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Abstract

This study examined the play of 4-year-old children with a forest diorama that included toy representations of plants and animals. To examine the potential role of culture and expertise in diorama play, children from three samples participated: rural Native American, urban Native American and urban non-Native American. Children's playtime was divided into time segments; these were coded for types of actions and for types of talk. Children from all three samples actively engaged with the diorama in both realistic and imaginative play. Furthermore, children from all samples were sensitive to ecological relations. In addition, Native American children talked at least as much as the non-Native American children, a finding that challenges widespread characterizations of Native American children as less talkative and possessing smaller vocabularies. The most striking finding was that Native American children (both urban and rural) were more than twice as likely as non-Native American children to take the perspective of an animal in their play. These results demonstrate the value of dioramas for assessing young children's biological cognition.

Keywords: Cross-cultural development, ecological relations, Native American.

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Children's Play with a Forest Diorama as a Window into Ecological Cognition

Introduction

What do young children know about living things? How do they represent their knowledge about individual biological entities (e.g., animals, plants) and the ecological relations among them? Questions like these are foundational, not only for theories of cognitive development, but also for practices in early science education. At issue is identifying how young children from diverse communities think about the living world, and how their existing knowledge and beliefs influence their subsequent learning about the living world, an increasingly important domain in preschool and primary grade classrooms (Longbottom & Slaughter, 2016).

Most research on children's understanding of the natural world comes from middle class, European American children living in urban or suburban communities, typically located close to universities. But considerable recent research, aimed at broadening this empirical base, reveals that children's knowledge about living things and the relations among them is sculpted by the cultural and environmental contexts in which they are raised (see ojalehto & Medin, 2015; Longbottom & Slaughter, 2016, Rogoff, 2003 for reviews).

In addition, most research on children's biological knowledge uses stimulus materials and experimental designs that are familiar to middle class urban and suburban children including, for example, protocols involving direct question and answer interchanges with an unfamiliar adult experimenter. Designs like these are likely less familiar to young Native American children than their non-native counterparts (Cazden, 1993; Rogoff, 2003). Moreover, because much of the

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research in this area relies on interaction formats that parallel school-based activities, what remains unknown is how young children express their knowledge about the natural world in less constrained contexts.

Our goal in the present study is to investigate young children's knowledge about the living world in a different way. Specifically, we examine their interactions with a 3-dimensional diorama designed to elicit spontaneous expressions about living things in an open-ended play context.

We position our study in the context of three vigorous, but until now independent, lines of research on preschool cognitive development. First, there has been active research investigating how culture and experience shape children's acquisition and expression of biological cognition (e.g., Gelman & Legare, 2011; Inagaki & Hatano, 2002; Longbottom & Slaughter, 2016; Rhodes & Gelman, 2009; Tarlowski, 2006, 2011; Taverna Waxman, Medin, & Peralta,2012; Taverna, Medin & Waxman, 2016; Tunicliffe & Riess, 1999, 2000; Unsworth, et al., 2012; Waxman Medin, & Ross, 2007; Winkler-Rhoades et al., 2010. Evidence suggests that children's culture and experience with the natural world influence their biological cognition.

One important factor is the amount and kind of contact children have with the outdoors in general and with environments not saturated with human artifacts in particular affects their understandings of the living world (Gaster, 1991; Tudge, 2006; Leander, Phillips, & Taylor, 2010). Informally such settings have been called "nature" (Nabhan & St. Antoine, 1993; Ross, Medin, Coley, & Atran, 2003; Louv, 2005). Moreover, "experience" includes not only children's direct encounters in the natural world, but also their access to representations of the living things

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in media, such as children's books and movies (Dehghani, Bang, Medin, Marin, Leddon, & Waxman, 2013; Waxman, Herrmann, Woodring, & Medin, 2014). In addition, children's reasoning about the biological world is shaped both by the environment in which they are raised (rural vs urban) (e.g., Shafto & Coley, 2003; Coley, 2012) and the biological knowledge of their parents (Tarlowski, 2006).

Second, there has been considerable research into the role of exploration and play in young children's informal learning (Bell, Lewenstein, Shouse, & Feder, 2009) and (Fleer, 2011; Pramling-Samuelsson & Fleer, 2008; Hirsh-Pasek, Golinkoff, Berk, & Singer, 2008; Lillard, et al., 2013). There is evidence to suggest that while formal instruction may reduce children's exploratory play and engagement (e.g., Bonawitz et al., 2011), play is essential because it provides critical opportunities to develop practices of theorizing and hypothetical thinking (e.g., Ochs, Taylor, Rudolph, & Smith, 1992). Results like these, coupled with the contemporary emphasis on school standards and assessments, has raised concerns from educators and parents alike about the lack of time at school for imaginative play (Fleer, 2010).

