Medin, D., ojalehto, b., Waxman, S., & Bang, M. (in press 2014). Relations: language, epistemologies, categories and concepts. To appear in: E. Margolis & S. Laurence, (Eds.), The Conceptual Mind: New Directions in the Study of Concepts, MIT Press.

Relations: Language, Epistemologies, Categories and Concepts

Relations: Language, Epistemologies, Categories and Concepts

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1. Introduction

For centuries, concepts have held a privileged position in inquiries about the nature of knowledge, the dawning of insight and reason, the discovery of language, and the acquisition of mind. Concepts matter, and in this chapter we argue that so does the language we use to describe them and the cultural practices in which we embed them. This position represents something of a shift from studies that have focused on properties of individual category members, such as whether they are good or poor examples of the category (e.g., Rosch & Mervis, 1975) or properties of individual categories, such as whether they are subordinate, basic or superordinate level (as in the classic studies of Rosch et al., 1976). Instead, we will take a more relational perspective, both with respect to how our language and how our cultural orientations permeate conceptual behavior.[1]

Our recent work has focused on acquisition and use of concepts pertaining to the biological world and on identifying the role of language, culture, and experience in shaping them. Transparently this requires a cross-cultural and cross-linguistic developmental approach. The work we summarize here represents the efforts of longstanding collaborations with psychologists, linguists and anthropologists from the US and abroad. A central theme in our work, and in this chapter, is the variety of ways in which the relation between humans and the rest of the natural world can be conceptualized.

We will consider this focal question from two perspectives: how are human beings conceptualized, taxonomically speaking, and how do we understand the relations between human beings and the rest of the natural

[1] Although we consider the interactions among concepts, cultural practices and language, our goal in this chapter is not to resolve broad, longstanding debates about linguistic relativity. In our view, progress on this debate depends upon evidence documenting *which* concepts are available in advance of (or in the absence of) language, and *how* these concepts are shaped by the availability within a language of *particular* linguistic devices. The research we present here bears on these questions, but takes no stance on whether the concepts favored by members of one language group are or are not available to members of another.

world, ecologically or relationally speaking? We begin with the taxonomic question.

2. Biological Categories: Humans, Nonhuman Animals, Plants and the Hierarchical Relations Among Living Things.

Young children acquiring biological categories (e.g., human, animal, plant, living thing) must identify not only the content or members of each category, but also the relations among categories. In this section, we focus on these relations, paying special attention to three issues in particular: 1. How do adults and children from diverse communities conceptualize the relation between human and nonhuman animals? 2. How do children come to understand the relation between the plant and animal kingdoms? 3. How are these relations shaped by cultural and linguistic forces?

Animals, and the (special?) case of humans.

"All animals are equal but some animals are more equal than others."

- George Orwell

What is the place of humans in the biological world? This question is intriguing because there is no one 'correct' answer. As adults, we answer fluidly. In the context of Western taxonomic science, we see human beings as biological organisms (Class Mammalia). In the context of Western religion, human beings typically are seen as distinct from the rest of the biological kingdom (humans alone were created in the image of God; this brings with it a notion of our dominion and the importance of stewardship over other living things). Everyday discourse is full of simile and metaphor involving comparison of humans to other animals ("I'm as hungry as a bear." "Don't eat like an animal.") How do children come to acquire and reconcile these different notions about the (biological) status of humans? As will be seen, there is an intricate interplay between linguistic and conceptual development.

Extensive evidence demonstrates that from infancy, names (and nouns in particular) are a catalyst in the formation of object categories (see Waxman and Lidz, 2006, for evidence from infants and Goss, 1961; Spiker, 1956 for adults). Infants' ability to form an object category (e.g., animal) when presented with a set of disparate exemplars in the absence of a name (e.g., a dog, a horse, a duck) improves dramatically when these exemplars are introduced with the same name. By 14 months, this link between naming and object categories is specific to nouns (Echols & Marti, 2004;Waxman, 1999; Waxman & Booth, 2001).

There is also evidence that the concept *animal*[2] emerges early in development. Infants are especially interested in animate objects and are captivated by animate properties, including faces, eyes, and autonomous, biological motion (Carey, Diamond, & Woods, 1980; Johnson, Slaughter, & Carey, 1998; Pascalis, de Haan & Nelson, 2002; Poulin-Dubois & Shultz, 1990; Scott & Monesson, 2009). By three to five months, babies begin to make a principled distinction between animate and inanimate objects (Bertenthal, 1993; Woodward, Sommerville, & Guajardo, 2001) and between agents and non-agents (Leslie, 1994; Massey & R. Gelman, 1988; Newman Keil, Kuhlmeier & Wynn, 2010; Opfer & S. Gelman, 2010; see also Luo, Kaufman & Baillargeon, 2009; Pauen & Trauble, 2009; Shutts, Markson & Spelke, 2009).

If names serve as invitations to form categories (Waxman & Markow, 1995), then the names that children hear for biological entities should support the acquisition of biological concepts (Gelman, 2003; Gelman & Markman, 1986; Graham, Kilbreath, & Welder, 2004; Waxman & Booth, 2001; Waxman, et al., 1997). A large body of ethnobiological research provides insights into how the entities in the natural world are named across diverse languages (Berlin, 1992) and it shows that most languages name the concept *animal*. This, coupled with infants' early predispositions to link names and object concepts, likely supports the early acquisition of *animal*.

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[2] We adopt the following notational convention to clarify, whenever necessary, whether we are talking about a concept or a name for that concept. *Concepts* will be marked by *italics*; 'words' will be marked by single quotations.

There is, however, one important complicating factor: The noun 'animal' is polysemous. This polysemy has gripped our attention, primarily because it has consequences for children's appreciation of the relation among living things and for understanding where humans fit into the taxonomic scheme for biological kinds.

'Animal' is polysemous.

For English-speaking adults, 'animal' can refer either to an inclusive concept, including all animate beings (as in, "Animals have babies"), or to a more restricted concept, including nonhuman animals but excluding humans (as in, "Don't eat like an animal"). For ease of exposition, we will refer to these two nested concepts, respectively, as $animal_{\text{inclusive}}$ and $animal_{\text{contrastive}}$. Although this polysemous use of 'animal' is endemic, the context in which 'animal' is used commonly provides strong cues about which sense is intended.

Whatever its source, this type of polysemy could pose developmental challenges: if nouns support the formation of object categories, and if the same name 'animal' points to two different, but hierarchically-related concepts, then it should be difficult for children to settle on its meaning.

A review of the developmental literature suggests that infants may begin to appreciate both concepts -- $animal_{\text{inclusive}}$ and $animal_{\text{contrastive}}$ -- within the first year. Although infants and children include both humans and nonhuman animals in a concept organized around *animacy* or *agency* (Massey & R. Gelman, 1988; Opfer & S. Gelman, 2010; See Luo, Kaufman & Baillargeon, 2009 for discussion), they also distinguish between humans and nonhuman animals (Scott & Moneson, 2009; Vouloumanos et al., 2009, 2010).

