

On the Importance of Comparative Research: The Case of Folkbiology

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If our goal as researchers is to understand the range and complexity of human conceptual development, increased attention to comparative research is essential. I draw on research in the domain of folkbiology—commonsense understandings of plants and animals—to argue that several lines of comparative research are needed to understand the acquisition of folkbiology in particular and conceptual development in general. First, comparisons are needed between children and adults within a given society. It is impossible to understand the process of conceptual development without a detailed look at adult endstates in a domain. Second, comparisons are needed between adult endstates in different contexts. For a complete understanding of conceptual development we must understand the range of variability of adult conceptual systems. Finally, comparisons are needed among children developing in different contexts. Such research complements comparative work on adults and would serve to distinguish between universal and particular patterns of development and thus to inform and constrain accounts of conceptual development.

INTRODUCTION

Over the last decade and a half, a central theme in research on conceptual development has been the idea that children acquire informal folk theories that allow them to explain and predict phenomena in important domains of experience (e.g., Carey, 1985; Gopnik & Wellman, 1994; Keil, 1989; Wellman & Gelman, 1992; Wellman & Inagaki, 1997). In this essay I argue that comparative research is essential for a full understanding of human conceptual development, especially in theory-rich domains. Careful comparative work is needed in at least three areas. First, more research is needed on the adult models and theories that children are presumably in the process of acquiring. To characterize the process of conceptual development, we need to understand the adult model, the modal “endstate” of development in a given society. We must be especially careful not to assume that adult cognition is necessarily normative or “correct.” For example, adult judgment and decision making is rife with biases and heuristics (e.g., Tversky & Kahneman, 1974). An account of the development of decision making must have as its endpoint this adult system; an account taking optimal decision making as its endpoint would be misguided. In general, an accurate characterization of conceptual development is not possible without careful consideration of adult models.

Second, we need comparative studies of adult models and theories in different populations. Clearly there is no single ideal developmental endpoint; without some sense of the variability in possible endstates of development, we cannot hope to accurately understand the process. For example, if adults in different societies have very different explanatory theories in a domain, developmental accounts would need to ex-

plain the source of this variability. In contrast, cross-cultural consensus might call for a very different developmental account. The truth, of course, is most likely “in the gray”; comparative research is likely to reveal both cognitive universals and cultural particulars. The specifics of these emergent patterns would then serve as a target for developmentalists to explain.

Finally, we need comparative studies of development in different populations of children. By now the rationale should be obvious: we cannot presume to understand processes of conceptual development generally when the issues have been studied almost exclusively among children in middle- to upper-class relatively urban settings. Such a truncated sample leaves us with almost no idea whether we are studying universal or particular patterns of development. Comparative work carries the promise of addressing this question. If a particular developmental pattern is observed in several different populations, it becomes a candidate for a universal. If different patterns emerge, then the search is on for correlates and causes of that pattern. Either way, the results have informed developmental research.

Comparative research along these three lines is necessary to present a more complete picture of the process of human conceptual development. I will use research in the domain of folkbiology to illustrate my point here, but the point applies to other domains as well. First, I review the current debate on the nature of conceptual development in folkbiology, and argue that the resolution of this debate awaits the specification of the adult model. Next, I briefly review comparative work on folkbiological thought in adults that

suggests divergent adult endstates and I consider the developmental implications of that work. Finally, I argue for the importance of comparative work with children, and present some preliminary findings indicating the value and potential informativeness of such research.

ACQUISITION OF FOLKBIOLOGY: WHAT IS THE ENDPOINT?

The study of children's developing conceptions of living things has been an extremely fertile area of research in the last 15 years for at least two reasons. First, folkbiology is an intrinsically interesting domain of human experience; the natural world of plants and animals is pervasive and salient in our present and in our past, both historic and prehistoric. Second, folkbiology provides a test case for more general ideas about how conceptual development takes place. In this section I argue that although this line of research has provided important insights into the nature of preschool thought, it hasn't necessarily taught us much about the process of conceptual development because there is a dearth of research on the adult endstate. To make this argument, I briefly consider the debate on the acquisition of folkbiology. This is not intended as an exhaustive review, but rather to give a sense of the debate and ultimately to underscore the point that resolution of the debate requires an understanding of the adult model.

