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Cultural Differences in Children's Ecological Reasoning and Psychological Closeness to Nature: Evidence from Menominee and European American Children

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Abstract

In spite of evidence for cultural variation in adult concepts of the biological world (i.e., folkbiological thought), research regarding the influence of culture on children's concepts is mixed, and cultural influences on many aspects of early folkbiological thought remain underexplored. Previous research has shown that there are cultural differences in ecological reasoning and psychological closeness to nature between Menominee Native American and rural European American adults (e.g., Medin et al., 2006; Bang et al., 2007). In the present research we examined whether these cultural concepts are available at 5–7 years of age. We conducted structured interviews in which each child viewed several pairs of pictures of plants and non-human animals and were asked how or why the species (e.g., raspberries and strawberries) might go together. We found that Menominee children were more likely than European American children to mention ecological relations and psychological closeness to nature, and that they were also more likely to mimic the non-human species. There were no differences between the two communities in the number of children's responses based on taxonomic and morphological relations. Implications for the design of science curricula are discussed.

Keywords

Culture, folkbiology, child development, ecological reasoning, psychological closeness

The present research explores cultural differences in young children's folkbiological thought (i.e., intuitive notions of the biological world). In spite of

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evidence for cultural variation in adult folkbiological concepts (e.g., Walker, 1992; Kellert, 1993; López et al., 1997; Proffitt et al., 2000; Atran et al., 2005; Medin et al., 2006, 2008; Bang et al., 2007; Au et al., 2008; Cimpian and Markman, 2009; Legare and Gelman, 2009), research regarding the influence of culture on children's concepts is mixed. Some evidence suggests that culturally learned concepts of natural kinds develop slowly and may only be apparent as children grow older (e.g., Johnson et al., 1992; Keleman, 1999; Walker, 1999; Evans, 2001; Rhodes and Gelman, 2009). Other evidence suggests that culture, experience, and language can influence folkbiological thought at an early age (Hatano and Inagaki, 1994; Inagaki and Hatano, 2002; Ross et al., 2003; Astuti et al., 2004; Tarlowski, 2006; Waxman et al., 2007; Medin et al., 2010). Our goal here is to examine whether two kinds of cultural concepts – ecological reasoning and psychological closeness to nature – are available at 5–7 years of age. Investigating cultural differences in this age group is important because it can tell us how rapidly children's acquisition is shaped by the conceptions of their communities as they learn about the natural world. If differences are apparent by the time formal schooling begins, there may be implications for the design of science curricula in early grades.

Several researchers have found evidence suggesting that biological concepts are processed and organized according to evolved cognitive structures that are functionally autonomous with respect to biological information (Keil, 1989; Gelman, 2003; Medin and Atran, 2004). For instance, there is marked cross-cultural agreement regarding the classification of living things into hierarchical taxonomies (Berlin et al., 1973; Hunn, 1977; Hays, 1983; Brown, 1984; Atran, 1990; Coley et al., 1997; Bailenson et al., 2002). Importantly, however, there is also evidence for considerable variability as a function of cultural worldviews (e.g., Walker, 1992; Lopez et al., 1997; Proffitt et al., 2000; Atran et al., 2005; Medin et al., 2006, 2008; Bang et al., 2007; Au et al., 2008; Cimpian and Markman, 2009; Legare and Gelman, 2009). Some research suggests that certain cultural concepts of the biological world are learned later in development. For instance, Johnson et al. (1992) have suggested that an understanding of biological similarities between humans and non-human primates involves cultural learning and may not be acquired until adolescence or adulthood. However, a growing body of research suggests that culture influences at least some aspects of early folkbiological thought. For example, Waxman et al. (2007) have found evidence for cultural differences in beliefs about biological mechanisms responsible for kindhood in children as young as 4–5 years of age.

