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Lions and Tigers and Bears, Oh My! Children's Conceptions of Forests and Their Inhabitants

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Abstract

Forty first-grade children, drawn from urban areas in Nebraska and New Jersey, were asked to produce drawings of forests and were interviewed about forests and the types of living things found in them. Results indicate that the children's concepts of animals and where they live are quite diverse, but highly concrete and unorganized. Although children correctly assigned most forest-dwellers to the forest (deer and squirrels, for example), they also tended to assign almost all other animals (elephants, sharks, etc.) to the forest as well, especially carnivores. A general lack of awareness of plant life, insects, water resources, and other forest features was also observed.

Children's acquisition of new information always occurs against the background of their previous knowledge. Since 1929, when Piaget first demonstrated that children's learning is powerfully influenced by their own preexisting conception of the world, educational researchers and practitioners have sought to understand children's notions and design curricular content to match (and build on) their previous understanding. The present study is an example of research conducted to achieve these goals. The data collected here were used to inform the development of a new life science curriculum for first-grade children. The major foci of this new curriculum, based on concepts defined in the California Framework (California Department of Education, 1990), were the fundamental commonalities among all living things (need for nutrition, reproduction, etc.) and the wide diversity among living things in terms of their specific adaptations to individual environments. These principles were to be applied in a concrete context: in this case, the forest habitat.

A separate study (Strommen, in press) was conducted to assess the appropriateness of the curricular concepts themselves. The purpose of the present study was different: to assess children's conceptions of the forest as a place, and to answer some basic questions about what children know of forests and the living things that inhabit them. A review of the literature reveals that children's conceptions of specific habitats have not been the subject of much empirical scrutiny. Studies of children's concepts of and attitudes toward animals in general have been examined (Kellert, 1985), and older children's knowledge of some aspects of coastal ecosystems have been studied (Brody & Koch, 1989), but there appear to be no data on what young children know about forests and the animals that inhabit them. As research conducted to address specific, concrete issues for the design of a specific curriculum, the questions of primary

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interest in the present study were highly pragmatic. Do children perceive forests as interesting and inviting places? How detailed is their knowledge of what lives in forests? Does their understanding deviate in any systematic ways from current scientific conceptions about forests that need to be addressed in the curriculum? In addition to these issues, there were questions of regional differences in children's knowledge. The curriculum was intended to be distributed nationally. Do children who live near forests differ in their conceptions from those who do not? The answers to all of these questions were critical to effective curricular design.

A general constructivist theoretical perspective that views children's knowledge as (a) actively created by children based on their own experiences and information they are exposed to, and (b) having its own coherent content and organization guided the design of both the curriculum and the study protocols themselves [c. Lawler, 1981; Resnick, 1987; for distinctive theoretical perspectives, see Piaget (1969) and Vygotsky (1978)]. The most appropriate method for assessing children's (and adults') knowledge about complex topics when previous data are lacking is the structured interview, which is similar to the think-aloud protocol used to assess problem-solving strategies of adults and children in a variety of contexts. This method was deployed in the present study.

Method

Site Selection

The participants in the present study were drawn from two states, Nebraska and New Jersey. Nebraska was selected as an appropriate site for assessing the views of children who did not have much direct experience with forests, because of its unique environment. The only forest in the state, Halsey National, was planted earlier in this century. There are few trees, and they generally only grow near open bodies of water. All parks in the state are man-made as well, and were planted in the last century. The dominant landscape is one of wide, flat plains covered with tall wild grasses or feed crops. New Jersey, by contrast, contains several large forests that serve as ecological preserves. The forests are considered a state resource, there is high public regard for them, and they are easily accessible to the population.

Subjects

Twenty first-grade children from public schools in Lincoln, Nebraska, and Plainfield, New Jersey, participated in the present study. Equal numbers of boys and girls were represented in both samples. A total of 25% of the Lincoln children and 35% of the Plainfield children reported visiting a forest, usually with their family as part of a vacation. All children were performing at or above grade level according to teacher reports.

Procedure

Children's conceptions of the forest were assessed in two ways: via drawings and through structured interviews. The children's drawings were created prior to the interview as part of a whole class activity. Teachers asked children to "Draw a picture of a forest. Try to show as many things as you can." Children were interviewed in their schools in a room near their regular classroom a few days after the drawings had been created. All interviews were videotaped for later analysis.

The interview began with the researcher and child first going over the child's drawing and

identifying what was drawn. Then, children were asked "What is a forest? What kind of place is a forest?" This question was followed up with the question, "What sort of things are in a forest?", which typically caused the children to produce a list of organisms. Children were asked if they had ever visited a forest, and also what they would like to see if they could visit one (or, for children who had visited a forest, if they could visit one again).