If both of these underlying concepts are represented by toddlers, which do they take to be the referent of 'animal'? We have pursued this question with several different methods, from interviewing children, observing their performance in categorization tasks, and analyzing the language input they receive from their parents.

Our studies with English speaking children suggest that they typically interpret ‘animal’ in the contrastive sense. For example, we asked 5-year-old children to name “…all the animals you can think of”. Children named a wide variety of animals, ranging from mammals to insects, but not a single child included humans (or ‘people’) in their list (Winkler-Rhoades, et al., 2010). We also asked 3- and 5-year-olds directly whether humans “…are animals” and both age groups overwhelmingly denied that humans are animals. By 9 years of age, roughly 40% of the children agreed that the name “animal” could be applied to humans (Leddon, et al., in press). In short, English-speaking children favor the contrastive sense of the term ‘animal’.

We also designed an experimental task to ask under what conditions young children might engage the overarching *animal*$_{\text{inclusive}}$ concept (Herrmann, Waxman & Medin, 2012). We used the link between naming and object categorization as an opportunity to explore 3- and 5-year-old children’s representations of *animal*. In this task, we presented children with two distinct training-items, labeled them with the same novel noun, and then probed children’s extensions of that noun to a range of other entities. In the first study both training-items were nonhuman animals; in the second, training-items include one human and one nonhuman animal. At issue is whether they would spontaneously extend the noun to include humans along with nonhuman animals as members of the same overarching *animal*$_{\text{inclusive}}$ concept.

Our materials included laminated photographs depicting humans, nonhuman animals and inanimate objects (plants, non-living natural kinds, artifacts). To begin, the researcher presented each card, in random order, helping the child to identify the object it depicted. Next, the experimenter introduced a hand-puppet (Pinky), explaining that Pinky lived far away and used “…funny words for things”. The experimenter then pointed to the two training-items (dog, bird) in random order, saying, “Pinky calls these both *blickets*. This one is a *blicket* and this one is a *blicket*”. The experimenter then presented each test photograph in random order, asking "Does Pinky call this one a *blicket*?"

As expected, both 3- and 5-year-old children extended the novel noun to the test-items that matched the training-items and to the other nonhuman animals, excluding the inanimate entities. But neither the 3- nor 5-year-olds spontaneously extended the novel noun to include humans. In fact, they were just as unlikely to say 'yes' to a human as to an inanimate object. In other words, children favored the *animal*$_{\text{contrastive}}$ category. Nonetheless, this does not preclude the possibility that they also represent the more inclusive sense.

We pursued this possibility by introducing another group of children to a novel noun for a human and either a bird or a dog. Otherwise, the stimulus materials and procedure were identical to those from before. For half of the children, a human and a dog served as training-items; for the others, a human and bird served as the training-items. We reasoned that if 3- and 5-year-olds do have access to *animal*$_{\text{inclusive}}$, they might engage it in this naming context.

Including a human as a training-item had a dramatic effect. The 3-year-olds's performance fell to chance. Their unsystematic extension of the novel word signaled their difficulty accessing an overarching concept including both human and nonhuman animals. In contrast, 5-year-olds extended the novel noun systematically, this time including both human and nonhuman animals. This illustrates their appreciation of *animal*$_{\text{inclusive}}$.

The fact that 3- and 5-year-olds did not spontaneously include humans in the first study suggests that humans are not prototypical animals, at least not for preschool-aged children. The fact that 3-year-olds had trouble including human and nonhuman animals in the same (newly) named category in the second study underscores the developmental challenge they face in identifying the scope of *animal*.

Does parents' use of language provide children with some help in identifying the relation between human and nonhuman animals? The answer seems to be "No." (Leddon, Waxman & Medin, 2011). Parents of young

English-speaking children offer considerable support for the concept *animal*$_{contrastive}$ by typically using ‘animal’ to refer to nonhuman animals. But they offer scant support for *animal*$_{inclusive}$; only rarely do they invoke the term ‘animal’ to refer to humans. This discourse practice likely highlights the uniqueness of humans and fortifies the distinction between human and nonhuman animals, but provides little support for the overarching *animal*$_{inclusive}$ concept spanning them.

Taking yet another tack on the conceptual polysemy, we shifted to a cross-linguistic approach, specifically focusing on the contrast between English and Indonesian. In Indonesian ‘animal’ is not polysemous. This has significant and sometimes counter-intuitive cognitive consequences. Our work in Indonesia has been a venture with our former student Flo Anggorro (e.g., Anggoro, Waxman & Medin, 2008). Before turning to these studies we need to broaden our conceptual focus to the concept *living thing*.

There is strong consensus that appreciation of the concept *living thing* (members of the plant and animal kingdoms) is a late and laborious developmental achievement. Piaget (1954) noted young children’s tendency to mistakenly attribute life status to inanimate objects that appear to move on their own or to exhibit goal-directed behavior (e.g., clouds). He interpreted this “childhood animism” as a reflection of children’s inchoate grasp of concepts such as *animal* and *living thing*. More recent evidence indicates that even 10-year-old children have difficulty understanding the scope of *living thing* (Hatano, et al., 1993). [3]

Our studies show that how these concepts are named in a given language shapes their acquisition. The work in Indonesia provides a case-in-point. In Indonesian, ‘animal’ refers to *animal* $_{contrastive}$; it cannot be applied to humans. The more inclusive *animal* $_{inclusive}$ concept remains unnamed. To examine how this cross-linguistic difference affects children’s acquisition of

[3] Later on we consider the idea that natural inanimates like ‘rock’ and ‘water’ may be animates in other cultural schemes.

concepts of the natural world, we recruited monolingual Indonesian-speaking children (in Jakarta) and monolingual English-speaking children (from the greater Chicago area) from urban elementary schools.

Because adult interpretations of word meanings may not mirror precisely those of children, we began by asking how Indonesian-speaking children interpret the word ‘animal’. The interview was identical to the one used earlier: an experimenter presented Indonesian 6- and 9-year-old children with a photograph of a human, and asked, “Could you call this an ‘animal’?” (“Mungkinkah ini ‘hewan’?”). Indonesian-speaking children uniformly endorsed the *animal* $_{\text{contrastive}}$ view. Recall that although English-speaking children from 3- to 5-years also favored *animal* $_{\text{contrastive}}$, by 9 years of age, roughly 40% endorsed the *animal* $_{\text{inclusive}}$ interpretation.

To ascertain whether this difference in naming practices is reflected in children’s conceptual organization, we designed two sorting tasks. In the first, we presented 6- and 9-year-old children with a set of picture cards representing humans, nonhuman animals or plants and invited them to place “…the kinds of things that belong together in the same pile.” If naming a concept facilitates its access, then the concept *animal* $_{\text{inclusive}}$ should be more accessible to English- than Indonesian-speaking children, and among the English-speaking children, it should be more accessible to older than younger children (see Anggoro, et al., 2008, for details).

