence for spontaneous mother-infant intersubjectivity in fetuses and preterm neonates and claims that from birth infants perceive the other as a "voluntary agent." Braten stresses that a "virtual other" is inherent in the human mind, giving it a dialogic form of functioning from the outset. We would respond that although this is certainly a coherent and defensible point of view, it, like nativism of all types, does not readily lend itself to refutation. We would thus ask: If it is all there from the beginning, what develops? Why do neonates not look where others are looking, make social reference to outside objects, or use intentional gestures? Trevarthen and Braten would presumably respond that something nonsocial is developing, for example, the infant's "growing sensibilities and expressive abilities" that allow us gradually to see their innate intersubjectivity. We can only respond that this distinction between the infant's innate intersubjectivity and its developing ability to express it – a notion reminiscent of Chomsky's competence-performance distinction to defend his nativism – has a nonempirical quality that we believe obscures rather than illuminates which psychological processes are developing, and how.

Hobson and, in a slightly different way **Barresi & Moore,** think we misconstrue the nature of the 9-month-old infant's abilities and that it is not until 18 months of age that infants understand others as intentional agents. The issue is this: We talk about the 9-month-old coming to understand other persons in terms of their perceptions and intentions toward the outside world and we claim that this is a basically cognitive (i.e., social-cognitive) process of the child attempting to make sense of the behavior of other persons. Hobson believes that 9-month-olds relate to others relating to objects in a more direct, "noninferential" manner based mainly on some type of affective attunement or ability to enter with others directly into intentional relations with objects; he thinks it is not until 18 months of age that they have an understanding of intentional agents. Barresi & Moore agree with this basic orientation, citing as evidence the joint attention to nonshared visual space that first happens at 18 months of age, along with more sophisticated forms of emotion reading

and mirror self-recognition that first occur at this same age as well. They go on to point out the possibility that the social referencing of 9-month-olds is a kind of emotional "contagion" associated with an object and that joint attention is simply mimicking an adult's head turning only to discover an interesting object – that is to say, in both cases, some kind of noninferential behavior matching plus conditioning.

Although we agree in general that the human infant's initial encounters with others rely on noninferential processes of perception and emotion (see next section), it is interesting that neither **Hobson** nor **Barresi & Moore** discusses the fundamental change in the nature of imitation that occurs at 9 months of age, namely, that infants for the first time imitate the adult's actions on outside objects. It is possible that this too is some form of mimicry plus reinforcement, but if this is true, it is hard to see why 6-month-olds should not show the same behavior, for at that age they can both mimic and be conditioned. We would also point out, following **Lillard,** that at 12 to 14 months infants learn to use words via imitative learning; and they use them in novel yet appropriate circumstances, which would seem to rule out simple processes of mimicry and conditioning, thus implying some level of understanding of the intentions of others. Finally, we should say that we do not see why looking where another is looking should change in its fundamental nature when the look is behind the infant; or why there should be posited a fundamental change in emotional understanding from 9 to 18 months; or why mirror self-recognition of the face should have anything to do with intentions at all. We do resonate to the criticism that in some places we may have implied that children have concepts when we meant to imply something less cognitive, but we still maintain that something important is happening at 9 months of age that cannot be explained without reference to the child's changed understanding of the behavior of others.

Several commentators invoke imitation as the underlying cause, not the effect, of growing social-cognitive competence in infancy. **Hobson, Mitchell,** and **Gopnik & Meltzoff** are particularly articulate in this regard, with Hobson emphasizing the prereflective nature of the imitative process that then leads to the understanding of what it means to take another person's viewpoint; Mitchell emphasizes more the level of self-awareness inherent in imitation; and Gopnik & Meltzoff emphasize the process of self/other identification. But because of all the problems outlined in the previous paragraph, we believe these approaches need something more. Gopnik & Meltzoff go a long way toward supplying that something more by supplementing their emphasis on infant imitation with a distinctly cognitive component in the form of "theory-formation abilities." Gopnik & Meltzoff point out that the protoconversations highlighted by Trevarthen provide no basis for a "like me" judgment, which requires some kind of identification of self and other such as the one inherent in the process of imitation. Gopnik & Meltzoff recognize, however, that imitation by itself is still not enough to allow the 9-month-old to turn to the world of the other. For that we also need theory-forming abilities. We could not agree more; indeed, although we perhaps failed to stress the importance of neonatal imitation and identification with others as much as we should have, Gopnik & Meltzoff's articulation of the view point expresses exactly what we intended: "As the child begins to understand relations between people and objects at 9 months, the relevant units . . . for imitation become actions on objects rather than actions per se. The basic mechanism . . . is the same but the construal of what the behavior of others is . . . has become far more sophisticated" (para. 8). This is exactly what we meant in saying that the infant comes to understand others as intentional agents and that the nature of imitation changes as a result.