To assess children's grasp of the areas or places in the forest where organisms might live, children were asked "Where could I look if I wanted to find all the different living things in a forest? Where in a forest can we find living things?" After each place was given, the children were asked what lived there. They were then given a series of specific probes about what could be found in five specific places if they were not spontaneously mentioned: in a tree, in the ground, on plants or leaves, in water, and under logs and rocks. The probes all took the form, "What if I looked in/on/under [place]? Would I find living things there?" If the children said yes, they were asked to name the organism that could be found there. To assess children's knowledge of the feeding habits among organisms, the children were asked, "If I wanted to go to the forest and feed all the different things that live there, what should I bring for them to eat?" For each food named, the identity of the consumer was elicited. After the children answered, they were given a series of specific probes about what animals might eat each of the following, if they were not spontaneously given: plants or leaves, bugs, fish, and meat. The probes all took the form, "If I brought some [food] to the forest, would something eat it?"

Finally, children were given picture cards featuring 46 different animals and insects. They were asked to sort the cards into three piles: those that lived in a forest, those that did not, and those the child was unsure about. The children were told, "Here are some pictures of different kinds of animals. I'd like you to show me which ones live in a forest and which ones don't. Put the ones that do live in a forest right here [gesture] and the ones that don't live in a forest over there [gesture]. If you find animals that you are not sure if they live in a forest or not, put them right there [gesture]. Periodically, during the sorting activity, the researcher would query or remind the child about the meaning of the different piles to prevent the child from miscategorizing cards by accident during the sort.

Scoring

Drawings of the Forest. The children's drawings were scored in three ways. First, the *classes* of animals and plants the children drew were recorded. The animal classes were defined as: mammals, reptiles or amphibians, fish, and bugs (this category includes insects, worms, caterpillars, etc.). The plant classes were tree, bush, grass, and flower. The total number of each class portrayed was recorded for each drawing.

Second, the *different types* of animals and plants within each class portrayed were also recorded. For example, if a child drew three bears, this was scored as a drawing containing three four-legged animals, with one type of animal portrayed. If a child drew a bear, a fox, and a lion, the drawing was scored as containing three four-legged animals, with three different types portrayed.

Third, the relationships between the drawn forms was scored. Animals were scored as *unrelated* if: (a) they were standing alone on the ground, or (b) were drawn floating on the page [a standard portrayal at this age; see Lowenfeld and Brittain (1982) and Neperud (1977)], not in close proximity to or in physical contact with any other objects in the drawing. If the animal was drawn in relation to another element (a bird in a tree or a fish in water) the drawing was scored as being *related.*

Finally, other elements included in the drawings (sun, clouds, humans, etc.) were scored as simply present or absent.

Interviews. The elements of the interview were scored as follows:

Definition of a Forest.

Children's definitions were recorded verbatim, and then compared to discern common characteristics.

Number of Different Animals Mentioned.

During the interview, all animals mentioned by the children were recorded. The total number of different animals mentioned was then calculated.

Number and Types of Different Habitats Spontaneously Named by Children.

The number of different habitats the children named was calculated, as well as the classes of animals associated with them. The kinds of habitats mentioned were examined as well.

Number and Types of Different Foods Spontaneously Named by Children.

The number of different foods children named was calculated, as well as the consumers of each food named. The kinds of foods mentioned were examined.

Number and Types of Animals Named for Probed Habitats.

These were scored as before for the spontaneous habitats.

Number and Types of Animals Named for Probed Foods.

Responses to probed foods were scored as before for spontaneous foods mentioned.

Card Sort. The frequencies with which each animal was placed into each of the piles were tabulated.

Results

Excerpts from Sample Interviews

Before proceeding to a quantitative analysis of the content of the interviews, it is worthwhile to present brief examples from two children to give a qualitative sense of the children's responses.

James, a New jersey participant, began the interview by stating that he had never visited a forest, but had been to "the woods" behind his house. "I saw a dead puppy there," he confided. "The flies were licking it!" His drawing contained trees and flowers, but no animals. "I can't draw animals too good," he explained. When asked to describe forests as places, he said they were "places with lots of plants and lots of animals." When asked to name animals, he said "foxes . . . alligators, and grizzly bears." During the discussion of where in the forest animals could be found, James spontaneously mentioned caves. When asked what animals lived in

caves, he said "cavemen, bats . . . and grizzly bears." He did not name other habitats, but when prompted about trees he became animated, saying, "Oh! Lots of things! Birds, monkeys, and cheetahs . . . and dead animals that the cheetahs eat." He explained that cheetahs carried animals into trees to eat them. Grizzly bears and cheetahs recurred throughout the discussion. When asked about what lived in water, he said, "Fish! And turtles . . . and grizzly bears. They go there to eat the fish." Quizzed about what animals eat, he could only mentioned cheetahs eating meat. But when given specific food types, such as grass, he quickly named the cheetah again, and crickets and snails. When fish were mentioned, he again stated that grizzly bears ate fish. He was enthusiastic when asked about what ate bugs: "Oooh! Turtles. And snakes, too. And frogs!" When asked if he would like to visit the forest, he nodded gleefully. "I want to see wild animals, like bears or lions!"