In a third line of investigation, researchers have identified what insights can be drawn from indirect assessments and open-ended tasks (Thomas & Silk, 1990). For example, simply asking young children to draw a forest sheds light on what they know about which animals live in the forest (Strommen, 1995); simply asking children to name living things reveals how children construe the living world and which entities they identify as its members (Seibert & Anooshian, 1993; Winkler-Rhoades, et al., 2010); asking children to "draw where you live" has been used as a measure of complex systems thinking (Olson, 2013).

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Weaving together these three lines, we ask: What information do young children express about the biological world in an open-ended, informal play session that utilizes a diorama of a natural (forest) scene? Building on previous work on Native American relational epistemologies (e.g., Cajete, 2000; Medin & Bang, 2014), our interest is not so much on which objects children choose to play with as on the relations among biological entities that they express in their play.

As noted earlier, we examined the play behavior of 4-year-old children from three distinct U.S. populations: 1. Rural Native American (Menominee) children 2. Urban Native American children, and 3. Urban non-Native American children. We selected these samples based, in part, on our commitment to doing community-based and culturally-based science education in Native American communities (Bang & Medin, 2010). We selected these groups to gain insight into biological cognition in communities that differ in a variety of ways. As in our prior work, we think of culture neither as an independent variable nor as a medium for examining variation along any single dimension (e.g., urban versus rural). Instead, we selected these populations because each represents a distinct point in a high dimensional space that involves ethnicity, environments, cultural practices, income, education, family structure, and any of a number of other variables, all of which likely shape the child's developing notions of the biological world. In short, we were aiming for diversity in our study samples.

We partnered with members of each community at every step of the design and analysis process. The importance of sustained engagement with the community is best introduced with a story. Previously we had noticed some interesting effects with young children that could well bear on biological cognition. For example, we found that in playing with toy objects, mother-

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child dyads (from primarily white, college-educated middle-class families) tended to 'personify' toy animals – 'speaking' for them or engaging them in human-directed activities (e.g., reading a book to a toy animal) (Gelman, Chesnick, &Waxman, 2005). In another task directly asking about ecological relations for pairs of living kinds, we found that these relations were more salient among 5-7 yr old Menominee children than for their rural European American counterparts (Unsworth et al., 2012). Menominee children were also more likely than rural, European American children to take the perspective of a non-human animal in this task (Unsworth et al., 2012).

These observations led us to wonder which kinds of relations among biological entities would be expressed among still younger children growing up in different US communities. At one research meeting at the Menominee Nation, the Northwestern team members brought some small 'realistic' plastic animals and suggested presenting children with pairs of these toy animals to probe for their spontaneous descriptions of relations among them. Our Menominee team members objected to this plan, pointing out that this task would be very unnatural for Menominee children because there was no "context" provided for the animal pairs. After an extended discussion, one Menominee research assistant volunteered to construct a diorama, using realistic models of trees, shrubs, water, and grass, as well as several pieces of "real" wood and rock, to provide a context for a task with toy animals. The diorama she created served as the model for the present study.

There are two points to this story. First, this represents an exception to the more usual methodology in which researchers and educators develop materials (experimental tasks,

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curricula) with children living in and around major research universities in mind, and then exporting these tasks elsewhere, a questionable research practice (Medin et al., 2010). Here, we developed a task designed to fit Menominee intuitions and exported it in the opposite direction. In short, in addition to the benefit of living in a forest environment, young Menominee children had the potential advantage of a play environment that Menominee adults judge to be a good one.

Second, the diorama task permits us to probe young children's knowledge in a novel way, using children's spontaneous talk and play as a window into their knowledge. It offers an opportunity to observe how children from each community engineer interactions in the natural world, including animals' interactions with other animals, with plants (trees, shrubs and grass), and with natural kinds (water and rocks); it also provides an indirect assessment of ecological knowledge. Importantly these two insights represent more than sample diversity in this study; they move this work towards methodological diversity as well.