There were also a few comments on our notions of instructed and collaborative learning. **Olson & Astington** point out that we have left out of our account the teacher and the "theory of mind" that he must possess and that "the ability to teach is what is critical to cultural development, not the ability to learn" (para. 7). Clearly these commentators do not mean this literally, as they certainly understand the reciprocity of teaching and learning; moreover, they understand that not all organisms can be taught everything. In our view, to overemphasize the role of teaching would be to underemphasize the activity of children in constructing their own knowledge. And it should be remembered that in our account the intentions of the teacher in eliciting the attention of the child will necessarily be a part of the perspective of the other that the child represents.

Olson & Astington's other main point is one also made by **Rogoff et al.** They claim that our notion of instructed learning is a specifically Western notion. There are cultures in which instruction consists mainly in showing and not telling, relying heavily on intentional modeling and imitation. Although we may have focused too much on the verbal form of instructed learning (as did Vygotsky), the last paragraph of section 2.2 is quite clear that language is not necessary for instructed learning and that the primary mode of instruction may be modeling. The crucial question is whether in instructional situations children internalize something of the adult's instructions, which in the nonverbal case means paying attention to adults' (nonverbal) directions and then internalizing their intentions in giving those directions. If children do this, then imitative learning is transformed into instructed learning as the child uses the nonverbal instructions to attend to the task for purposes of self-regulation.

Užgiris and **Goldman,** each in their own way, express the opinion that imitative and instructed learning are difficult to distinguish. Užgiris points out that in infancy imitative learning seldom if ever takes place with an infant surreptitiously imitating an unknowing adult; rather, it is most often an interactive process in which the adult models in specific ways adapted for the child's needs, that is, the adult instructs. The point is well taken, but in our definitional scheme, if the child is too young to internalize something of the adult's instructions we would say that the child is engaging in imitative learning supplemented by adult scaffolding. Goldman does not see the difference between the social-cognitive bases in the two cases, as he does not distinguish between intentions and beliefs. In philosophy this may be a problem, but in the study of infants what we mean by intentions is really something closer to goals or purposes (see **Gómez** concerning this distinction). The young child simply sees the mother attempting to open a jar (not just her hand moving in a circular fashion) or the dog trying to get out the door. For these, no attribution of thoughts or beliefs is necessary.

Goldman and **Lillard** both see a problem in relating collaborative learning to the notion of reflective agent. They ask why the dialogue characteristic of instructed learning would not be sufficient for collaborative learning as well. In response, we can only repeat that the dialogue one hears when school-age children collaborate is manifestly reflective and that, not coincidentally, this is the first time they seem to learn anything new from collaborating with others. We have empirical support for a connection between the reflective dialogue and child learning in Kruger's (1992) study and we hypothesize that this correlation is due to children's emerging understanding of the utterances of others as reflective, which allows them to form an integrative understanding and representation in which all points of view are simultaneously present.

Finally, we are heartened that **Baron-Cohen** and, less explicitly, **Hobson** find our account of autism to be roughly accurate. Although some autistic children do acquire some language and do produce some material artifacts, in both cases there is little evidence that the children are designing them for an audience – suggesting the possibility that they are acquired by learning processes different from those used by typical youngsters. Baron-Cohen gives a few examples of things that some autistic individuals do that seem more clearly cultural but there are important differences in degree of autism among different individuals that make overall evaluations difficult. He also points out that cross-cultural studies of possible differences among autistic children have not been done.

R4. Questions of process. If our interest is ultimately in the processes by which immature humans become members of cultures there are three key issues that emerge from the commentaries as a whole. First, although the issue was not discussed by anyone at length, both **Goldman** and **Gopnik & Meltzoff** bring up the simulation view of perspective-taking in which children must have some notion of intentionality or mentality from their own experience before they can recognize it in others. This seems much too metacognitive to us; children do not know their own thoughts explicitly and conceptually before they can understand the behavior of others in terms of their (the others') thoughts. Here we might invoke something like **Barresi & Moore's** dialectic between conceptualizations children can use in behavior and those they can really know reflectively. Several other commentators touch upon this distinction as well. Although at this point we cannot hope for a definitive resolution of this issue – much more research needs to be done, especially with infants – we also think that an evolutionary perspective can provide at least a plausible starting point. In the context of what we have learned in recent years about the importance to primates of knowledge of the behavior of conspecifics, what makes most evolutionary sense with regard to this question is that humans evolved the capacity to understand and learn from others, which they then applied to themselves in a reflective move. In combination with a plausible account of how this reflective move might take place – in the target article we suggest that cultural learning turned on the self and its products – it is incumbent on those who think that children generalize from their own case to propose a viable evolutionary alternative.