Erica, a Nebraska participant, announced at the beginning of the interview that she knew a lot about forests and animals. Her drawing included trees with holes for owls to live in. "They have all kinds of trees and all kinds of animals, and people are wrecking the forest. I don't know why," was her definition of the forest. Asked to name things that live in a forest, she said, "Snakes, spiders, flowers . . . do they get hippos?" When asked what she would like to find out about forests, she said, "How all the animals got there, and how the forest got made." Regarding where animals could be found, her spontaneous answer started with: "Look really good in the green bushes for green snakes. They hide really well. And if there's a hippo, look where puddles are, because they get really thirsty!" Trees held "nests with eggs, and flying things that look like squirrels." Asked what might live in the ground, she said, "In the winter, toads and bears. They dig for some reason. I don't know why." She also mentioned worms. Did I know that worms laid eggs in the ground, she asked? She and her friend had found some. Another organism she noted lived in trees: ticks. "They jump out of trees. I had a tick on my ear once," she said, nose wrinkled in disgust. When asked about foods, she recommended "fruit for the snakes, and meat for the tigers . . . and the wild turkeys." When asked what might eat bugs, she told a story about a dragonfly she caught, which ate mosquitoes. "But I forgot to make holes for air, so I let it go." When asked why the holes were important, she said, "Well they're just like us. They need air, they just don't have nostrils." What asked if she would she like to visit a forest, she nodded. "I want to see all the different kinds of green. And all kinds of different birds . . . what are those birds that have mohawks? Those."

Drawings of the Forest

The frequencies of organisms, plants, and other pictorial elements represented in the children's drawings are shown in Table 1. Of 35 specific organisms portrayed, 13 (37%) can be classified as inappropriate to the forest environment (tigers, cheetahs, elephants, etc.). No children drew bushes. As the table indicates, trees and mammals were the most common elements in the drawings, with more conventional elements such as the sun and grass drawn almost as frequently. A notable finding is that with the exception of mammals, those children who drew animals or plants of a specific class tended to portray only a single type of animal or plant in their drawing. This was true even though they tended to include multiple examples of each class of object in the drawing ($M = 3.30$ trees, $M = 3.96$ animals, $M = 1.11$ reptiles or amphibians, $M = 4.0$ birds, $M = 1.20$ bugs, and $M = 2.40$ flowers).

In terms of the elements of the drawings being portrayed in relation to one another, the vast majority of forms portrayed were not related to each other. In a minority of drawings, however, animals, birds, and bugs were drawn in trees (24% of drawings), and in other drawings animals and fish were portrayed in water (15% of drawings).

Table 1
Content of Forest Drawings Produced by First-Grade Children, in Order of Frequency

Classes represented	% Drawings containings	% Different types shown				
		1	2	3	4	5
Trees	97.5	62	26	5	5	
Mammals	64.0	36	24	12	24	4
Sun	62.0					
Grass	54.0					
Birds	43.6	82	12	6		
Clouds	22.5					
Reptiles/Amphibian	22.5	89	11			
Water	18.0					
Bugs	13.0	80	20			
Flowers	13.0	40	60			
Fish	8.0	100				

Definition of a Forest

The children's definitions of a forest were impressively uniform across both samples. The typical description was a variation on "The forest is a place with lots of trees and lots of different kinds of animals." The children generally thought of the forest as a positive place and wished to visit one, but a minority of the samples (10% of each) expressed a fear of large carnivores. One child said he would prefer to visit the forest in the winter, when most of the dangerous animals would be hibernating. When asked what they would like to see if they visited a forest, children universally said they wanted to see animals, often naming specific species.

Animals and Plants Mentioned

In the course of the interview, children spontaneously generated between 6 and 33 names of different organisms, with an average of $M = 14.60$ living things per child. A list of all the different organisms mentioned by both samples is shown in Table 2. As the table indicates, children's knowledge of animals is quite diverse. By contrast, different forms of plant life were much less frequently mentioned, with children naming only from one to seven different plant types, for an average $M = 2.85$ plants per child. Trees were one plant type universally mentioned.