Two competing views about the nature of conceptual change in the domain of folkbiology have been put forward. The first is the idea of *radical conceptual change*. In this view, children's conceptions of living things undergo radical revision during the early school years, to the extent that preschoolers' understanding of basic biological concepts such as life, death, and living things are incommensurate with those of adults; they belong to a completely different conceptual framework. An alternative view, *knowledge enrichment*, argues that the basic distinctions made by adults are in place early. In this view, children conceive of living things in essentially the same way that adults do, although much elaboration of these conceptions takes place during development.

The resolution of this debate has ramifications for how we characterize the process of conceptual development, in the domain of folkbiology and perhaps more generally. The radical conceptual change view portrays the preschooler's conceptual system as discontinuous with that of the adult, posits the overthrow of one system by another, and requires the specification of mechanisms by which conceptual reorganization takes place. In contrast, the gradual conceptual change view portrays the child's conceptual sys-

tem as continuous with the adult's, posits the gradual elaboration of a single system, and thus requires no mechanism or trigger for radical reorganization.

The beginning of concerted developmental interest in the nature of children's folkbiology was Susan Carey's 1985 book, *Conceptual Change in Childhood*. Therein she argued that children's conceptions of living things undergo radical reorganization during the first decade, and that an intuitive biology emerges from an intuitive psychology. Although this view has been amended more recently (Carey, 1995, 1999), the central tenet—that children organize knowledge of plants and animals in a way that is incommensurate with that of adults—remains unchanged.

This radical theory change view has a number of implications for how "pre-biological" children (i.e., children younger than 10 who have yet to construct an autonomous folkbiology) should see the world. First, if their conceptions of living things are essentially psychological and behavior-based, pre-biological children should see animals and plants as fundamentally different kinds of things, in part because "living thing" means nothing apart from "behaving being," and plants don't behave. Second, pre-biological children should not be able to differentiate biological from psychological construals of living things because these do not yet represent distinct systems of explanation for them. Third, pre-biological children should not appeal to any specifically biological causal mechanisms to explain biological phenomena, because they have not yet constructed folkbiology as an autonomous domain.

Since Carey's book, there has been a great deal of research on children's conceptions of biology, the bulk of which shows that children reason about living things in ways distinct from how they reason about other kinds of objects. In particular, there have been empirical demonstrations of violations of all three of the implications of the radical conceptual change view.

Plants versus animals. A number of recent studies have shown that preschoolers know quite a bit about the commonalities between animals and plants. For example, 4-year-olds reliably report that plants and animals, but not human-made artifacts, can spontaneously heal or regrow injured parts (Backscheider, Shatz, & Gelman, 1993). Four-year-olds also show an impressive understanding of seeds and plant growth and of the underlying similarities between growth in plants and in animals (Hickling & Gelman, 1995). Inagaki and Hatano (1996) present evidence that 4- and 5-year-olds believe that animals and plants, but not artifacts, spontaneously change over time; 5-year-olds also projected biological properties such as growing and needing water on both plants and animals and

coherently explained biological processes (taking in nutrients, growth, death) for plants by drawing on analogous properties for animals. Taken together, these results suggest that preschoolers have begun to form a rich category of living things that unites plants and animals.

Biological versus psychological construals. Likewise, it has been demonstrated in several ways that children possess distinct biological and psychological understandings of living things. Inagaki and Hatano (1993) showed that 4- and 5-year-olds clearly differentiate biological from psychological cause; children understand that mental effort is required to influence mental outcomes like improving one's memory, but is irrelevant for biological outcomes like digestion. Coley (1995) demonstrated that 8-year-olds, and to some extent kindergartners, show clearly different patterns of projections for biological (e.g., "has blood") versus psychological (e.g., "is smart") properties over the same set of animals. These results directly contradict the claim that preschoolers cannot in principle differentiate between biological and psychological construals of animals.

Biological causal mechanisms. Finally, a number of lines of research suggest candidates for explicitly biological causal mechanisms used by preschoolers to explain biological phenomena. These include *growth and natural change* (Backscheider, Shatz, & Gelman, 1993; Rosengren, Gelman, Kalish, & McCormick, 1991; Springer, Ngyuen, & Samaniego, 1996), *inheritance* (Hirschfeld, 1995; Springer, 1992; Springer & Keil, 1991; but see Solomon, Johnson, Zaitchik, & Carey, 1996, for an alternative view), and *illness and contagion* (Kalish, 1996a, 1996b, 1997; Solomon & Cassamites, 1999). In addition to these specific causal mechanisms, several independent proposals have been put forward to characterize early folkbiological framework theories. One of these is *teleology* (Keil, 1994, p. 237), which is the idea that "Properties have a purpose for biological kinds. There is a compelling, albeit sometimes mistaken sense . . . that the properties of biological kinds are there for reasons, that they solve design problems for the kinds that possess them." The other is *vitalism* (Hatano & Inagaki, 1994, 1999; Inagaki & Hatano, 1993, 1996; Miller & Bartsch, 1997) which, briefly, is the notion that living things take in vital energy from the environment and use it to grow and function properly.