Material and Methods

Description of Study Populations

1. Rural Native American (Menominee) population. Twenty-four Menominee children (mean age = 3;9, range 3;3 - 4;3) were recruited either from a Head Start center on the Menominee reservation or from community meetings associated with our research project. The diorama task was conducted in a quiet room at the Head Start. Data from three children were

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excluded from analysis; two played with the diorama for less than five minutes; the other child's data was used exclusively in training.

Parents and children commonly had mixed tribal and ethnic background but at least one parent and all of the children in our sample were enrolled members of the Menominee tribe. The Menominee nation is rural. It is also so heavily forested that the borders of the reservation are readily apparent in satellite images, even for the part of the reservation that is adjacent to the Nicolet National Forest. Forestry, in the form of logging, the lumber mill, and natural resource conservation is a major form of employment on the reservation. It is not uncommon for children and adults to see eagles, deer, and bears as part of their everyday experience.

2. Urban Native American population. Sixteen Urban Native American children (mean age = 4;4,, range 3;2 – 5;2) participated, three in their homes and 13 in a quiet place in the American Indian Center (AIC) building. The urban Native American children were recruited from various activities at the AIC and from family and friends of research assistants and AIC staff social circles. The tribal affiliations within in this urban community tend to be diverse; even within a family, parents are often from different tribal and ethnic backgrounds. These families came from a wide variety of neighborhoods. The urban Native American population obviously does not live in a dense forest, but in our community-based and culturally-based science education programs at the AIC we facilitated seeing Chicago as an urban forest and relied on local forest preserves frequently.

3. Urban, non-Native American population. Twenty-one non-Native American children (mean age = 4;0, range, 3;9 - 4;5) were recruited from Evanston and Chicago, either through

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their preschool (n = 15) or a research database at Northwestern University (n = 6). Children participated in the diorama task in a quiet place, either in their preschool or at Northwestern University's Project on Child Development. Data from four children were excluded from analysis because they played with the diorama for fewer than five minutes.

Although children from all three populations were roughly the same mean age, the Urban Native American sample was reliably older than the Rural Native American sample (Main effect of Community: $F(2, 51) = 6.489$, MSE= .186, $p < 0.01$). The urban non-Native American sample didn't differ from either of these extremes.

Materials

Diorama. The diorama represented a fixed forest scene with moveable elements as playing pieces (toy animals and trees). See Table 1 for a complete list of fixed and moveable elements.

[Table 1 about here]

Forest scene. The open diorama was mounted on a 30 x 46 cm piece of 2.5 cm thick polystyrene foam. Items fixed to the diorama were realistic models of vegetation and real pieces of rocks and sticks. See Table 1. The surface of the diorama was covered with a textured green mat simulating grass. The trees (6 trees, each ranging 10 cm to 12.7 cm tall) were located along the perimeter of the scene; bushes, logs, grasses, rocks, and a pond were situated to represent an open woodland scene. There was ample room for children to place moveable pieces (below) on this forest scene.

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Moveable pieces. See Table 1. Animals ranged from 2.5 cm to 5.0 cm in height and length. Trees ranged from 10 cm to 12.7 cm in height.

Procedure

Children were tested individually, seated at a table with a research assistant from their own community. The diorama was positioned within the child's easy reach, with the moveable items on the table beside it. The experimenter explained that the child should just, "go ahead and play" with the items. If the child hesitated, the experimenter encouraged the child, saying, for example, "Here are pieces you can play with. Go ahead and use any pieces you want. There is no right or wrong way to play, it's all up to you!"

Experimenters were trained not to be play partners, but rather to observe the child's play. When a child first chose a piece, the experimenter asked, "What's that?" To help maintain the child's engagement, the experimenter occasionally asked, for example, "What are you doing with that?" Otherwise, the experimenter observed the child's play silently.

Children were allowed to play freely with the diorama for up to 40 minutes. If a child stopped after less than 15 minutes, the experimenter encouraged, but did not require, the child to continue. Of children who played at least five minutes, over half (61%) played for 15 minutes or longer (urban Native American 50%, rural Native American 76%, urban non-Native American, 47%). Sessions were video-recorded.

Coding

To ensure that our analyses were based upon a sufficient sample of play from each child, we included for analysis only those videos that were at least five minutes in duration. Each

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child's video was divided into 30-sec segments; we coded the first 15 mins of each. For each 30-second segment, we noted the presence or absence of each code (below). One researcher from each community served as a coder. Each coded approximately one third of the videos from each population.

Codes:

For each time segment, we tallied whether the child talked about or acted with: each object (Content), identifiable activity (Behavior) or interactions between objects (Relations).