Children's Knowledge of Forest Environments

The children appeared to have some difficulty identifying locations within the forest where living things could be found. They spontaneously named only $M = 1.95$ different places per child, and only $M = 1.62$ living things per each place named. The majority of environments spontaneously named by children were the same as those environments probed during the interview. However, two specific environments that children associate with forests which were different from those for which the interview probed are the ground or dirt (22.5% of children) and caves (17.5% of children). Children who named dirt, mud, or the ground most frequently named mammals (deer, bear, etc.) as the animals likely to be found there. This seems odd, but

Table 2
Different Living Things Mentioned by Sample of 6 Year-Old Children

Mammals	Lion	*Bugs*	Roli-poli	*Aquatic*	Toad
Anteater	Mole	Aphid	Scorpion	Blue whale	Turtle
Baboon	Monkey	Ant	Slug	Catfish	
Bat	Moose	Bee	Snail	Clam	*Plants*
Bear	Mouse	Beetle	Spider	Crab	Acorn
Beaver	Panda	Butterfly	Tick	Dolphin	Apple
Bobcat	People	Caterpillar	Tarantula	Fish	Apple tree
Cat	Polar bear	Centipede	Walking leaf	Hermit	Bamboo
Cheetah	Porcupine	Cockroach	Walking-stick	crab	Bushes
Chipmunk	Rabbit	Crawler	Wasp	Horsefish	Carrots
Cow	Raccoon	Cricket	Worm	Killer whale	Corn
Coyote	Rat	"Crunchy bug"		Lobster	Flowers
Deer	Reindeer	Daddy	*Birds*	Shark	Grapes
Dog	Sheep	longlegs	Crow	Starfish	Grass
Donkey	Skunk	Dragonfly	Dove	Octopus	Leaves
Elephant	Squirrel	Earthworm	Duck	Whale	Lilypads
Ferret	Ground	"Fishy bug"	Eagle		Roses
Fox	Flying	Fly	Goose	*Reptiles/*	Seaweed
Giraffe	Tiger	Grasshopper	Hawk	*Amphibians*	Seeds
Goat	Wallaby	Grub	Owl	Alligator	Trees
Gopher	Weasel	Hornet	Parrot	Cobra	Vegetables
Hippopotamus	Wildcat	Inchworm	Pelican	Crocodile	
Horse	Wolf	Killer bee	Swan	Frog	
Kangaroo	Yak	Ladybug	Wild Turkey	Rattlesnake	
Leopard	Zebra	Praying mantis	Woodpecker	Snake	

an examination of children's interviews indicates that children viewed the ground as an environment in the sense that the mammals could be found standing on it, whereas the bugs children mentioned were presumed to be living *in* it. Regarding caves, there is striking uniformity in children's concepts of what lives in them: All children who listed caves named bears as their inhabitants.

When queried about environments they did not spontaneously mention, children named $M = 2.20$ organisms per place. A paired t-test indicates that children named significantly more animals for places they were probed on than for places they named spontaneously [$t(39) = -2.71$, $p < .01$].

The frequencies of classes of organisms mentioned both for spontaneous environments and for probed environments are shown in Table 3. Two findings are apparent from the table. First, the results for both the spontaneous and probed locations suggest that children associate certain classes of living things with specific environments. Birds and mammals (most commonly squirrels, but also including tigers, lions, and bears) are strongly associated with trees. Similarly, bugs tended to be associated with plants and being under logs and rocks. Second, a comparison of the spontaneous and probed environments also reveals that children appear to have more knowledge about living things and their environments than they can provide in answer to open-ended queries. When asked about environments they themselves did not mention, not only were subjects able to provide the names of living things found in them, but there was an impressive uniformity to the content of their answers, closely mirroring their responses for spontaneous places.

Table 3
Forest Environments and the Animals Found in Them, by 6-Year-Old Children

Spontaneous vs. probed	No. kids	Animal classes mentioned at least once				
		Mammals	Reptiles/amphibians	Birds	Bugs	Fish
			Trees			
S	20	18	2	13	2	0
P	20	13	2	16	4	0
			Water			
S	14	6	4	3	1	7
P	26	5	14	7	2	25
			On the ground, in dirt, mud			
S	9	7	1	0	4	0
P						
			In caves			
S	7	7	0	0	0	0
P						
			Plants			
S	4	3	2	0	1	0
P	36	3	4	3	35	0
			Underground, in holes, etc.			
S	4	4	4	0	1	0
P	36	12	9	0	25	0
			Under logs/rocks			
S	1	0	0	0	1	0
P	39	2	7	0	34	0

Children's Knowledge of Animal Foods

Children spontaneously named 41 different things to eat for forest life, naming an average of $M = 2.90$ different foods each. Seven children provided generic terms such as "monkey food, snake food," and so forth, and when asked, were unable to say what such food consisted of. The children also named 45 different organisms that ate the foods they named. Lists of the foods children named and the consumers of those foods are shown in Table 4. As the table indicates, the relationships between the foods and their consumers given by children were quite specific. Typically, children associated a single organism with each food that they named.