Cultural influences on many other aspects of early folkbiological thought, including ecological reasoning and perceived closeness or 'psychological closeness' to nature, remain underexplored, in spite of evidence for cultural differences among adults. In research examining conceptual organization of fish species, Medin et al. (2006) found that Menominee fishermen were more likely than rural European American fishermen to organize their knowledge of fish ecologically (e.g., by habitat), and that Menominee fishermen more readily report ecological relations (fish–fish interactions). There were no differences in the likelihood to organize fish on the basis of taxonomic category (e.g., bass family), and there were no fundamental differences in knowledge of ecological relations, suggesting that differences were due to accessibility of knowledge. It would be interesting to determine whether cultural differences in ecological reasoning are evident at an early age. Ross et al. (2003) have found preliminary evidence suggesting that there might be differences in ecological reasoning in children as young as 5 years of age. They conducted an inductive reasoning task with rural European American and Menominee children in which children were first taught that some novel biological property was true of one biological kind and were then asked if other kinds also had this property. Although this task is premised on the idea that generalization will be based on (biological) similarity, some of the spontaneous justifications (e.g., a bear might have the same property as a bee because bears eat honey or because the property might be transmitted by a bee sting) suggest that Menominee children were reasoning ecologically at least some of the time (e.g., young Menominee children generalized more from bee to bear than young European American children). Although Ross et al.'s (2003) task was not designed to directly examine ecological reasoning, these findings are suggestive of cultural differences in ecological reasoning among young children.

Other research suggests that young Menominee and European American children might also differ in perceived closeness or 'psychological closeness' to nature. Bang et al. (2007) found that Menominee and rural European American parents differ in what they would like their children to learn about the biological world. When asked to list five things they would like their children to learn, Bang et al. found that Menominee parents tended to talk about personal utility (e.g., we use milkweed for soup) and to take a relational view of nature (e.g. "I want my children to understand that they are a part of nature"). Rural European Americans tended to mention distant utility (e.g., "wood is used for construction") and to describe nature as an externality (e.g. "I want my children to respect nature"). These differences in closeness were also reflected in reports of outdoor practices among both children and adults. Bang et al. found no reliable difference in total number of nature-related activities reported. They did, however, find that Menominee outdoor activities were more likely to place nature in the foreground (e.g., forest walks, maple sugaring) while European Americans' activities were more likely to place nature in the background (e.g., boating, snowmobiling).

As mentioned, Ross et al.'s (2003) task was not designed to directly examine ecological reasoning, and in spite of parents' reports regarding what they want their children to know about the biological world, Bang et al. (2007) did not examine psychological closeness to nature in young children. Our goal was to examine cultural differences in young children's ecological reasoning more directly and to investigate potential differences in psychological closeness to nature. We conducted structured interviews with 5–7-year-old rural European American and Menominee children in which each child viewed several pairs of pictures of plants and non-human animals and were asked how or why the species (e.g., raspberries and strawberries) might go together. We predicted that Menominee children would be more likely than rural European American children to give ecological responses (e.g., "squirrels eat them") and utility responses (e.g., "we eat them"). Based on Medin et al.'s (2006) research, we anticipated that children would mention taxonomic categories (e.g., "raspberries and strawberries are both berries"), but we did not expect to observe cultural differences in these responses. Because stimuli morphological properties were obvious in the pictorial stimuli (e.g., "raspberries and strawberries are both red"), we also anticipated that children would mention morphological properties and we did not expect cultural differences in these types of responses. We did not develop a priori predictions regarding other response types that emerged during the interview (e.g., mimicking the sounds of animals), but we did code and compare these responses as well.

Method

Participants

Children were recruited from the Menominee reservation and from the town of Shawano, WI, USA. Approximately 5000 Menominee people live on the Menominee reservation, which consists of 234 000 acres of heavily forested land along the Wolf River. The reservation also contains numerous lakes, other rivers and small streams. The rural European American children involved in this work live in or around the rural towns of Shawano, WI, USA, which is located approximately 7 miles from the Menominee reservation. Approximately 8500 people live in Shawano. Shawano County has many small-scale farms but it also has lakes, rivers and patches of forest. Year-round, outdoor recreation is important in both of our study populations.