As predicted, English-speaking children were more likely than their Indonesian-speaking counterparts to spontaneously place humans and nonhuman animals in the same category, and among the English-speaking children, 9-year-olds were more likely to do so than 6-year-olds. These results suggest that children’s spontaneous categorizations reflect their appreciation of the naming practices in their communities

Next we used a more tightly structured categorization task, this time tapping into English- and Indonesian-speaking children’s appreciation of the overarching concept *living thing*. A chief goal of this study was to test

Waxman's (2005) prediction about the relation between naming and the establishment of biological categories. Before presenting the prediction, a bit of background is necessary.

Attributing life status to plants is a late developmental achievement. When English-speaking children are asked to sort objects on the basis of which ones are 'alive', they systematically exclude plants (Carey, 1985; Piaget, 1973; Richards & Siegler, 1984; Waxman, 2005). Moreover, in Japanese and Hebrew – two other languages in which the word denoting the concept *animal* is polysemous – children also tend to deny that plants are alive (Hatano et al., 1993; Stavy & Wax, 1989). This observation, coupled with evidence that children avoid polysemy whenever possible, suggests that children should be open to aligning a word other than 'animal' with the *animal* $_{\text{inclusive}}$ concept, should a suitable candidate arise.

By Waxman's conjecture that candidate is 'alive'. If English-speaking children (mis)align the word "alive" to the concept *animal*$_{\text{inclusive,}}$ then they should have more difficulty than Indonesian-speaking children in learning the broader meaning of 'alive'. By misaligning this word with *animal*$_{\text{inclusive}}$, they miss the insight that plants, too, are alive. Paradoxically, this difference between languages might be more pronounced in older children (9-year-olds) for whom *animal* $_{\text{inclusive}}$ is more firmly established.

We can now return to the structured sorting task. Children were presented with a set of cards depicting humans, nonhuman animals, plants and artifacts, and asked to sort these cards three different times, on the basis of three different predicates – 'alive', 'die', 'grow'-- each of which applies to all living things. Because our primary focus was on 'alive', that predicate was always presented first followed by the other two, in random order. If children appreciate an overarching concept *living thing*, they should consistently distinguish the living from the non-living entities. By comparing the sorting patterns of English- and Indonesian-speaking children, we were able to consider the consequences of polysemous and non-polysemous 'animal'.

There were two main findings. First, English- and Indonesian-speaking children's performance with the predicates 'grow' and 'die' showed an appreciation of the concept *living thing*. Second, their performance with 'alive' revealed special interpretive difficulties for English-speaking children, and especially at the older ages, exactly in accordance with Waxman's conjecture (English-speaking children were less likely than their Indonesian counterparts to include plants under 'alive'.) Interestingly, it is not that English-speaking children were in the dark about properties of plants. In fact, they were more likely than Indonesian-speaking children to recognize that plants die and grow. Instead, it is specifically the meaning of 'alive' that is harder for English-speaking children to grasp--they misalign 'alive' to the node of human and nonhuman animals.

This work shows that the way in which biological concepts are named influences their acquisition. What remains unanswered is whether this difference between children acquiring Indonesian and English is attributable to the polysemy of 'animal' (English) or the unnamed status of animal-inclusive (Indonesian). Answers will rest upon evidence from languages that name the *animate* node, but in which the name is not polysemous. For example, Czech appears to be one such language: *animal* $_{\text{inclusive}}$ is named ('živočich'), and this name is distinct from that for *animal* $_{\text{contrastive}}$ ('zvíře'). That is a task for future work.

We have focused thus far on how children from distinct linguistic communities establish fundamental biological concepts and discover the relations among them. With this as background, we now consider how children use these biological kinds in inductive reasoning, and the role of language, culture, and expertise in reasoning.

3. Reasoning about Biological Kinds.

We begin with a small detour. The evidence so far suggests that children have difficulty conceptualizing humans as animals, and, at best, see humans as atypical or unusual members of the animal category. This latter observation seems to imply that the category, human being, would make a poor base for generalizing (biological) properties to other biological organisms. So, for example, if I told you that humans have some property x and that dogs have some property y and asked you whether it is more likely that squirrels also have property x or property y, you might expect most bets to be placed on y, because x could be some peculiarly human sort of thing. Surprisingly, however, there is a body of research and theory that comes to just the opposite conclusion: that for young children, humans are the prototype or paragon for inductive biological reasoning, and that this human-centered focus is only overturned between 5 and 7 years of age, when children come to reason more like adults, seeing humans as an atypical instance of animal (Carey, 1985).

This shift has been interpreted within a ‘domain-specific’ view of human cognition. A trend in the cognitive and developmental sciences has been a shift from viewing cognition as a domain-general, general purpose learning and thinking system to seeing cognition as a set of domain-specific mechanisms that are specialized in their processes (Cosmides, Tooby, & Barkow, 1992; Medin, Lynch and Solomon, 2000). That is, learning may be guided by certain (possibly innate) skeletal principles, constraints, and assumptions about the world (e.g., Gelman, 1990; Keil, 1981; Spelke, 1990). In an important book, Carey (1985) developed a theory of concept learning as built on framework theories that entail ontological commitments in the service of a causal understanding of real-world phenomena.

That’s quite a mouthful; basically it means that different causal principles may operate in different domains. Consider, for example, an event in which a baseball shatters a window. The relevant features and rules underlying our appreciation of the *physical* aspect of this event (e.g., force mechanics) are quite different from the relevant features and rules that underlie our understanding of the *social* or *psychological* aspects of the same event (e.g., blame, responsibility). Developmentalists have argued that (at least) three distinct domains guide children's development of knowledge: physical processes and events (naïve or folk physics), biological processes and events (naïve or folk biology) and psychological events and processes (naïve or folk psychology).

For Carey (1985, 2009) a key childhood achievement consists of developing a (naïve) biology distinct from naïve psychology. For Western adults who tend to endorse a dualism between mind and body, psychology and biology are distinct domains with distinct causal principles. Eating a candy bar can give someone instant energy but it will not make them a sweeter person. Carey (1985) argued that (young) children have not yet carved out a domain for biological processes. Instead, biological processes are initially interpreted within the domain of naïve psychology.

That's a strong claim and Carey (1985) offered some striking evidence to support it. There are two steps to her argument. The first step to note is that though humans may not be prototypical within a biological domain, they are the premier psychological beings. The second step is to show that children's biological reasoning is organized around humans as the prototype. If this is the case it would support the idea that children's biological reasoning is organized in terms of psychology.

The strongest evidence for a human-centered stance in young children's biological reasoning comes from Carey's own pioneering research (Carey, 1985). In an inductive generalization task involving children (ranging from 4 to 10 years of age) and adults from Boston, participants were introduced to a novel biological property (e.g., "has an omentum"), taught that this property is true of one biological kind (human, dog or bee), and then a few days later asked whether other entities might have this property.

Carey reported dramatic developmental changes in inductive reasoning. If the novel property had been introduced as true of a human, 4- to 5-year-olds generalized, or projected, that property broadly to other biological kinds as a function of their similarity to humans. But if the identical property was introduced in conjunction with a dog or bee, 4- to 5-year-olds made relatively few generalizations to other animals. This produced a pattern of generalization that violates intuitive notions of similarity. For example, 4- to 5-year-olds generalized more from human to bug (stinkoo) than from bee to bug. Overall, Carey (1985) provided two strong indices of anthropocentric reasoning: (1) projections from humans to other animals were stronger than projections from dog or bee; and (2) there were strong asymmetries in projections to and from humans (e.g., inferences from human to dog were stronger than from dog to human).