The results for the probed foods, summarized by classes of animal that eat each food type, are shown in Table 5. The findings are similar to those obtained for the probed environments: Not only do children appear to have specific ideas about what animal eats each type of food, but the results are often redundant with the specific answers given in Table 4. When asked what eats bugs, for example, children typically said spiders (another bug), or toads or snakes (reptile or amphibian). In keeping with their apparent fascination with predators, the children named meat and meat-eaters both spontaneously and when probed.

Picture Sort

The results of the picture-sorting task for showing which animals live in a forest are shown in Table 6. As can be seen, the children generally had an accurate appraisal of the types of

Table 4
Spontaneous Foods and Consumers Named by 6-Year-Old Children

Food	Consumers
Ants	Snake
Anything	Raccoons
Bamboo	Panda
Bear	Tiger
Berries	Bear
Bread, crumbs	Bird (8), duck (3)
Bugs	Bird
Carrots	Bobcat, giraffe, rabbit (2)
Cheese	Caterpillar, fish, mouse
Chips	Bear
Corn	Bird
Dirt	Worm
Fish	Bear, bird, cat
Flies	Spider, toad
Flower	Deer, monkey
Fruits[a]	Bat, monkey (banana), snake, worm (apple)
Grass	Cheetah, grasshopper (3), snail, tiger
Hair	Gorilla
Hay	Horse (2)
Honey	Bear, bee (3)
Leaves	Bear, deer, grasshopper
Meat	Bear (4), bees, cat, deer, dog (2), flies, human, leopard, shark, tiger (3)
Milk	Bobcat
Nuts, acorn[a]	Elephants (peanuts) (3), squirrels (5)
Pebbles	Giraffe
Seeds	Bird (5), horse, squirrel, zebra
Sugar	Ant
Vegetables	Human
Worms	Bird (5), fish (2)

Note. Numbers in parentheses are numbers of children in the sample listing this food–consumer pair.
[a] These categories were collapsed across specific examples. Examples are listed in parentheses with name of consumer.

Table 5
Probed Foods and the Classes of Animal that Eat Them

Food	Mean no. of animals per child	Animal classes mentioned at least once (% children)				
		Mammals	Reptiles/amphibians	Birds	Bugs	Fish
Plants, leaves	1.63	32.5	0	7.5	52.5	2.5
Bugs	1.68	20.0	30.0	12.5	47.5	2.5
Fish	1.13	47.5	5.0	5.0	2.5	20.0
Meat	1.75	50.0	10.0	10.0	7.5	2.5

Table 6
Animals that Live in a Forest, by Consensus Level, 6-Year-Old Children

Animal	% Children selecting as living in forest	Animal	% Children selecting as living in forest
Very likely (≥75%)		Very unlikely (≤24%)	
Frog	97.5	Penguin	22.5
Deer	95.0	Cow	20.0
Spider	90.0	Sheep	20.0
Snake	87.5	Cat	15.0
Tadpole	87.5	Dog	22.5
Ant	85.0	Horse	12.5
Cardinal	85.0		
Salamander	85.0		
Fox	82.5		
Turtle	82.5		
Bluejay	80.0		
Fish	80.0		
Fly	80.0		
Koala bear	80.0		
Beetle	77.5		
Butterfly	77.5		
Caterpillar	77.5		
Grasshopper	77.5		
Snail	77.5		
Monkey	75.0		
Somewhat likely (50–74%)		Somewhat unlikely (25–49%)	
Ladybug	72.5	Zebra	45.0
Rabbit	72.5	Elephant	42.5
Tiger	70.0	Pelican	42.5
Parrot	65.0	Giraffe	40.0
Gorilla	65.0	Dolphin	30.0
Squirrel	65.0	Camel	25.0
Lion	62.5	Rooster	25.0
Seagull[a]	60.0		
Polar bear[b]	57.5		
Crab	55.0		
Kangaroo	55.0		
Stork	55.0		
Duck	50.0		

[a] Some children identified this bird as an eagle.
[b] Children who included the polar bear stated that it is actually an arctic animal, but that it was still a bear, and bears live in forests.

organisms found in the forest, but there was a notable tendency to include carnivores such as lions or tigers, and other exotic animals. The most interesting result shown in Table 6, however, is that there was almost universal agreement among the children that a frog is a forest creature, with deer rated as the next most likely inhabitants. The one result seemingly discrepant with the rest of the interview is the rather modest frequency of children who said that bears are forest animals. This result, however, is apparently due to an artifact: A picture of a polar bear was used in the card sort, and this led some children not to include the bear in the forest pile. As noted in the table, however, children who included the polar bear simply disregarded the bear's color.