Taken together, this large and growing body of research documents violations of the aforementioned implications of the radical theory change view. Preschoolers acknowledge important commonalities between animals and plants. They distinguish biological and psychological construals of living things. And

although the evidence is not yet decisive, candidates for biological causal mechanisms and framework theories have been put forward. Thus, several important implications of the radical theory change view are violated, casting doubt on radical restructuring as a mechanism of conceptual change and suggesting that the acquisition of folkbiology may be a more gradual process. Children's folkbiological belief systems may not be incommensurate with those of adults after all.

The response of proponents of radical theory change (e.g., Carey, 1995, 1999) has been to acknowledge that children have distinct ways of thinking about living things, to push the age at which an autonomous intuitive biology emerges from 10 down to 6 or 7, and to acknowledge that a strong version of the radical conceptual change claim does not hold. However this should not be taken as a surrender. Proponents of radical conceptual change have argued that the understanding of animals/living things revealed by the aforementioned body of research is not a *biological* understanding. Rather it springs from an understanding of behavior and intuitive psychology. For instance, Carey (1995) argues that "We know that children have the concept *animal*; what is at issue is whether *animal* is a biological concept" (p. 291) and ". . . preschool children think that one person can 'catch' such symptoms as rashes and watery eyes through physical contact with a person who has them, but not weird beliefs or behaviors . . . the question is whether the child has any knowledge of any biological mechanism underlying such 'catching'" (p. 291). Likewise, Solomon et al. (1996, p. 169) summarize their results on inheritance by saying "The present studies challenge the claim that preschoolers' understanding of inheritance is biological."

Whether children's early thinking about living things is "biological" depends, of course, on one's definition of "biological." If by biological we mean "utilizing the same explanatory mechanisms as scientific biology," then children's early understanding of living things is obviously not biological. Clearly, preschool children do not yet understand the mechanisms underlying many biological processes (e.g., the viral transmissions of AIDS, Au & Romo, 1996). Young children are terrible at specifying details of genetic inheritance or disease transmission or the functions of various internal organs. Nor do they seem to have a clear notion about the kinds of things that are inside animals (Simons & Keil, 1995). At the other extreme, if by "biological" we mean "about living things," then the answer is trivially yes. By age 4 children have accumulated a great deal of encyclopedic knowledge about animals and plants. Obviously, neither of these definitions will do. Furthermore, I don't believe that the

question of whether young children's conceptions of living things may properly be called "biological" is the most central question facing us. To the degree that we are truly interested in understanding conceptual development in the domain of folkbiology, the central questions facing researchers in this area are three: First, what are children's conceptions of living things like? Second, what are adults' conceptions of living things like? And third, how do we best characterize the process by which children's conceptions come to resemble those of adults in their culture? Indeed, the question of whether children's understanding of living things is biological is perhaps more profitably rendered as "Is children's understanding of living things like adults' understanding of living things?"

At present we cannot answer this question because we lack detailed research on the nature of adults' folkbiological conceptual systems, especially with respect to their understanding of biological causal mechanism. The research briefly mentioned above yields a rich picture of children's conceptions of living things. We know very little, however, about adults' conceptions of folkbiology beyond their responses as a comparison group on tasks designed for preschoolers. For example, consider recent research on children's understandings of inheritance and contagion. Children appear to understand that offspring resemble their parents, but are not always clear on exactly how or why. Children appear to understand that germs can make you sick and that you can catch germs from physical contact, but they're not always clear on exactly how or why. Before these patterns of partial understanding are dismissed as nonbiological, it is crucial to assess whether the understanding of the average adult in our culture is significantly more detailed or sophisticated. To what degree do adults demonstrate detailed knowledge of the mechanisms of inheritance or disease transmission? We cannot simply assume that adults' understanding of underlying biological mechanisms is significantly more sophisticated; indeed, adults may have a surprisingly tenuous grasp of biological causality, at least with respect to disease (Au & Romo, 1999; Keil, Levin, Richman, & Gutheil, 1999).