Content. Each object in the diorama that the child talked about or played was recorded.

Behaviors. Each identifiable animal behavior (e.g., flying, running, but not simply placing an item on the diorama) was recorded. Additionally, each behavior was coded either as realistic (possible in the natural world, e.g., an eagle flying) or imaginary (not possible in the natural world, e.g., a bear flying).

Relations. All interactions between any animal and another animal, a plant, or a member of another natural kind (e.g., water, rocks) were recorded. Relations were coded either as realistic (possible in the natural world, e.g., an animal drinking water) or imaginary (not possible in the natural world, e.g., a zebra on top of a tree). We also defined animal-animal relationships between native animals and the domestic or exotic animals as imaginary, because those kinds are not part of the North American woodland ecosystem.[1] This definition does not mean that action with non-native animals would automatically be coded as imaginary--a zebra drinking from the pond, a cow eating grass or the gorilla climbing a tree would be scored as realistic relationships.

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Perspective taking. Further, we determined whether a child took the perspective of any animal. We defined perspective taking either as vocalizing *for* the animal (making an animal noise (e.g., "moo") or 'speaking for' the animal (e.g., "I'm going to drink the water")) gesturing *for* the animal (imitating an action of the animal in the scene (e.g., moving arms in a swimming motion) or pantomiming a body part of the animal (e.g., putting hands on head to pantomime deer antlers). Arguably "speaking for" may be considered a form of anthropocentrism, but we distinguish between announcing or explaining an action that animals normally and naturally engage in and actions that are specific to humans such as "I'm going to put on my jacket." The latter is less perspective taking than projection of a human characteristic.

See Table 2 for examples of coding scenarios.

[Table 2 about here]

Inter-rater reliability.

We computed reliability among coders on data from 9 participants (3 from each community). For each coding category (talk, etc.), we computed Cohen's Kappa for each of the three pairs of coders, using each time segment as a unit of analysis (376 total time segments). Agreement was good, with average Kappa values for each coder pair of 0.47 for talk, 0.42 for action, and 0.54 for perspective taking.

Results

Children from all three communities engaged actively with the diorama; more than 90% of their play involved the diorama. We tallied the average number of instances per time segment in which each child either talked about or acted upon an object and submitted these to an ANOVA using Community (3: urban Native American, rural Native American, urban non-

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Native American) and Type of play (2: Talk vs. Action) as factors. Although we do not think it is especially meaningful to compare talk versus action, because it is often claimed that Native American children are reticent to talk (Connelly, 1985; Wolfe, Schwartz, & Peterson, 1996; Mitchell, Croy, Spicer, Frankel, & Emde, 2011), we were motivated to assess the possibility of a Community by Action interaction. An ANOVA test of this interaction gave no support for it (F (2,51) = 114.738. MSE = 1.333, p = .872) as is evident in Table 3. Hence we will not report main effects of Talk versus Action.

[Table 3 about here]

Content: What objects did the children play with?

We next asked what objects children played with. Although we had entertained the possibility that Native American children would play more with native animals than exotic or domestic animals because of their fit with the forest diorama context, Table 4 reveals little difference in talk or action between communities or between native and non-native animals. An ANOVA using Community (3: urban Native American, rural Native American, urban non-Native American) Type of Play (2: talk, action) and Type of Animal (2: native, exotic or domestic) as factors indicated no main effect of interaction of Community with Type of Animal. We did not conduct analyses using individual animal kinds as a factor because we had no specific hypotheses about species effects; play was widespread across animals in all three communities. Rural Native American children played relatively more with evergreen than deciduous trees, especially in comparison with our other two samples but again we hadn't anticipated such a difference and will not discuss it further.

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[Table 4 about here]

Realistic and Imaginary Play

In principle, the diorama task affords opportunities for both realistic play (e.g., placing an eagle on a treetop, having an eagle fly) and imaginary play (e.g., placing a turtle on a treetop, having a turtle fly). Nonetheless, distinguishing between realistic and imaginary play is a conceptual challenge. After all, identifying whether play is imaginative involves making an inference about the child and realistic play is difficult to establish without some sort of chance baseline. What may appear to be realistic play might have occurred by accident and what may appear to be imaginative play might have occurred without intention. To address this interpretive challenge, we first present the coding frequencies for the two categories and then provide a straightforward test for realistic play in the context of presenting results on relational play.