Relationship of Drawings to Interviews

The children's drawings reflected their interviews to the extent that their verbal descriptions of the forest reflected the modal content of their drawings: Just as trees and animals were the most common features in the children's drawings, they were also mentioned most often in their definitions of a forest. However, in terms of specific content, the drawings were much less rich than the interviews: Only $M = 2.13$ different animals were portrayed per drawing, for example. It is especially striking that while even the least voluble child named at least 6 animals, 21% of the drawings actually portrayed no animal life at all, but only trees. Plant life in drawings fared somewhat better, with $M = 1.77$ different kinds of plant per drawing, typically trees with grass.

The number of different animals mentioned by children during the interview was correlated with the number of different animals portrayed in the drawings, with no significant relationship found. Similarly, the number of different plants mentioned by children was not correlated with the number of different plant types they portrayed in the drawings.

The Effects of Experience on Knowledge

One of the key questions for the present study was the degree to which exposure to forests affected children's perceptions and knowledge of them. The two sites selected for the interviews were thought to provide a contrast between children who had and children who had not visited forests. However, as reported above, the percentages of children in both samples who had actually visited a forest was approximately equal. Therefore, to assess the effects of experience, children from both sites who had visited forests were combined ($N = 12$), and compared on all variables to the combined total of children who had not visited forests ($N = 28$). Three differences appeared, only one of which was statistically significant. Interestingly, however, all differences favored the children who had actually visited a forest.

First, when asked what sorts of living things could be found on plants, children who had visited a forest named significantly more organisms ($M = 2.58$ vs. $M = 1.89$ for children without forest experience). This difference approaches significance [$t(37) = -1.89$, $p < .07$]. The other two differences relate to the children's drawings. Children with forest experience included more different types of animals and plants in their drawings than those who had not. Children who had visited a forest drew $M = 5.17$ animals vs. $M = 3.65$ for the rest of the sample [$t(37) = -1.87$, $p < .07$]. Children who reported visiting forests drew significantly more different types of plants [$M = 2.25$ vs. $M = 1.53$, $t(37) = -2.57$, $p < .01$].

Demographic and gender differences in knowledge

All of the interview and drawing variables were submitted to 2 (Site) × 2 (Gender) independent factor analysis of variance. Comparisons of the responses of children from the two sites, regardless of their experience with forests, yield consistent differences between the samples favoring the New Jersey children, as well as results favoring boys over girls in knowledge of forest life.

In terms of total different animals mentioned throughout the interview, there was a significant Site difference [$F(1, 36) = 61.07$, $p < .0001$] and a significant Site × Gender interaction [$F(1, 36) = 9.93$, $p < .003$]. These results reflect the fact that not only did children in New Jersey of both sexes name more animals overall than those from Nebraska ($M = 19.25$ animals for New Jersey children; $M = 9.95$ animals for Nebraska), but that whereas Nebraskan boys and girls were similar in the numbers of animals named ($M = 9.00$ animals for boys and $M = 10.90$

animals for girls), boys in New Jersey named significantly more animals than girls ($M = 22.44$ animals per boy, but $M = 16.63$ per girl). The same site difference holds for total different plants mentioned [$F(1, 36) = 1.62$, $p < .002$]. New Jersey children named $M = 3.60$ different types of plants versus $M = 2.10$ for children from Nebraska.

Site differences favoring the New Jersey children also emerged for three specific interview variables. In response to specific environment probes, New Jersey children named more animals that live in trees [$M = 3.10$ vs. $M = 1.80$ for Nebraskan children, $F(1, 36) = 10.07$, $p < .003$]. This sample also named more animals that live in water [$M = 2.90$ vs. $M = 2.05$ for Nebraska, $F(19, 36) = 7.12$, $p < .01$]. A gender difference favoring boys was found for this variable as well [$F(1, 36) = 11.33$, $p < .002$, $M = 3.05$ animals per boy, but $M = 1.95$ animals per girl]. There was no Site $\times$ Gender interaction. New Jersey children also scored higher on the probe regarding animals that eat fish [$F(1,36) = 6.46$, $p < .015$], naming $M = 1.45$ animals per child versus $M = 0.80$ per child in Nebraska. It should be noted that the difference in the number of animals mentioned is unrelated to the accuracy of the animal species as forest organisms. Despite their increased numbers, the additional animals mentioned in New Jersey were no more likely to be appropriate to the forest than the animals mentioned by the children in Nebraska.