Thus, in order to characterize the nature of conceptual change in the domain of folkbiology, we must first understand the nature of the adult endpoint. If adults do possess sophisticated knowledge of biological mechanisms, then perhaps radical conceptual change does take place. In contrast, adult models may amount to little more than elaborated versions of the input-output relations understood by children (Au & Romo, 1999). Either way, to understand development we need a detailed description of the adult conceptual system that preschoolers are presumably in the

midst of acquiring. Without a relatively detailed characterization of adult folkbiological conceptual systems in a particular culture, the trajectory of development cannot be adequately understood. Before we can understand the *process* of development, we must understand the *endstate*. Without some sense of endstate, we cannot hope to resolve the debate on the nature of conceptual development in this, or any, domain.

VARIATIONS IN ADULT FOLKBIOLOGICAL THOUGHT

In the previous section I argued that understanding conceptual development requires specification of the adult endstates. This is an oversimplification; conceptual development proceeds toward a range of possible outcomes rather than a single ideal. As pointed out by Super (1980), general theories of development are not possible without comparative research on the range of variation among adult endpoints. Moreover, such research reveals conceptual universals and cultural particulars that would then constrain possible accounts of development. Recent comparative research on adult folkbiological thought reveals both universal patterns and group differences that are attributable to cultural beliefs about the natural world, personal experience with flora and fauna, and other factors (Atran, 1998). Importantly, although we can perhaps point to a consensual "adult model" that represents knowledge shared by most adults in a given culture, recent comparative research has begun to uncover variability in adult models between and within cultures (e.g., Atran et al., 1999; Coley, Medin, & Atran, 1997; Coley, Medin, Proffitt, Lynch, & Atran, 1999; López, Atran, Coley, Medin, & Smith, 1997; Medin, Lynch, Coley, & Atran, 1997; Walker, 1992, 1999). This variability has important implications for accounts of conceptual development.

For example, different populations use animal categories differently in inductive reasoning. The similarity-coverage model of Osherson, Smith, Wilkie, López, and Shafir (1990) predicts that an argument whose premises are more diverse will be judged stronger than an argument whose premises are similar. For example, one should be more willing to generalize to all birds from sparrows and flamingos than from sparrows and robins. Osherson et al. attribute this finding to *coverage*; reasoners compare the taxonomic similarity of the premise categories to sampled members of the more general conclusion category. The premise set with better coverage—that is, higher taxonomic similarity to sampled instances—makes for the stronger argument. For the most part, undergraduate research participants reason in accordance with

this diversity principle, based on taxonomic similarity. This finding has provided the foundation for several studies of the development of category-based induction which in general reveal that children through age 10 have difficulty grasping this phenomenon when reasoning about living things (Gutheil & Gelman, 1997; López, Gutheil, Gelman, & Smith, 1992). So far, this appears to be a straightforward developmental story; diversity is a complex inductive reasoning principle, and is relatively late in developing (but see Heit & Hahn, 1999, for evidence that by age 5 children can successfully reason according to diversity when reasoning involves familiar properties).

Comparative research, however, reveals that this diversity phenomenon is by no means a universal feature of folkbiological reasoning. The Itzaj Maya, native to the Peten region of Guatemala, do not use diversity in evaluating arguments about local mammals. Instead of computing taxonomic distance in evaluating possible inductions, they use expansive specific knowledge on the species in question (López et al., 1997). Nor is this simply a difference between urbanized and traditional thinkers; when the subject matter is trees, some Chicago-area tree experts use diversity-based reasoning like the undergraduates do (taxonomists and landscapers), whereas others (parks maintenance workers) prefer alternative strategies, like the Itzaj (Coley et al., 1999). Indeed, it appears that for experts, diversity is one reasoning strategy among many available, and one that often loses out when pitted against domain-specific knowledge about ecological propensities and causal principles. For relative folkbiological novices (such as the participants in the original experiments by Osherson et al., 1990), diversity may be the only reasoning strategy available.

In this case, comparative work on adult patterns of induction recasts the developmental findings and the phenomenon that a developmental account must explain. Diversity-reasoning adults are not necessarily the endstate of development, but may represent instead an intermediate stage wherein one has sufficient taxonomic knowledge to use diversity, but perhaps little specific knowledge to go beyond it. Moreover, comparative adult work suggests that the content of what is learned may differ by culture. Diversity is based on taxonomic relations among categories; perhaps children in the United States learn primarily about taxonomic relations among living kinds (indeed, recent evidence suggests that parental input to children in the United States focuses on the importance of taxonomic relations, Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). In contrast, Itzaj children, growing up in an environment where plants

and animals are salient and important, may be more likely to learn about causal-ecological relations. More generally, as this case study demonstrates, the "adult model" of folkbiological thought is influenced by culture, experience, and probably many other factors. We are only beginning to understand the nature and complexity of this model. Still, the range of variation we see in adult folkbiological cognition, as well as apparent universals, represents important constraints on possible accounts of development.