A second general issue concerns the origin of the social-cognitive abilities we posit. Several commentators attributed to us the belief that children need fully reflective concepts of intentional, mental, and reflective agents before the corresponding type of cultural learning can emerge. Although we may not always have been clear about this in the target article, this is not what we mean. What we mean is only that at certain ages children come to understand and interact with others in new ways and that this does not imply an explicit concept; perception, understanding, and interaction can take place without concepts. As **Užgiris, Rogoff et al.**, and **Forman** argue, the interaction comes first, the explicit concept afterwards. The new levels of social-cognitive understanding that develop at various points in human ontogeny emerge out of social interactions of particular types; there is nowhere else they could come from (**Barresi & Moore's** account is also relevant here). In being treated as an intentional agent, and in being intentionally instructed and using certain kinds of semiotic mediation, the infant, for example, begins to understand others as intentional agents. Indeed, interactions of this type are necessary for skills of cultural learning to develop, as we specified in our discussion of the enculturation process for chimpanzees. Once this new level of understanding develops, social interaction takes on a different character and this may then lead to another new level. Interaction is the raw material out of which the social-cognitive concepts are constructed, which embeds these concepts in (but does not reduce them to) the social processes and cultural practices of the organism's social group. Each of these steps depends on an organism of a certain type, possessing certain "capacities." We must be careful not to reify these capacities into explicit concepts.

Finally, we would like to acknowledge the pivotal role of imitation in understanding social-cognition and cultural learning, as **Gopnik & Meltzoff** (and **Mitchell** and **Hobson**) in particular stress. It is possible that this ability by itself leads to much of what we discuss as cultural learning. We do not believe, however, that anything like the conceptual analysis necessary to distinguish imitation from other types of social learning, and to relate them all in one coherent theoretical framework, has taken place. In just this target article and the commentaries on it we counted ten terms: "social facilitation," "response facilitation," "local enhancement," "stimulus enhancement," "mimicking," "emulation," "action-outcome contingency learning," "imitation," "program-level imitation," and "imitative learning." This means that it is simply not clear at this point how imitation is related to individual learning and cognition or to other forms of social and cultural learning. The other two types of cultural learning likewise require much work to distinguish imitative learning from instructed learning, to disentangle such terms as scaffolding, instruction, and collaboration, and to discover whether these forms of learning are indeed universal across cultures and important in human evolution. To talk about these different forms of learning productively, a detailed theory – much more detailed than our general scheme – will be required.

R5. Conclusion. Because we began our response on the level of scientific paradigms, we would like to close on that level with one very important point. Coming from both

cultural psychology and cognitive ethology some commentators feel that comparisons simply cannot, or at least should not, be made. According to these commentators, it is never appropriate to compare the behavior of people from different cultures, who live in worlds that are fundamentally different from ours; nor is it appropriate to compare different species that live in even more distant worlds. Each culture and each species occupies its own *Umwelt* and all we can do is to describe that world naturalistically, either ethologically or ethnographically. We simply cannot agree with this argument. The presuppositions of the investigator are just as unavoidable in naturalistic description as they are in comparisons, or even in some experiments for that matter. The *reductio ad absurdum* of the argument is its application to human development: May we not make comparisons between different levels of child functioning because at each age or stage the child is in a different world – or even individuals in their own individual worlds? Some of the agenda here is clearly political. Western researchers at one time had the view that evolution was a great chain of being leading to its pinnacle in "mankind," and that human societies formed a similar chain from the "primitive" to the "modern." We are no longer subject to thinking in that mistaken way, however, either in biology or psychology, and making comparisons does not imply the superiority, in any sense of the term, of any one of the things being compared. Comparison is the essence of the scientific method in many disciplines and to rule it out of court on the basis of outdated political concerns is in our opinion simply not productive.

Finally, we would like to express our thanks to the commentators for their time and perceptive commentaries and to apologize for not being able to devote the amount of attention each deserves in the limited space available to us here. We hope to continue the discussion in other forums. To repeat the sentiment expressed at the end of our target article: We hope we are contributing to a *Zeitgeist*.

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Letters *a* and *r* appearing before authors' initials refer to target article and response respectively.

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