Seventeen 5–7-year-old Menominee children (10 male, 7 female, average age 6.29) and fifteen 5–7-year-old European American children (7 male, 8 female, average age 5.93) participated in this study. Children were interviewed at their schools, and the school received $10.00 for every child who participated. Menominee children were recruited through Keshena Primary School (KPS) on the Menominee reservation. At least 99% of children attending KPS are American Indian/Alaska Native, and the vast majority of these children are formally enrolled as Menominee Tribal members. To be an enrolled Menominee, one must be able to establish at least 25% Menominee lineage. Children with less that 25% lineage are referred to as descendants. Of course a child may have 25% or more lineage associated with more than one tribe and in some cases Menominee parents may choose to enroll their children in a different tribe, even though they and their children live on the Menominee reservation and participate in the Menominee community.

All of the children lived on the Menominee reservation. European American participants were recruited from the nearby town of Shawano, WI, USA. Children in both communities typically learn English as a first language.

Materials

The materials included 30 pairs of pictures of plant and non-human animal species situated within their natural habitats. There were 15 animal–animal pairs (e.g., coyote, rabbit), 9 animal–plant pairs (e.g., frog, lily pad) and 6 plant–plant pairs (moss, birch tree). Each picture pair was presented on an 8×11 inch (20.32×27.94 cm) sheet of paper, and each picture was approximately 4×4 inch (10.16×10.16 cm) in size. Position of the pictures on the page (i.e., top versus bottom) was counterbalanced across participants. All species represented in the pictures can be found in the state of Wisconsin. We selected pairs that shared a variety of relations, including taxonomic relations (e.g., eagle and hawk are both birds), and ecological relations (e.g., eagle and hawk both eat small rodents). Many species depicted in the picture pairs shared morphological properties as well (e.g., eagle and hawk both have wings).

Procedure

Warm-up Trials. The experiment began with two warm-trials, designed to familiarize children with the task. For each warm-up trial, the experimenter revealed a pair of pictures (Pair 1: green stink bush and berry bush; Pair 2: rock bass fish and blue gill fish), named each at the species level, and then asked children how or why they might go together. She assured children that there were no right or wrong answers. After the child's response, the experimenter offered additional suggestions to illustrate the breadth of relations available. For example, she noted that the items in Pair 1 might go together because both are green (morphological), both are alive (taxonomic), both are found in the forest (ecological: habitat), and because the stink bug might eat the leaves of the berry bush (ecological: food chain). After the warm-up trials, the experimenter explained that she had more pictures of plants and animals.

Structured Interview. The experimenter presented each of the 30 picture pairs, one pair at a time, in random order. For each pair, she named each at the species level, and then asked the child to describe why or how the species might go together. Children were reassured that there were no right or wrong answers; they were encouraged to say whatever came to mind, and to say as little or as much as they pleased.

Coding

Responses were audio-recorded and then coded. Our primary coding categories included taxonomic relations, ecological relations, psychological closeness, and morphological similarity. Taxonomic relations were responses about category membership (e.g., "they are both plants, they are both alive"). Ecological relations were responses about relations between the species; they included (a) habitat relations (e.g., "woodpeckers live in trees"), (b) food chain relations (e.g., chipmunk would eat the berries), and (c) references to other biological needs (including water, sunlight, or soil). Psychological closeness was coded following Bang et al.(2007); it included all references to utility associated with nature (e.g., "I eat berries;" "people eat berries"). In addition, many children mentioned morphological relations that were depicted in the stimuli (e.g., "they are both green").

In addition to these primary coding categories, other themes emerged in the interviews. We selected for analysis any themes that were mentioned by at least a third of the children in one of the cultural groups. These themes included personal sentiments about species (e.g., "I hate snakes"), personal experiences in nature (e.g., "we used to go to the lake all the time"), mimicry of non-human species (e.g., "this one says ' "beeee" – it buzzes"), and inferences about species' mental states (e.g., "deer like eating ferns"). A full list of codes and their definitions is provided in Appendix A.

All responses were coded by a primary rater as well as a second rater who was blind to the hypotheses. Agreement between the two coders was excellent (98.75% agreement; Cohen's Kappa=0.60).

Results

Children from both the Menominee and European American communities were readily engaged in this task and responded freely. There were, however, differences in the kinds of responses they provided. Menominee children were more likely than European American children to mention ecological relations and psychological closeness to nature; they were also more likely to mimic the non-human species. There were no differences between the two communities in the number of children's responses based on taxonomic and morphological relations.