CONCEPTUAL DEVELOPMENT IN NEGLECTED POPULATIONS

In the preceding sections I have argued that to characterize the process of conceptual development, we must better understand the adult models that children are in the process of acquiring, and better assess the variation among different possible adult endstates. It is equally crucial to examine conceptual development among different populations of children, especially those that differ along dimensions relevant to the domain in question. In the domain of folkbiology, these dimensions include daily experience with the natural world, and cultural beliefs about the relations between humans and the rest of the biological world. Most research in the domain of conceptual development has been done using predominantly White, predominantly middle- and upper-class urban or suburban children of relatively well-educated parents.¹ The population is remarkably uniform with respect to cultural beliefs about the natural world and human beings' rightful place therein, and with respect to their (relative lack of) direct experience with, and dependence on, plants and animals. As such, this population might be a good one in which to observe the acquisition of a relatively impoverished folkbiology, but a remarkably bad one from which to glean any sense of the range of variation in patterns of conceptual de-

¹ Not all research on the development of folkbiology has focused on this population. The work of Inagaki and Hatano—although it is not explicitly comparative—examines emerging biological knowledge among Japanese children. Hatano et al. (1993) compare biological reasoning among children in Japan, the United States, and Israel, and find striking commonalities along with some specific differences. While valuable, this work is conducted with primarily urban samples from industrialized societies that presumably have little contact with plants and animals, and therefore may not be as broad as it initially appears. Another exception is the research done by Walker (1999) among the Nigerian Yoruba. This work looks at the preservation of identity over superficial transformations, and reveals different developmental courses for rural, urban, and elite populations. Despite the existence of these studies, comparative work is nevertheless the exception rather than the rule.

velopment in the domain of folkbiology. From this research we have learned much about how young children in this population conceptualize plants and animals, but almost nothing about the different paths that conceptual development may take. One example from an ongoing research project with a Native American population in Wisconsin illustrates the potential value of comparative developmental research.

Carey (1985, 1995) argues that children's early understanding of plants and animals is anthropocentric. In other words, prototypicality of humans is central to children's conceptions of the biological world; children's understanding of other living things is largely in reference to, or by analogy to, human beings. One source of support for this view is a property projection task where children are taught a new fact about a given biological kind (e.g., a dog "has an omentum") and asked whether other kinds (a bird, a fish, a plant) share that property. Carey (1985) reports a pattern of results consistent with the view that 4- and 6-year-old children's conceptions of the natural world are indeed anthropocentric. First, overall projections from humans were stronger than projections from other living things. Second, specific asymmetries in projection emerged, such that (for example) inferences from *human* to *dog* were stronger than from *dog* to *human*. Finally, children's reasoning followed striking violations of similarity, such that (for example) inferences from *human* to *bug* were stronger than from *bee* to *bug*. These patterns suggest that human is a privileged inferential base for the children Carey studied. As discussed above, this pattern of reasoning has been interpreted as demonstrating that young children possess an understanding of biological phenomena incommensurate with that of adults, and that pervasive conceptual change is necessary for children to acquire the adult model in which humans are seen as one animal among many.

It is important, however, to examine the generality of this anthropocentric pattern of reasoning on at least two grounds. First, rather than being diagnostic of deep conceptual commitments, this anthropocentric folkbiology may reflect a lack of knowledge about the biological world. Carey's subject population, in Cambridge, Massachusetts, may be relative folkbiological novices. Indeed, some evidence suggests that children who are more familiar with certain living kinds prefer to use knowledge of those kinds in reasoning. Specifically, Inagaki (1990) shows that children who raised goldfish reasoned about a novel aquatic animal (a frog) by analogy to the goldfish, not to humans. So, perhaps Carey's population (and that studied by most developmental researchers) did not have sufficient knowledge of nonhuman living kinds to use them as an inferential base. Increased knowledge

might provide more salient biological exemplars which could in turn mitigate anthropocentrism.