Older children and adults gave no indications of anthropocentric reasoning. Instead they tended to generalize novel biological properties broadly from one biological kind to another, whether the property had been introduced as a property of a human or nonhuman (dog, bee) animal. Moreover, they showed no human-animal asymmetries in their reasoning. These data suggest that for older children and adults, reasoning about the biological world is organized around a concept of animal that includes both human and nonhuman animals.

Carey (1985; Carey & Spelke, 1994) has argued forcefully from these data that young children hold a qualitatively different understanding of biological phenomena from that of adults. Carey (1985) entitled her book "Conceptual Change in Childhood" because her data suggested that children begin with a human-centered, psychological understanding of biology and later on must reorganize their conceptual system to reflect the understanding that, biologically speaking, humans are one kind among many.

A place for language. With these striking results as background, we are ready to turn to the role of language in children's inductive reasoning. Recall that Indonesian, unlike English, has no dedicated name for the overarching category of animate beings. Our first question (Anggoro, Medin & Waxman, 2010) was whether the *animal* $_{\text{contrastive}}$ term in Indonesian would limit generalization of properties from humans and (other) animals and vice versa.

Following Carey, we employed a category-based induction task in which children are introduced to a novel property of an entity (the *base*), and then asked whether this property can be generalized to other entities (the *targets*). Human-nonhuman animal asymmetries should be attenuated in Indonesian-speaking children, if evident at all. Indonesian children's tendency to generalize from either a human or nonhuman animal base should be associated with the distinctive category of the target (human or nonhuman animal).

The predictions for English-speaking children are a bit more complex. We suspected that when a nonhuman animal serves as the base, English-speaking children would favor the *animal* $_{\text{contrastive}}$ category. Put differently, when a property is attributed to a nonhuman animal base and a human appears as the target, English-speaking children may be reluctant to generalize on grounds that "people are not animals" (this is the *animal* $_{\text{contrastive}}$ interpretation). In contrast, when a human serves as the base, English-speaking children may access the *animal* $_{\text{inclusive}}$ category. This category should support their generalization from a human base to nonhuman animal targets. That is, children should be less likely to make the appeal that "animals are not people". In sum, English-speaking children's access to the *animal* $_{\text{inclusive}}$ category (a category that should be less available to Indonesian-speaking children) may account for their asymmetries favoring generalizations from humans than from nonhuman animals (see Medin and Waxman, 2007 for related arguments and evidence).

Finally, because factors other than naming practices shape children's biological reasoning, we expected that the differences between English- and Indonesian- speaking children's patterns of induction would become less pronounced as children from both communities gain access to other sources of information about biological phenomena. That is, cultural practices (including naming) may have the strongest effects on the youngest children; as children get older and are exposed to a broader range of biologically-relevant information, these effects may be attenuated.

Colored photographs depicting a range of living and nonliving entities served as stimuli. Four of the living things served as bases; the remaining photographs served as targets. We selected items that were familiar to both Chicago and Jakarta children.

Because procedural details will prove to be important, we're going to describe the task in more detail than we might otherwise. To begin, the experimenter showed the first base (e.g., a dog) and said, for example, "Dogs have some stuff inside them, and it is called *sacra*. *Sacra* is inside some kinds of things, but it is NOT inside some other kinds of things." She then presented each target picture (e.g., a bear) and asked, "Do you think bears have *sacra* inside like dogs do?" Then a different base was selected and children were told about a different novel property (e.g., "belga") it had and were asked what else might have it and so on for the other two bases.

We found that when a human served as the base, English-speaking children were more likely than Indonesian-speaking children to generalize to nonhuman animal target categories but when a nonhuman animal served as the base, English- and Indonesian-speaking children performed comparably. This is exactly as predicted. These differences were much attenuated among 9-year-olds, consistent with the prediction that, with or without a dedicated name for the category that includes human and nonhuman animals, as children acquire more biological knowledge, they bring human and nonhuman animals into closer correspondence.

A closer look at children's performance as they progressed through this task revealed an intriguing finding. Thus far, we have interpreted our results as evidence that when English- and older Indonesian-speaking children are introduced to a novel property on a human base and asked to generalize to a nonhuman animal target, their access to the *animal*$_{\text{inclusive}}$

category results in asymmetries favoring humans. We further reasoned as follows: If this is the case, then perhaps the salience of this category will then influence children's performance on subsequent trials. If on the child's first trial, a human happens to serve as the base, perhaps their use of the *animal* $_{\text{inclusive}}$ category would carry over to subsequent trials when a human serves as the target. But if on the child's first trial, a nonhuman animal happens to serve as the base, then their use of the *animal* $_{\text{contrastive}}$ category could carry over to subsequent trials.

To test this possibility, we analyzed the effect of order (human base first versus later) on children's performance. When a human was the base for the first trial, English-speaking 6- and 9-year-olds and Indonesian-speaking 9-year-olds generalized strongly from a human to nonhuman animals (overall $M = .67$), but when the human base was introduced in subsequent trials (after human had been a target), they were much less likely to do so (overall $M = .37$). That is, the human-nonhuman animal asymmetries were much stronger if a human served as the initial base.

One reason why order effects are important is that several claims about producing different results from Carey's (including some of our own) also have differed by, unlike Carey, using multiple bases. Consequently, it isn't clear whether the different patterns observed in other studies reflect order effects associated with multiple bases or deeper differences associated with different study populations.

In summary, young children's reasoning about this biological relation is influenced by naming practices, and this influence is attenuated over development. Clearly, then, children's biological reasoning is influenced by factors other than language alone. The developmental attenuation likely reflects the influence of learning experiences beyond naming practices alone. Of course, the children in Jakarta are exposed not only to a Western curriculum, but also to Western-inspired media (e.g., movies) that adopt an anthropocentric model of nonhuman animals. We'll take up this idea again shortly.

Responses to Carey's arguments.

Carey's provocative claims about biological reasoning stimulated a great deal of research. Some of the research showed that young children appreciate some distinctively biological mechanisms such as growth (Hickling & Gelman, 1995) and inheritance (e.g., Hirschfeld & Gelman, 1994, see also Gelman, 2003). One intriguing suggestion is that young children do begin with a distinctively biological framework theory, but it is based on the principle of 'vitalistic energy' (Hatano & Inagaki, 2000; Inagaki & Hatano, 2002). They proposed that cultural models espoused within a community shape children's biological reasoning. Their studies revealed that 5- to 8-year-old Japanese children understand many bodily processes in terms of vitalism – a causal model pervasive in Japan and one that relies on the distinctly biological concept of energy. We will take up this notion of cultural models and biology again after a modest detour.