Informal Observations

Certain qualitative aspects of children's characterizations of forests could not be captured by the scoring system, but are noteworthy nonetheless. First, although children clearly distinguished deserts, or the Arctic, from forests (and could indicate that camels and penguins were unlikely forest creatures because they lived in these places), they did not distinguish clearly between different geographic and habitat concepts. One child said, for example, "Zebras don't live in forests, they live in Africa," but then went on to name lions as animals that lived in Africa *and* in forests. Another child asserted that forests were only found in America. Such confusion over geographic and habitat terms was common.

The children also appeared to be unclear on the distinctions among the following terms: forest, jungle, and woods. All children agreed that forests and jungles were different, but few could give criteria for distinguishing the two. The children in each sample that did mention criteria for distinguishing them were surprisingly consistent, however. Palm trees and more ferocious animals were given in both samples as features of jungles. The term *woods* produced less clearcut results. The majority of children in both samples either indicated that woods and forests were the same, or were unsure. Interestingly, all those who said that forests and woods were different came from the New Jersey sample. Only one child could articulate a difference, however, and he suggested that woods were smaller and had no animals.

Discussion

The Content of Children's Knowledge

An examination of the types of animals children name when discussing the forest, and the types of animals they selected as forest-dwellers during the card sort, indicate that although the children appeared to have a generally accurate sense of animals that actually inhabit forests, three systematic misconceptions about what lives in a forest were evident. First, children appeared to overestimate the number and types of large carnivores to be found in forests. Second, when thinking about water in the forest, and what lives in it, the children do not clearly distinguish between marine and fresh-water environments. They confidently and nonchalantly

include sharks, whales, dolphins, and other sea animals as forest inhabitants. Finally, although children tended to reject desert creatures such as camels and arctic animals such as penguins as forest inhabitants, animals from less stereotypical habitats (the savanna, for example), including high-familiarity zoo animals (lions, giraffes, elephants, etc.) were readily included. All of these misconceptions make sense if it is recognized that the forest as an idea appears to act as a sort of catch-all wild place for children, a place where all sorts of temperate- and tropical-zone organisms live. This may be due in part to the quasimythical status of forests portrayed in fairy tales, television cartoons, and so on. Whatever the reason, children's notions of which animals live in forests are often inaccurate, even though their other knowledge about the animal (what it eats, for example, or other behavioral information) may be correct.

The Organization of Children's Forest Knowledge

The present findings suggest that children's conceptions of forests and animals can be broadly characterized as *rich in content but poor in structure*. The children's knowledge is rich in the sense that they have an impressive store of knowledge of different types of animals, plants, bugs, and other organisms. They appear to possess a fair amount of knowledge about very specific, almost prototypical animal–environment and animal–food relationships. However, the broader conceptual relationships among the different organisms, foods, and environments the child knows about are incomplete and partial. Indeed, their knowledge could be characterized as a collection of very concrete facts, detailed in their own right, but isolated from one another such that common features are not recognized or coordinated into systematic categories.

One of the consequences of the lack of systematic structure in children's knowledge about animals is that, aside from some stereotypical associations, children do not always express what they know without being provided with concrete hooks, or facts to direct their thinking. When describing forest environments, for example, children spontaneously mentioned trees and were highly consistent in their attributions of what live in them (birds and certain mammals). They also were unanimous when mentioning caves as environments in stating that bears were their inhabitants. However, when queried about other environments they did not mention, their answers demonstrated that the children did indeed possess detailed ideas about what lived in them (bugs under rocks, for example, or fish in water). Similar results were found for food types. The foods they mentioned spontaneously were highly individualized and always related to a specific organism. Yet, when queried about food types they did not mention, the children's answers again indicated that they did have highly consistent ideas about what ate each food type probed for. It appears that the children do not think of where an animal lives or what animals eat as categories or concepts. Instead, they only know about particular animal–place or animal–food relationships ("Birds live in trees," or "Bears eat meat") that require the naming of the specific animal or place to be accessed.