We analyzed children's responses in two ways. We compared both response types (i.e., whether children ever gave a type of response) as well as response tokens (i.e., the number of responses each child gave for each response type) across cultural groups (see Table 1). To examine response-type patterns, we compared the number of participants in each cultural group who ever gave a type of response in chi-square analyses. To examine response token patterns, we tabulated the number of times each child gave a particular response and compared the frequency of these responses across groups. The results from both sets of analyses converge, revealing robust cultural differences in patterns of responses.

Morphology and Taxonomy

Every child mentioned morphological properties. This is not surprising, especially because the morphological properties were depicted in the stimuli. There was no difference in this response type across the two cultural communities, $t<1$. In addition, as predicted, there was no difference across the two communities in taxonomic response tokens, $t<1$, or in the number of children who gave a taxonomic type of response, $\chi^2(1, N=32)=1.21$, $p=0.27$.

Relations

In our next set of analyses, we examined children's tendency to talk about species relations. We considered relations between the depicted species (ecological relations) and relations between the depicted species and humans.

Ecological relations. We submitted the number of ecological response tokens to a mixed model Analysis of Variance (ANOVA), using Culture (2: Menominee, European American) as a between-subjects factor and Ecological Response (3: Food Chain, Biological Needs, Habitat) as a within-subjects factor. This analysis revealed a main effect of Ecological Response, $F(2, 60)=51.40$, MSE=40.02, $p<0.05$, indicating that children in both cultures were more

Table 1
Mean number of responses given by Menominee and European American children for each response type

Response type	Menominee (N=17)	European American (N=15)
Morphological properties	31.65	24.80
	17	*15*
Taxonomic	3.00	3.00
	12	*13*
Ecological relations		
Food chain*	9.00	3.73
	16	*10*
Other biological needs[a]	1.12	.07
	6	*1*
Habitat	15.06	17.87
	17	*15*
Utility relations**	1.00	.00
	8	*0*
Individual experience	2.76	1.73
	7	*7*
Other		
Sound mimicry*	0.65	0.00
	6	*0*
Inferences about mental states	1.35	1.20
	9	*7*

Number of children who ever have a particular type of response in italics.
* $p<0.05$, significant difference between cultural groups; ** $p<0.01$, significant difference between cultural groups
[a] Difference between cultural groups is approaching significance, $p<0.10$.

likely to mention habitat relations (M=16.38) than either food chain (M=6.53) or biological needs (M=0.63). Each child gave habitat responses. As was the case with morphological responses, this likely reflects the simple fact that habitat information was depicted in the stimuli themselves (e.g., moss and a birch tree were both depicted in the forest). This main effect was qualified by a significant interaction between Culture and Ecological Response Type, $F(2, 60)=3.25$, MSE=40.02, $p<0.05$. Menominee children gave significantly more food chain responses than rural European American children. This effect held up for both Token analysis, $t(30)=2.51$, SE=2.10, $p<0.025$, and the Type analysis: $\chi^2(1, N=32)=3.94$, $p<0.05$. Menominee children were also more likely to mention commonalities in other biological needs, Token analysis: $t(30)=2.05$, SE=0.51, $p=0.05$; Type analysis: $\chi^2(1, N=32)=3.82$, $p=0.05$. There was no cultural difference in the number of habitat responses, $t<1$.

Utility relations. Menominee children were significantly more likely than European American children to talk about utility associated with nature (utility responses included both personal utility and distant utility responses and there were no differences between these types of responses. Although Bang et al. (2007) found that Menominee adults gave more personal utility responses than distant utility responses, they used a different task. It is possible that for the Menominee, personal utility responses become more salient with development, but investigating this possibility is beyond the scope of the present study); this effect held up in analyses of Tokens, $t(30)=2.92$, SE=0.34, $p<0.01$ and Types, $\chi^2(1, N=32)=9.41$, $p<0.01$. Strikingly, although almost 50% of the Menominee children mentioned utility associated with nature, not a single European American children ever mentioned utility associated with nature.

Individual experience. There were no cultural differences in the likelihood to talk about experiences in nature or personal sentiment toward species, $t<1$, $\chi^2<1$.