Expertise. In the mid- to late 1990's we teamed with cognitive anthropologist Scott Atran and a cadre of bright graduate students and postdocs to explore the role of culture and expertise in people's understanding of biology (Atran & Medin, 2008). Our interest in expertise was driven by two main factors. One consisted of close parallels between Itza' Maya elders and U.S. biological experts who differed from the Maya elders in almost everything but biological expertise (Bailenson, et al., 2002; Lopez, et al., 1997; Medin, et al., 1997; Proffitt, Coley, & Medin, 2000). The other was corresponding evidence of "devolution" or loss of biological knowledge in technologically-saturated cultures such as the United States (e.g., Wolff, Medin & Pankratz, 1999).

An ingenious study by Inagaki and Hatano also pointed to the importance of experience and expertise. Inagaki and Hatano (Inagaki, 1990; Inagaki & Hatano, 2002) found that urban children raised in Tokyo who were closely involved with raising goldfish generalized biological facts to kinds similar to humans *and* to kinds similar to goldfish. This suggests that the relative advantage for humans over nonhuman animals as bases for induction derives from children's greater willingness to generalize from a familiar base than from an unfamiliar base. Although they did not use Carey's induction task, the anthropocentric pattern produced by urban Japanese children who did *not* raise goldfish converged well with her (1985) results. But the full pattern of results points to a different interpretation--urban children's tendency to treat humans as a privileged base may be driven by the fact that humans are the only biological kind that they know much about.

Observations like these may offer insights into children's behavior in Carey's induction task. We began to suspect that 5-year-olds' human-centered reasoning patterns might reflect urban children's lack of knowledge about and intimate contact with the natural world. To pursue this idea, we employed Carey's inductive reasoning task with rural children, who presumably have "more." As we anticipated, 4- to 5-year-old rural children did not exhibit the asymmetries and human-centered reasoning that Carey had noted in their urban counterparts (e.g., Atran et al., 2001; Ross, et al., 2003).

Medin and Waxman recall chatting with Susan Carey about these expertise effects. She offered two responses as challenges: (1) maybe all children pass through a human-centered stage but rural children do it sooner, and (2) by the way, no one had used a procedure close enough to hers to convincingly demonstrate a different pattern of results.

As we noted in reporting the Anggoro et al. (2010) order effects, this second issue is not just an in principle one. Carey's procedure involved teaching a child about only one base and then bringing them back a few days later for generalization tests. In contrast, typically after using one base and one novel biological property, we went on to present another base and a new property, following by a new set of generalization tests, and so on. Notice that these design differences (coupled with the order effects Anggoro, et al.

observed) raise the possibility that we might indeed have seen human-centered reasoning if we had followed Carey's procedure more closely.

We therefore adopted a closer approximation to Carey's original procedure in a series of follow up studies with urban children, rural European American and rural Menominee (Native American) children. Following Carey, we taught children only about a single base and gave the generalization test a day or two later. Here's what we found (see Medin, et al., 2010; Waxman, et al., 2007). First, we replicated Carey's (1985) pattern of human-centered reasoning for the urban 4- to 5-year-olds. These young children showed greater generalization for a human base than for a dog base and they also showed greater generalization from human to dog than from dog to human. Second, unlike their urban counterparts, 4- and 5-year-old rural European American children generalized more from a dog base than from a human base. Interestingly, however, they did show greater generalization from a human base to a dog target than from a dog base to a human target. Third, and somewhat surprisingly, like their urban counterparts, 4- to 5-year-old Menominee children favored the human over the dog as a base when generalizing a novel property to other animals. In part, this may reflect the cultural significance of bear: generalizations from human to bear are especially strong (86%) for 4- to 5-year-old Menominee children; as compared to the urban (67%) and rural European American (52%) children. But in contrast with urban children, young Menominee children showed no evidence of human-dog asymmetries.

In summary, we followed Carey's method with enough fidelity to replicate her finding of human-centered reasoning in 4- to 5-year-old urban children. With worries about procedure more or less out of the way, we found that neither rural European American children nor rural Menominee children demonstrated Carey's two markers of anthropocentrism (human-animal asymmetries and humans as a more effective base than animals).

These results have two key implications. First, human-centered reasoning in 4- and 5-year-old children is far from universal. Second, the two signatures of anthropocentric reasoning in Carey's account-- generalization and asymmetries-- do not necessarily tap into a single underlying model or construal of biological phenomena.

These results leave Carey's first point intact. Perhaps our rural children did indeed go through the stage of a human-centered biology, but passed through it earlier than urban children. The obvious way to address this question is to run younger rural children. But there's a problem--for a task like this, four years old is about as young as one can go and still get meaningful data. Three- and 4-year-old children may answer the various induction questions, but may say "no" (or "yes") to everything.

To accommodate children as young as 3 years of age, we took our cue from developmental studies using puppets. Rather than having an experimenter provide the information, we used puppets to do so (Herrmann, Waxman & Medin, 2010). We introduced two small puppets, and in a warm-up period, showed children that each puppet was 'right some of the time and wrong some of the time'. In the induction task the two puppets disagreed and the child was enlisted to cast the deciding vote. With this method (and an experimenter who has excellent rapport) 3-year-olds provided systematic, meaningful data.

Cultural models matter. We began this series of studies by focusing on 3- and 5-year-old urban children. We reasoned that if the human-centered reasoning pattern seen in young urban children represents the acquisition of a culturally-transmitted anthropocentric model, it may be the case that urban children younger than 4- to 5-years old, who have received less exposure to the anthropocentric model, would not (yet) favor humans over nonhuman animals in their reasoning.

And that is what we found (Herrmann et al., 2010). Three-year old urban children responded systematically, generalizing more from a dog base than from a human base and showing no reliable human, dog asymmetries.

Moreover, with this modified puppet procedure, urban 5-year-olds continue to show the now-familiar anthropocentric reasoning pattern (greater generalization from human than dog base; human - dog asymmetries). We have also used the puppet procedure with 4- to 5-year-old rural European American and Menominee children, just in case these design modifications change their patterns of performance. In this task, children show neither of the markers of a human-centered biology.

These results offer unambiguous evidence that the anthropocentric pattern of reasoning observed in urban 5-year-old children is not an obligatory initial step in reasoning about the biological world. Instead, the results show that anthropocentrism is an acquired perspective, one that emerges between 3 and 5 years of age in American children raised in urban settings.

Summary of induction studies. Our initial singular focus on biological expertise or lack thereof got in the way of our seeing the importance of cultural models embodying different relationships between humans and the rest of nature. Carey (1985) may have been correct in thinking that biological cognition may involve competing, incommensurable models, but we suggest that these are competing cultural models, not some acultural naïve psychology competing with an acultural naïve biology.

We now turn to the question of where humans fit with the rest of nature from an ecological and relational perspective.

4. Concepts of Human-Nature Relations: Ecological Reasoning.

So far we have examined how the concept ‘human’ is relationally positioned within broader linguistic and knowledge frameworks. We now turn to explore how what we will refer to as “epistemological orientations” affect conceptual behavior. We explore how concepts are informed by local ecological and cultural contexts, focusing on contrasts between Indigenous and majority culture communities.