Second, an anthropocentric folkbiology may reflect cultural assumptions about relations between humans and nature. Again, in the population studied by Carey (and most others), the differences between humans and nonhumans is very sharply drawn. Direct interaction with and dependence on nature is relatively rare. In Western culture, humans are seen as distinct from nature. However, in a culture where humans are perceived as an integral part of nature, people might be less likely to make anthropocentric construals.

In an ongoing comparative study of members of the Menominee Indian Tribe of Wisconsin, we are currently addressing some of these questions. This population is interesting for a number of reasons. First, on the traditional Native American view, humans are an integral part of the natural world (Bierhorst, 1994; Suzuki & Knudtson, 1992). This contrasts sharply with the Western view. Second, traditional folkbiological knowledge is especially salient to the Menominee. Unlike many woodland tribes, the Menominee reservation occupies (a small fraction of) their traditional range; thus, traditional knowledge of local plant and animal species is still very relevant today. Moreover, the Menominee run a successful logging operation that employs traditional ecological knowledge to guide forest management; thus, many Menominee depend in part on traditional knowledge for their livelihood. Children spend time fishing and hunting and in general have a very high degree of contact with plants and animals. Thus, Menominee children differ from a typical urban or suburban sample in terms of both having a cultural tradition of viewing humans as an integral part of the natural world and having a great deal of experience with plants and animals. In this work we ask whether these differences might lead to variant patterns of folkbiological reasoning.

As part of this project, we examined inductive inferences among Native American children using a property projection task. Contrary to results with middle-class urban children, Menominee children aged 6 years and above show no evidence of anthropocentric folkbiological reasoning (Coley, Medin, & James, 1999). Specifically, we find no evidence that *human* functions as a privileged inductive base, little evidence of asymmetries in projections, and no evidence for violations of similarity. Rather, Menominee children's projections were largely based on similarity among living things, and to some extent on causal/ecological relations.

These results raise several intriguing possibilities about the shift in reasoning reported by Carey (1985).

First, the shift away from anthropocentric folkbiological reasoning may take place earlier in this population. In order to answer this question, the next step is to examine property projection in younger (4-year-old) Menominee children. Another possibility is that this population may never adopt anthropocentric reasoning patterns at all. Either of these patterns reflects a departure from what has been reported in the literature and provides a challenge to current explanations of conceptual development by providing an alternative developmental trajectory in need of explanation. These preliminary results are far from conclusive, but they broaden our view of the process of conceptual development, and raise clear questions about the generality of the process as currently described in the literature. Furthermore, they demonstrate the potential value of documenting patterns of development in populations that differ substantially from mainstream developmental research participants on relevant dimensions.

CONCLUSIONS

Using the domain of folkbiology as a demonstration case, I have argued that the study of conceptual development stands to benefit greatly by increased comparative research in several ways. First, we need comparisons between children and adults within a given society. I have argued that it is essentially impossible to understand the process of conceptual development without a detailed look at adult conceptions of folkbiology. Without such research, we cannot hope to specify how children's models come to resemble those of adults in their culture. Second, we need comparisons between adults' endstates in different contexts. A complete understanding of conceptual development demands that we understand the variability of adult conceptual systems, including the differences attributable to experience and cultural beliefs, among other factors. Conceptual development proceeds toward a range of possible outcomes, not toward a single ideal. Documenting this range is necessary for understanding development and would shed light on conceptual universals and cultural particulars that would then constrain possible accounts of development. Finally, we need comparisons among children developing in different contexts. To understand conceptual development broadly construed, comparative research needs to be conducted on the process of development in groups of children other than the standard research population. This research is needed especially among groups that differ from standard populations on relevant dimension such as habitual experience or specific cultural beliefs. Such re-

search goes hand-in-hand with comparative adult work and would serve to distinguish universal from particular patterns of development and thus to inform and constrain accounts of conceptual development.

It is important to acknowledge that comparative research is by no means a panacea. Like any other research paradigm, comparative studies have limitations. By definition, comparative studies violate a cardinal rule of experimental method by leaving many differences between groups uncontrolled (Cole & Means, 1981). So whereas similar patterns of development in disparate populations indicate potential cognitive universals, different patterns of development in such groups indicate the need to search further for an explanation of those differences. But the search might never have seemed necessary without the comparative findings. Thus, comparative research can be seen as a tool for raising core questions about conceptual development as well as for answering those questions. As such, comparative research is absolutely essential for deepening our understanding of the range and complexity of human conceptual development.

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