Other response types. Menominee children were significantly more likely than European American children to mimic the sounds of species, as shown in response tokens, $t(30)=2.37$, SE=0.27, $p<0.05$ and the number of children who ever give this type of response, $\chi^2(1, N=32)=6.52$, $p<0.05$. Again, none of the European American children ever mimicked the sounds of species. There was no cultural difference in the likelihood to make inferences about the mental states of species, $t<1$; $\chi^2<1$.

Discussion

The results of this experiment provide the first direct evidence for differences in children's ecological reasoning across cultural communities, and provide additional evidence for an influence of culture on young children's folkbiological thought. This outcome, combined with previous findings with adults and children (Astuti et al., 2004; Medin et al., 2006; Bang et al., 2007; Waxman et al., 2007), reveal that by the time they enter formal schooling, children are well on their way to learning conceptualizations of nature that manifest within their cultural communities. In our task, children were given an open opportunity to describe why species pairs might go together. Menominee children were more likely than their rural European American counterparts to talk about ecological relations and utility associated with nature. In addition, Menominee children were significantly more likely than European American children to spontaneously mimic non-human species.

Although our species relations task was not explicitly designed to examine mimicry of non-human animals, cultural differences in spontaneously mimicking non-human species aligned with cultural differences in ecological reasoning and psychological closeness, and this pattern might reflect different ways of orienting toward the natural world. According to construal level theory, the perceived closeness of an entity or event can affect the way people mentally represent and ultimately reason about it, such that greater psychological closeness can lead to more situational or contextual reasoning (Henderson et al., 2006; Trope and Liberman, 2010). Other research shows that first person perspective taking is also associated with situational reasoning (Frank and Gilovich, 1989; Schultz, 2000). This work may have implications for the understanding of orientations toward nature, to the extent that ecological reasoning reflects an appreciation of the environment as a system of dependencies and animal mimicry reflects first person perspective-taking of animals. More research is needed to explore these possibilities and to examine the kind of cultural input that might support children's learning of cultural orientations toward nature.

One might wonder if the results from the present research derive from the fact that Menominee children really are "closer to nature" than their rural, European American counterparts. This is a useful observation, if for no other reason than to remind us once again that conceptions of nature are a cultural construction. If nature consists of space where humans are not the dominant species or where human artifacts are less in evidence, then Menominee children may indeed be closer to nature. But if we are all part of nature and there is no distance between humans and the rest of nature, then we need to describe our cultural differences in terms other than distance. It is important to note that although we found clear cultural differences, there was substantial variability and less than half of our Menominee children showed mimicry of animals. Our present study does not allow us to look for correlates of this within-culture variability but it does highlight the importance of avoiding essentialized notions of culture in which cultural groups are viewed as homogenous (see also Gutiérrez and Rogoff, 2003; Atran et al., 2005).

In conclusion, we have shown cultural differences in the likelihood of young children to engage in ecological reasoning, to talk about interrelationships between themselves and other species, and to mimic other species. These findings have implications not only for our understanding of cognitive development, but also for early science education. As we design early science curricula, it is important to identify and build upon the knowledge that the increasing numbers of children of minority-culture families bring with them to the classroom (see McIntyre et al., 2001).

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Appendix A

Coding Scheme

Code	Code description
Morphological	Form or physical attribute of species (e.g., both green)
Taxonomic	Classification of species (e.g., "both mammals")
Ecological	Interconnections among species and environment
Food chain	A consumer or source of food (e.g., "the chipmunk would eat the berries")
Other biological needs	Non-human species needs water, air, sunlight, soil (e.g., "they both need water")
Habitat	Natural environment of the organism (e.g., "it digs underground")
Utility	Referring to way in which using organism provides benefit to self or people (e.g., "we eat berries")
Individual experience	Reference to personal experience (e.g., "we used to go to the lake all the time") or personal feeling toward an organism (e.g., "I hate snakes")
Other	Other responses that emerged in the interview
Sound mimicry	Sound of non-human animals demonstrated (e.g., "hissing like a snake")
Inferences about mental states	Inference about mental state of organism or organism's purpose (e.g., "the frog wants to sit on the lily pad")