Much of our thinking about human orientations to nature is grounded in a set of cultural frameworks known as *relational epistemologies*. Our notion of epistemological orientations is based on research in anthropology and in education and this may differ somewhat from philosophical notions of epistemology. We think of relational epistemologies as sets of (often implicit) assumptions that inform skeletal principles of reasoning. Specifically we assume, *epistemological orientations reflect the decisions, processes and practices that determine the nature of observation, ideas about what is worthy of attention and in need of explanation (or understanding) as well as the kinds of hypothesis that are likely to be considered, and notions of what constitutes a satisfactory explanation.* On our account, epistemologies are reflected in cultural practices (in our case for engaging with nature) and these cultural practices, in turn, affect epistemological orientations. In what follows we will describe just what aspects of indigenous epistemologies make them *relational* epistemologies.

Note that our use of "relational epistemologies" is plural,[4] as are the Indigenous communities with whom we collaborate (e.g., Native Americans in Chicago; Indigenous Ngöbes in Panama; members of the Menominee Nation in Wisconsin). This signals our commitment to cognitive and cultural diversity within the realm of "relational frameworks."

As a broad framework theory, relational epistemologies vary in their particulars among different geographic and cultural communities; their coherence obtains in common signatures of "relationality" structuring modes of attention to and interaction with the world. We focus on relational frameworks grounded in Indigenous Amerindian cultures, in an approach consistent with that offered by Raymond Pierotti (2011):

> "The influence of local places upon cultures and the corresponding diversity of peoples attached to those places guarantee the existence of variation…Despite this spatial variation in ecology and physical space there appear to exist a fundamental shared way of thinking and a concept of community common to Indigenous peoples of North America." (p. 5)

[4] As we will see shortly, this move is also consistent with anthropological theory on "relational epistemologies" plural (see Bird-David 1999).

We will have more to say about this in our concluding discussion, along with some observations on domain-specific causal frameworks.

Part of the power of relational epistemologies derives from their capacity to channel everyday practices and patterns of attention. Organizing knowledge along particular habitual lines of thinking changes how one attends to the environment, as patterns of expectation train our awareness, leading us to see the world in different ways. For example, if one thinks of plants as unthinking, deaf-and-dumb organisms, one will hardly be attuned to potential signs of plant communication. In contrast, attending to multiple signs of mindfulness in plants creates the conditions for observing complex patterns of reaction, memory, anticipation, and response among the vegetal world.

The studies on relational orientations described below were conducted among Menominee, Chicago inter-tribal, and Ngöbe Indigenous communities.

Rural Menominee population. The Menominee are the oldest continuous residents of Wisconsin. Historically, their lands covered much of Wisconsin but were reduced, treaty by treaty, until the present 95,000 hectares was reached in 1854. The present site was forested then and now - there are currently about 88,000 hectares of forest. Sustainable coexistence with nature is a strong value (Hall & Pecore, 1995). Hunting and fishing are important activities and children are familiar with both by age 12. There are 4-5000 Menominee living on tribal lands. Over 60% of Menominee adults have at least a high school education and 15% have had some college.

American Indian Center of Chicago population. There are approximately 40,000 Indian people in Cook County, many of whom were relocated to the area during the 1950s and 60s during the federal relocation era. The Chicago community is quite diverse, with individuals representing more than 100 tribes across the country. Native American children are scattered across a number of schools in the district and are a minority in every classroom. The AIC is the oldest urban Indian center in the country and serves as the social and cultural center of the Chicago Indian community. Menominee and other Wisconsin tribes are well-represented at the AIC.

Ngöbe population. The Ngöbe people of Panama are the largest indigenous group in Central America after the Maya, with a present population of approximately 170,000 (Young, 2007). We have been conducting community-based research with the Ngöbe for almost three years, and one of us has spent more than 15 months living in the village. The Ngöbe community that collaborates with us in our research has about 600 habitants and is located on a heavily forested island off the Caribbean coast of Panama. Community members live in family hamlets and practice agroforestry supplemented by hunting, fishing, diving, artisan crafts or periodic wage labor (primarily in connection with the eco-tourism industry and a few nearby resorts). The community hosts two Christian Evangelical churches as well as the Ngöbe syncretistic Mama Tata Church. The village has a public school offering primary and partial secondary education. In most families, children are expected to achieve competence in domains beyond that of formal schooling, including farming, fishing, childcare, and other household contributions. Most families speak both Spanish and Ngöbere (the native language) in the home. Our research has been conducted in both languages.

Practicing relational epistemology: engaging human-nature relations.

Different cultures have arrived at different ideas concerning the quality and extent of relations between humans and the rest of the natural world. For a child, figuring out the relation between humans and nonhuman animals depends largely on the kinds of relations their own community entertains with the nonhuman world. We have begun to explore how young children are educated into different sets of relations with the natural world through the values and activities of their communities (Bang et al, 2007). In a study comparing parental values, Native Americans (both Menominee and urban

Natives) and rural European American parents were asked what they believed was important for their children to learn about nature and the biological world. As compared to European American parents, Native parents' values reflected more spiritual orientations (talking in terms of "Mother Earth"), holism (children should understand that they are a part of nature), and traditional values (activities that are important to pass on to future generations). While the majority of parents across communities emphasized moral values and respect for nature, European American parents tended to emphasize caregiver relations with nature (children should learn to "protect" nature), a model that reflects the stance that humans are apart from nature. In contrast, Native parents tended to focus on how people are "a part of" nature and children should learn their place and role within the world.

These self-reported values are not merely ideals, but correlate with the kinds of activities children experience within their communities. Further interviews with children and parents in these same communities revealed cultural differences in practices involving nature (Bang et al., 2007). Native parents and children report engaging more frequently in outdoor practices that foreground nature (e.g., berry-picking; forest walks) while European Americans engage relatively more in back-grounding outdoor practices (e.g., snowmobiling; playing sports). Even within the same practice type (e.g., fishing), there are significant differences in configurations of practice (e.g., fishing from a boat on a lake verses fishing on the shore of a river) that affect attentional habits and the range of content taken up in discourse and other practices (Bang, 2009). These findings suggest that cultural values feed directly into the activity structures and everyday habits of children's early experiential worlds.

If cultural frameworks channel attention and observation, then they might also be reflected in the way we recall our experiences through personal narratives. The data on outdoor practices and converging measures suggest that our Native American samples are "psychologically closer" to the rest of nature. According to the Trope and Liberman (2003) construal level theory, psychological closeness is associated with greater attention to context. Building on this idea, we predicted that Native Americans and European American fishermen may tell different kinds of stories with respect to contextual information (Bang et al., 2007).

To test this idea, we asked rural Wisconsin adults to tell us about a recent or memorable fishing trip. Then, we measured how long it took them to "get to the point" and mention a fish (presuming that a fish was the point, of course). Greater attention to context should lead Native participants to mention the fish later in the story. This is what we found: the median number of words generated before mentioning fish was 27 for European American adults and 83 for the Native adults, a large and reliable difference (Bang, et al., 2007). A closer examination of these narratives found that there was a correlation between where one fished (e.g., the shore of a river or in a boat on a lake) and the scope of ecological reasoning and biodiversity mentioned in their fishing narratives (Bang, 2009).