The overall results on amount of play that was realistic or imaginary is summarized in Table 5. Across all three communities, children engaged in substantial imaginary play and roughly to the same degree. Rural Native American children were relatively more likely to engage in realistic play than children from the other two samples. ANOVAs for talk and for action revealed a main effect for real vs. imaginary play (talk: $F(1, 51) = 16.019$, MSE = .074, $p = .000$); action: $F(1, 51) = 17.751$, MSE = .200, p = .000), but no main effect for community, and no interaction between community and type of play.

[Table 5 about here]

In addition, as in many children's books, the play could involve treating animals as human surrogates and having them engage in human-like behaviors. We suspected that urban,

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non-Native American children might be more likely to do the latter. We coded anthropomorphic play separately and the results are summarized in Table 6. The main finding is that anthropomorphic play was relatively rare and a small fraction of imaginary play levels seen in Table 5. There was no tendency for urban non-Native American children to engage in more anthropocentric play than the Native American samples.

[Table 6 about here]

Expressing relational knowledge through talk and action. The open-ended nature of the diorama task leaves room for children to express information about individual kinds (the bear, a tree), behaviors of the individuals (the eagle flying), and relations involving the elements (the turtle swimming in the pond). Based on the Unsworth et al. (2012) findings, we might predict that rural, Native American children might be more likely to enact relations in play than urban, non-Native American children. If children are using the diorama as a relevant context for realistic play we might expect relatively more animal-plant and animal-natural kind interactions for realistic play than for imaginative play. (We do not report plant-plant, plant-natural kind and natural kind-natural kind relations because they were so rare in all three samples).

The main results are summarized in Table 7. An ANOVA using as factors type of interaction (3: animal-animal, animal-plant, animal-natural kind), type of play (2: Real, Imaginary), form of play (2: Talk, Action) and community (3: rural Native American, urban Native American, urban non-Native American) revealed main effects of type of interaction ($F(2, 102) = 9.836$, MSE = .017, $p = .000$), type of play $F(2, 102) = 57.419$, MSE = .022, $p = .004$), form of play $F(1, 51) = 47.034$, MSE = .010, $p = .000$), and community $F(2, 51) = 6.886$, MSE =

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.031, p = .002), interactions between type of play and type of interaction $F(1, 51) = 16.019$, MSE = .012, p = .000), and between form of play and type of interaction $F(2, 102) = 9.511$, MSE = .004, p = .000). The 3-way interaction between type of play, form of play, and type of interaction was also reliable ($F(2, 102) = 10.658$, MSE = .004, p = .000).

The community difference we noted for overall talk and action (Menominee children enacting more of it) obviously is preserved this further breakdown. The result of primary interest is the interaction of type of interaction with type of play. For realistic play, animal-plant and animal-natural kind interactions dominate animal-animal interactions but for imaginary play these relations are reversed.

[Table 7 about here]

This pattern of findings lends additional support to the view that the diorama functioned to encourage realistic play. Nonetheless there is the lingering question of how to take into account the contributions of "chance factors" on these results. If a child picks up a cow and a gorilla any play will be coded as imaginary, but either of them interacting with a plant or a natural kind may or may not be imaginary. We now turn to a test of realistic relational play that addresses these chances factors.

In response to these puzzles concerning establishing chance levels, we developed one concrete analysis of relational play where there is a readily determinable chance level. Specifically, we examined actions involving the eagle, turtle, pond, and trees. If children placed the diorama items randomly in relationships with other kinds, then placing the eagle in a tree

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should be just as likely as placing the turtle in the tree; by the same logic, placing the turtle in the pond should be just as likely as placing the eagle in the pond. For each child we tallied the number of Habitat Typical (Eagle Tree; Turtle Pond) and Habitat Atypical (Eagle Pond; Turtle Tree) responses.

The full results are shown in Table 8 and they show the interaction between eagle versus turtle and water versus tree in all these communities. For purposes of analysis we combined eagle-tree and turtle water into "habitat typical" and eagle-water and turtle-tree into "habitat atypical" and combined talk and action into a single measure of play. An ANOVA for action, using Community (3: rural Native American, urban Native American, urban non-Native American) and Habitat (2: typical vs atypical) as factors indicated a main effect of Type of Habitat [$F(1, 51) = 18.85$, MSE = 6.59, $p = .000$) and no reliable Habitat by Community interaction ($p = .509$). The same analysis for talk also revealed a main effect of Type of Habitat [$F(1, 51) = 21.12$, MSE = 1.44, $p = .000$) and no reliable Habitat by Community interaction ($p = .430$).Young children from all three communities were more likely to produce habitat-typical than habitat-atypical responses,

[Table 8 about here]

Did Children Take the perspective of the animals? Earlier we noted that 5- to 7-year-old Menominee children were more likely than rural, European American children to take the perspective of a non-human animal when answering questions about ecological relations (Unsworth et al., 2012). At issue was whether a similar cultural difference in perspective taking would be true of preschool-aged children.