Assessing Children's Forest Knowledge

The children's ideas about forests and their inhabitants were assessed verbally through interviews and through an examination of drawings they produced. As these results indicate, even within the interview format the design of the question (open-ended versus specific) had a substantial influence on the amount of information children could provide. A comparison of the content of their interviews and that represented in their drawings gives similar results: The children's drawings of forests are consistently less detailed than the information they convey

verbally. Overall, less information was portrayed in the drawings than that which children provide in an interview situation. Not only were the amount and types of living things portrayed in the drawing far fewer than those obtained from similar measures in the interviews, but the children verbally reported knowledge of habitat relationships (birds in trees, bugs on plants, etc.) that were almost never portrayed in their drawings.

It is possible that the drawings could still reflect individual differences in knowledge, however. One possibility investigated in the present study was whether the most knowledgeable children (i.e., those who provide the richest material from the interviews) also produced drawings that had more diverse content than those drawn by children with less knowledge. No evidence was found to support this idea. There was no relationship between the richness of the child's interview results and the richness of their drawing. These findings suggests that drawings should be used only with great caution to assess children's knowledge of this topic.

The Role of Experience, and Demographic Differences

Children participating in the present study were compared with each other on three variables: experience with forests, site of schooling, and gender. Experience with forests proved to have only a modest effect on children's performance, increasing the numbers of different animal and plant types portrayed and increasing the number of organisms children reported as living on plants. These results should be viewed with caution, however. The children's self-reports of visiting forests do not provide any indication of the quality of their experiences, and it may well be that experience with forests influences children's conceptions of them in beneficial, systematic ways not reflected in the current data.

Regarding site effects, it is notable that the New Jersey sample consistently outperformed the Nebraska sample on interview variables relating to the variety of animals and plants names, both spontaneously and in response to probes. Interestingly, their fluency was no more accurate than that of the Nebraska children: They were just as likely to name yaks, elephants, and other inappropriate creatures as were the Nebraskan children. The sample difference is not due to curricular differences between the sites: The Nebraska district is the one that has a life sciences curriculum in the first grade (although the curriculum had not been started when the interviews were conducted); the New Jersey district does not. One possible explanation for the increased knowledge base of New Jersey children could be that they live in an area that is richer in resources providing information about animals than the Nebraskan children. New Jersey children not only have access to two major zoos and several major natural science institutions (such as New York's Museum of Natural History); they also live in a huge media market saturated with dozens of channels, many of which carry nature shows and other programming related to wildlife, often targeted specifically at young children. Future studies should determine if site differences such as those found in the present results are replicable, and investigate their causes more carefully than is possible in the present article.

Finally, gender differences favoring boys were observed in children's responses on two variables: naming creatures that live in water in response to the interview probe, and overall number of different animals mentioned. For the total number of different animals mentioned, the sex difference is found only in New Jersey. For the water environment probe, the sex difference is a main effect. It is difficult to know how to interpret these two findings. Both suggest that boys are somewhat more knowledgeable than girls about living things, at least those they think inhabit forests. But the highly specific nature of the results (on only two of many variables) also suggest that if boys do possess more knowledge, their superiority is very limited. As with the

significant differences observed between sites, future studies should replicate this sex difference before any conclusions about its reliability or causes are drawn.

Conclusion

The present results provide useful information for curriculum design. Children appear to possess a substantial and varied base of knowledge regarding living things, but their ideas appear to be extremely concrete and isolated from each other, such that they cannot systematically examine what they know and report it. They know more than they can spontaneously volunteer, which suggests the importance of guided discussions when eliciting children's responses about specific animal behaviors, such as eating, and animal habitats. While knowing where specific animals live and what they eat, they are nonetheless unable to generate sets of environments (or foods) on demand, suggesting that they do not possess higher, more general categories of animal foods or animal homes. Educational efforts should therefore focus on helping children recognize how the information they possess can be organized into such deeper, more powerful concepts.

In terms of factual information, children's ideas about forests and their inhabitants appear to be very global and imprecise. It is apparent that they lack an awareness of the wide variety of terrestrial habitats, and are aware only of stereotypical extremes (desert or tundra). They do not seem to be aware of the difference between marine and freshwater habitats, either. Whether because of the nature of its portrayal in stories and fairy tales or for other reasons, the forest appears to function as a general, nonhuman setting for animals to inhabit. Providing children with information about other habitats and the creatures that live in them will most likely help reduce children's misconceptions.

Using children's established concepts as a base on which to build, it is possible to create curricular content that will be maximally effective in assisting children's cognitive growth. By assessing what children already know, it is possible to: (a) avoid wasting resources providing information that children already have acquired and (b) tailor educational materials to both fill in the gaps in their knowledge and provide the appropriate structure for their existing ideas. The present data fill a gap in our understanding of what children do and do not know about forests and forest life. The next task is designing educational experiences that capitalize on this insight.

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