Interestingly, the fact that different cultural groups engage with nature in different ways may be salient, even in the eyes of young children. In our work with Ngöbe children, we have found evidence that young children are attuned to distinctive cultural patterns of human-nature relations (Herrmann, et al., 2012). When Patricia Herrmann visited our Ngöbe host community in Panama in 2011, she set out to extend her previous U.S.-based research by exploring ecological reasoning among Ngöbe children. Children completed a standard triad task with three cards depicting entities from different biological categories (e.g., human, animal, plant) and asked children to choose "which two go together". The 20 triads of interest included a human (either Ngöbe (12 sets) or non-Ngöbe Latino/Caucasian (8 sets)) and two natural entities (animals or plants).Children could choose to pair the human with one of the natural entities (a human-nature relation), or to exclude the human and pair the two natural entities together (a human exclusion).

When given a triad that included a Ngöbe person, children were more likely to pair the Ngöbe with a natural entity; but when given a triad including a non-Ngöbe person, children were more likely to exclude the human. This suggests that children saw the relations between Ngöbe people and natural entities as more pertinent and salient that for non-Ngöbe people.

In our view, these sorting patterns reveal that children see Ngöbe and non-Ngöbe relations with nature differently. Children implicitly view Ngöbe individuals as more closely related to their environments than non-Ngöbe individuals.[5] The question then arises: How do children learn to structure these human-nature correspondences? This is where cultural frameworks enter the picture and we begin to explore the cognitive consequences of different cultural orientations to the natural world.

Thinking relational epistemology: Ecological reasoning.

At this point, the reader might be wondering: If Ngöbe children recognize (implicitly or explicitly) that their own communities engage with nature in a manner distinct from non-Ngöbe communities, then what does this difference consist of? We can turn to the children themselves for an answer. When asked to explain their sorting choices, children explained the majority of Ngöbe-natural kind pairings through appeal to ecological relations. In fact, if the human included was a Ngöbe, justifications were universally ecological (e.g., "People live near cows and they give us meat"). But if the human included was a non-Ngöbe, then justifications were more frequently taxonomic than ecological (e.g., "They are both alive"). Herrmann et al. (2012) concluded that, "When children consider the place of humans in the natural world, they take into account their knowledge about the relevant practices of particular communities. The children seemed to view the Ngöbe as more a part of nature and non-Ngöbe as more apart from nature."

Relational epistemology.

[5] In a related unpublished study we have found that Chicago area Native American children sort animals, plants and natural inanimates differently, depending on whether we ask them to take the perspective of an elder or a science teacher.

Before describing further research findings, we first outline important dimensions of relational epistemology from the perspective of anthropology. "Relational epistemology" was a term introduced by Bird-David in an influential paper (1999) in which she critiqued previous approaches to animism as a failed epistemology or primitive religion, and argued for a new appreciation of relational ways of engaging with the nonhuman world. For our purposes, relational epistemology can be seen as closely related to relational ontologies (e.g., Ingold, 2006; Santos-Granero, 2009), animisms (e.g., Harvey, 2006), perspectivisms (e.g., Stolze Lima, 1999; Viveiros de Castro, 1998), and Indigenous Science and Traditional Ecological Knowledge (e.g., Cajete, 2000; Pierotti, 2011).

In regards to human-nature relations, the relevant aspects of relational epistemology are: (1) an appreciation of interdependencies among all components of the natural world, that is, *all things are connected* (e.g., Cajete, 2000; Pierotti, 2011: p. 62); (2) a framework for reasoning about things in terms of relationships; (3) a focus on whole organisms and systems at the macroscopic level of human perception (also a signature of complex-systems theory) (Pierotti, 2011: p. 72-73); (4) viewing nonhumans as individual "persons" in their own right. Overall, this worldview is aptly summarized by Indigenous biologist Raymond Pierotti (2011) as an:

> "Indigenous understanding of the natural world [that] emerged from conceiving of the living world as a network of relationships across communities that include humans. Because of this understanding based on relationships, Indigenous principles and insights are also superior at understanding links between systems that are often considered to be separate by the Western tradition." (Pierotti, 2011: p. 76).

Building on Indigenous science and philosophy, our research has sought to explore the cognitive consequences of these cultural worldviews and practices.

Ecological reasoning among children.

One sign that ecological reasoning may play an important role in children's developing notions of human-nature relations comes from children's spontaneous discourse during the category-based induction tasks described earlier. When asked why they generalized a property attributed to bees to bears, Menominee children told us that the bee might transmit the property through the honey bears eat or by bees stinging bears (Ross et al., 2003). The standard category-based induction task was originally designed on the assumption that generalization will follow taxonomic or biological similarity, but, like biological experts and Indigenous adults in previous studies (Atran & Medin, 2008); at least some Menominee children viewed ecological relations as the relevant cues for biological induction.

Do cultural orientations to nature impact cognitive development? We set out to explore this question more systematically in a comparative study among rural European American and rural Menominee children in Wisconsin (Unsworth et al., 2012). Previously, we had done studies with Menominee and European American expert fishermen and found that, although the two groups had comparable knowledge bases, including ecological knowledge, there were substantial differences in how that knowledge was organized. European American experts favored a taxonomic organization and Menominee experts, an ecological organization. These differences were evident in spontaneous sorting and sorting justifications as well as in speeded probes of fish, fish interactions (Medin et al., 2006). We wondered whether there would be parallel differences in the salience of ecological relations for young Menominee and European American children.

In one study (Unsworth et al., 2012) 5- to 7- year-old rural Menominee and rural European American children were presented with pairs of photos (including nonhuman animal-animal; plant-animal; and plant-plant pairs, e.g., raspberries and strawberries) and asked why the two might go together. Both groups used habitat relations equally (e.g., both are found in the forest), but Menominee children were reliably more likely to mention food-chain (e.g., the stink bug might eat the leaves of the berry bush) and biological-needs relations (e.g., both need water, sunlight, or soil).

Yet another dimension of difference that unexpectedly emerged during interviews was mimicry. Menominee children sometimes spontaneously mimicked nonhuman animal species during the interview (e.g., "bees go buzzzzz"). Strikingly, not one of the rural European American children engaged in mimicry. Unsworth et al. interpreted this as evidence of Menominee children's psychological closeness to nature through greater ease of perspective-taking.

Given that Indigenous children and adults reason about human-nature relations in terms of ecological relations and interdependencies--both signatures of relational epistemologies--do cultural orientations have the potential to fundamentally change the way we see and think about the world around us? This brings us to the question of conceptual organization and folk theories of reality.

Conceptual organization and causal reasoning.

> "One reason that the role of Indigenous people as part of their ecological communities is so important is that they do not think of the nonhuman elements of their community as constituting 'nature' or as 'wilderness,' but as part of their social environment." (Pierotti, 2011: p. 29).

Knowledge organization: Seeing interconnectedness.

