he raises as to whether third-order routines and correspondences also develop in non-cross-fostered apes will be significant to resolving this issue.

Finally, Langer shows what these data on species differences reveal about the evolution of cognitive development. He notes that human cognitive development is precocious, accelerated and extended compared to that of monkeys and chimpanzees. He also notes that human cognitive development is synchronous across domains as compared to the asynchronous development of monkeys and the only partially synchronized development of logical and physical knowledge in chimpanzees.

Langer says that these patterns of evolutionary change are heterochronic but not recapitulatory; it should be noted, however, that developmental evolutionary biologists recognize recapitulation as one possible outcome of heterochrony (e.g. McKinney & McNamara, 1991). Recapitulation occurs as a consequence of terminal elaboration and addition of new stages of development occurring in conjunction with acceleration of development (both of which occurred within some domains in the evolution of hominoid cognition). Recapitulation does not, however, address the kind of realignment of rates across domains that Langer emphasizes in his cascading constructivist model.

I emphasize disciplinary differences in usage because different conceptions of innateness and recapitulation have sometimes been an impediment to communication across disciplines. Consistent usage becomes increasingly important as psychologists, anthropologists, biologists and paleontologists join forces in the common goal of understanding the evolution of cognitive development in hominoids.

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Coordination of actions, visual perception and inhibition in non-human and human primate development

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The originality of Langer's approach to cognitive development (Langer, 1980, 1986) lies in the study of the pragmatic components (actions, object manipulations) of protologicomathematical and protophysical cognition before the age of 2. This perspective falls in line with Piaget's constructive psychology.

In this target article, Langer proposes an overview of his work on the comparative psychology of non-human primates, a field that, like the study of human infants, investigates 'thought without language'. His thesis is a very strong one: the origin of constructive protologic and protophysics does not depend upon enculturation and language (symbolic) rearing by humans. Cognition, logicomathematical as well as physical, is an original development of all primates. Human enculturation and language are not required!

We believe that Langer's approach can be criticized on his use of findings and concepts of both comparative psychology of cognition and developmental psychology.

Coordination of action schemes in non-human primates

As concerns non-human primates, comparative developmental studies of object manipulations in these

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animal species reveal that these manipulations differ from those performed by human infants in terms of both their goals and complexity. In effect, most of the observed manipulations in non-human primates correspond to the Piagetian secondary reactions (e.g. simple holding or moving schemes: see Spinozzi & Natale, 1986, for studies with macaques and chimpanzees) with sometimes, for chimpanzees, tertiary circular reactions (e.g. mostly through the use of the dropping scheme: Mathieu & Bergeron, 1981). For example, a study examining three 8–11-month-old chimpanzees (including the bonobo Kanzi) and a human infant of the same age showed that chimpanzees indeed performed multiple manipulations with objects. But, in the apes, these manipulations mostly consisted of simple holding or moving an object against a substrate (Vauclair & Bard, 1983; see also Poti & Spinozzi, 1994). By contrast, the human infant more frequently detached an object from the background and, furthermore, moved the object or explored its unique characteristics. It is likely that this frequent extraction of objects by human infants, but not by ape infants, helps the human infant develop superior abilities for manipulation and combination of objects (Vauclair, 1984).

As a consequence, the young apes (and *a fortiori* the young monkeys) do not develop the same type of object-oriented behaviours as the human infant; this is not to say that these primates have not evolved sophisticated cognitive tools to deal with the challenges of life. But such tools are obviously not a strict extension of these primates' abilities to construct larger sets of objects with age. Most generally, modern comparative psychology is less concerned with the study of logicomathematical cognition than with cognitive skills expressed in perceptual learning of adaptive behaviours: e.g. categorization (Bovet & Vauclair, 1998), cognitive mapping and social strategies (see references in Vauclair, 1996; Tomasello & Call, 1997).

Visual perception and learning versus logicomathematical coordination of actions

Child psychology during the 1980s and 1990s is characterized in particular by the discovery of the important role of visual perception in knowledge construction by infants. On this specific point, Langer, like Piaget, grants a minor role to perception compared with action (e.g. 'Cognitive development that can be produced by perceptual as compared to sensorimotor acts is extremely limited' (p. 364; see also Schlesinger & Langer, 1999) – hence Langer's techniques consisting of observing the object manipulation and action sequences of human and non-human primates. However, contrary to this classical conception of cognitive development, current findings in infant psychology suggest that there exist protophysical (Baillargeon, 1995; Spelke, Vishton & von Hofsten, 1995) and protoarithmetic (Wynn, 1992, 1998) reasoning mechanisms that are associated with a powerful ability to learn through visual perception. Note that similar involvement of high-level perceptual representations might also operate in the mastery of comparable skills by monkeys (e.g. in numerical cognition: Hauser, Macneilage & Ware, 1996; Brannon & Terrace, 1998). In this respect, modern comparative psychology and infant psychology converge in their emphasis on the role of perceptual activity for cognitive skills more than that of logicomathematical coordinations of actions *à la* Langer.

Relationship between cognitive development and inhibition

One of the current criticisms of Piagetian and neo-Piagetian models (e.g. Case, Fischer, Halford etc.; see Demetriou, 1988) is that they are all models of the coordination or co-activation of structural units rather than models of selection inhibition. Yet many cognitive psychologists working in a wide range of logicomathematical as well as physical domains including object construction, number, categorization and reasoning (Bjorklund & Harnishfeger, 1990; Dempster, 1995; Diamond, 1991; Harnishfeger, 1995; Houdé, 1999, in press) have shown that cognitive development can be conceived of not only as the progressive acquisition of knowledge (or structural units), but also as the enhanced inhibition of reactions that get in the way of already acquired knowledge. The new models of development proposed in this perspective are essentially based on the concepts of inefficient/efficient cognitive and behavioural inhibition (Diamond, Harnishfeger and Houdé) and resistance to interference (Dempster). Seen from this new angle, Langer's comparative approach centred on the coordination or co-activation of structural units (combinativity operations) is still largely Piagetian, while inhibition is now regarded as a key process in an evolutionary framework (Bjorklund, 1997; Bjorklund & Harnishfeger, 1995), a kind of 'Darwinian algorithm' as Cosmides and Tooby would say (1987).

The roles of these two important adaptive processes, visual perception learning and cognitive and behavioural inhibition, along with limitations in the transposition to primates of a strict Piagetian framework should be incorporated into Langer's model to make it fit better into today's child and comparative psychology.

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