How knowledge is organized--where it exists in (the ecosystem of) awareness, the roots and branches it shares with neighboring concepts--is critical to defining the 'content' and 'form' of that knowledge. Can a habitual focus on relational interactions train attention to reveal different aspects of the natural world? We are beginning to see evidence converging from different research sites to suggest that Indigenous communities see a wider range of cooperative and symbiotic relationships in nature when compared to their non-Indigenous local counterparts.

Engaging relational understandings of the natural world may partially determine the “nature” of the nature that you see around you. In studies in Guatemala examining the relationship between how different culture groups think about the rainforest and how they act on it we have found striking differences between Indigenous Itza’ Maya and immigrant Ladino agroforesters (e.g.. Atran, Medin and Ross, 2005). In one line of studies we directly probed for understandings of plant-animal helping and hurting relationship. We found that Maya and Ladino farmers had essentially the same understanding of how plants help animals. For Itza’ Maya this was part of a rich reciprocal model where animals also help plants, but Ladino farmers overwhelmingly saw animals as having no effect on or as hurting plants. In developing our materials as part of a more opened-ended interview we asked how animals help plants. Ladino adults denied the presupposition in the question, typically saying “animals don’t help plants, plants help animals.” Other observations suggest that Ladino farmers were learning from the Itza’, but this learning apparently did not include sensitivity to reciprocal relationships (Atran, et al., 2005). It appears that a relational orientation to nature nurtures recognition of mutual dependencies and inter-species relationships in the biological world.

We have observed parallel results in a storytelling task that was designed with a different purpose in mind--eliciting mental-state discourse about nonhuman animals. We used a nonfiction picture book about coyote and badger hunting in the American Southwest (ojalehto, Medin, Horton, Garcia, & Kays, in prep.). When Ngöbe and U.S. undergraduates narrated the (text-free) story, the anticipated cultural differences in discourse emerged, but so did something unexpected. Ngöbes (correctly) interpreted the hunting relationship as cooperative, while U.S. undergraduates (mis)interpreted it as competitive. (Indeed, Western biologists have only recently corrected their longstanding misunderstanding of coyote-badger competition.) How did

Ngöbe participants, who are unfamiliar with these animal species, “know” the hunt was cooperative?

Perplexed, we turned to Ngöbe colleagues for help. They explained that this was a case of Western versus Ngöbe sciences, which diverge on three major points: (1) an emphasis on interactions and relationships; (2) an approach to living with nature, as a system, rather than studying about nature, as isolated parts; (3) viewing nonhumans as intelligent beings worthy of respect. We do not think that Ngöbe necessarily see all relationships as cooperative but rather that, like the Itza’ Maya, they are prepared to “see” cooperation when it is present. While Indigenous sciences focus on inter-species relations and mutual dependency—supporting perceptions of cooperation and socialization among nonhuman species—Western sciences have a tradition of focusing on individual species and fitness—assuming competition among species (Pierotti, 2011).

Re-organizing domains.

Earlier we suggested that a human-centered folk-biology seen in young urban children may involve competing cultural models rather than some acultural naïve psychology or naïve biology. For non-Western adults who tend not to endorse a dualism between mind and body, psychology and biology may not be such distinct domains with distinct causal principles. As biologist Raymond Pierotti argues, European American folk ideas such as theory of mind have permeated academic science and invariably colored how researchers design the parameters of “relevant” inquiry:

> “Assuming that animals are sentient is linked to the concept referred to in Western science as a “theory of mind”. Until the last few years Western science did not accept that nonhumans could have a theory of mind; however, recent discoveries have changed the way nonhuman thinking is perceived…These new developments reveal that Western science has had to rediscover knowledge assumed to be part of the understanding of Indigenous societies.” (Pierotti 2011, p. 32)

In exploring how epistemological orientations interact with folk-biological, -ecological and -psychological knowledge, our research increasingly points to concepts that crosscut these domains, suggesting that these conceptual systems can be fruitfully studied via integrated approaches. One example of this conceptual interfacing appears in an ongoing line of research in which we are exploring how indigenous Ngöbe adults reason about the psychological capacities of plants, animals and other natural entities (sun, ocean) or processes (rain, clouds). The tendency to attribute mental states to nonhuman kinds is closely related to folk biology and folk ecology, with important consequences for human interactions with the natural world. Cultural framework theories organize folk-psychological knowledge around diverse concepts of "mind" and "intelligence," pointing to divergent conceptual organization across cultures.

Unsettling domains.

Studying relational epistemologies with indigenous communities has had the bottom-up effect of redirecting our conceptual boundaries of inquiry, leading us to focus on the relations *between* human, biological, and ecological worlds in a new kind of domain-like perspective. It is instructive to consider that Western psychologists proposed three "core" domains of conceptual processing based on their perceptions of the relevant metaphysics (ontological categories and correlated causal systems) and unit size (individual entities). This thinking produced folk-psychology (minds), folk-biology (organisms), and folk-physics (things).

Domain-specificity has played a key role in catalyzing understanding of conceptual development, leading to many important discoveries. However, missing from this picture is a framework that accommodates how people conceptualize interactions among these systems. There was no folk-ecology (interactions between organisms, persons, and matter, as well as climate systems), no folk-dynamics (tracking weather systems, wave systems, waterflow systems), and no folk-sociology (interactions between persons, human or nonhuman). Lately, anthropologists and psychologists have been trying to make amends for this gap (see Atran, et al. 2005; Hirschfeld, 2012; White, 2008).

We reckon that developing such folk-theories would have required a different perception of the relevant metaphysics (process categories, or kinds of relations) and unit size (systems). In fact, it is tempting to think, based on what we have learned from our Native Science colleagues, that Indigenous psychologists may have had the relevant tools and insights to develop folk-ecology, folk-sociology, and folk-dynamics right from the start. But that's another story.

4. Summary and Conclusions

We continue to be immersed in these and closely related research projects and are no doubt are guilty of team-centrism in focusing so much on our own research. With this apology in mind, we see these findings as carrying implications for core questions and issues in the cognitive sciences. The first question concerns the nature of concepts and categories and how we should study them. We see our research program as just one instance of groups of cognitive scientists placing the study of conceptual behaviors into broader contexts. These broader contexts include: (1) analyses of information available in the environment such as cultural artifacts (e.g., Morling and Lamoreaux. 2008), (2) examining how the context of use affects conceptual representation (Markman and Ross, 2003); (3) studying the interactions between language and conceptual development using cross-linguistic and developmental comparisons as a tool; (4) assessing conceptual orientations implicit in (cultural) practices that form the background and perhaps the backbone of conceptual knowledge.

There is also a reflexive component to our research as we scramble to detect cultural or epistemological presuppositions lurking in our studies (see also Medin & Bang, in press). For example, restricting our probes of ecological relations to plants and animals may reflect our seeing natural inanimates as irrelevant, despite the fact that "niche construction" is an important construct in contemporary evolutionary theory. In our studies of folkecology in Guatemala we also excluded natural inanimates and the "Arux" forest spirits, which is a sensible practice only if the Itza' Maya also exclude them. Even our preferred stance as "detached scientific observers" may be less about science than it is about the psychological distance that is part of a Western cultural model. We are left to wonder what the psychology of concepts would look like if it were not owned and operated by Western scientists.

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