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To assess whether children's tendency to take the perspective of an animal varied as a function of community, we tallied the number of children who took the perspective of a diorama animal at any point during their play. Native American children were significantly more likely to do so than non-Native American children: 16 out of 21 rural Native American children and 14 out of 16 Urban Native American children displayed perspective taking; only 7 out of 17 urban non-Native American children did so (Chi-square = 9.14, df=2, p = 0.01).

Discussion

Overall, the results for 4-year-olds playing with a forest diorama reveal four key findings. First, the children were quite engaged with the forest diorama in both their talk and action. Their play overwhelmingly included the diorama rather than playing with single animals on their own or playing with two animals without the diorama (e.g., having two animals "play fight" with each other). The rural Native American sample (Menominee) was more engaged than the other two populations in both action and talk. The latter observation is important given the long standing notion reflected in some research that Native American children are less verbally communicative (e.g., Philips, 1992; Teeter et al., 1992; Latham & Budworth, 2006). These current findings suggest that when tasks reflect community cultural contexts, Native American children are quite verbal.

Second, children's diorama play included both realistic and imaginary talk and action. Realistic play was substantially more common than imaginary play and the relationships enacted in play were correlated with this difference. For example, imaginary play commonly involved animal-animal interactions while realistic play more commonly included animal-plant and

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animal-natural kind relationships. One should be cautious in interpreting the Menominee children's greater tendency to engage in realistic relational play. It may reflect engagement with the diorama but it might also, in part, reflect their knowledge about relationships that occur in forest ecosystems for the animals and trees we selected for the study.

Third, children from all three samples of 4-year olds reliably enacted realistic ecological relations. It is difficult to determine what "chance levels" of realistic play might be or what might be considered as a "baseline" for ecological play. In practice, we compared turtle-water versus turtle-tree play in relation to eagle-water versus eagle-tree relationships. We found that for both talk and action, play involving a typical habitat was reliably greater than play involving an atypical habitat for all three samples.

Fourth, perhaps the most interesting cultural difference was in perspective taking. Native American (both rural and urban) 4-year-olds were almost twice as likely as non-Native American children to engage in perspective taking at least once. The direction of this difference converges with the Unsworth et al. (2012) finding that rural Native American 5-to 7-year-olds were more likely than rural non-Native American 5-to 7-year- olds to spontaneously take the perspective of animals on a task probing knowledge about ecological relationships.

In some respects our results are most striking for what we did not observe. Consider the forms of play that might have been dominant. Many children are accustomed to playing with single objects in the absence of any relevant context. Nothing prevented the children from just picking up an animal and playing with it by itself. Similarly, the children readily could have

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picked up two animals, treated them as surrogates for humans (as many children's books do) and engaged in human-related talk and action. But these patterns were very uncommon.

Previous work interpreted as showing ecological knowledge found that young children prefer pictures not showing pollution to those do show sources of pollution (Cohen & Hom-Wingerd, 1993). To our knowledge, our diorama observations represent the first clear evidence that 4-year-old children take into account ecological (habitat) relationships in play. These results held across our rural Native American, urban Native American, and urban non-Native American samples.

With respect to sample differences, the most consistent pattern was that the rural Native American (Menominee) children were more engaged with the diorama in both talk and action, even after adjusting for total time of play. Menominee children's relational play also tended to be more realistic than the relational play in our other two samples. It is also interesting that both of our Native American samples talked as much or more than our urban non-Native American sample in the context of diorama play. It should not come as a surprise that children's talk varies with context and we may have observed more talk with our Native American 4-year-olds because the diorama represented an engaging, relevant context for them.

Note also that realistic play was dominant even though our diorama was not accurately scaled (e.g., the turtle and eagle were large compared with the other animals). The animals were also large relative to the trees and this may have limited both children's play and our interpretation of it. The deer was about half the size of the trees, but even so we were able to

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distinguish between a deer interacting with a tree in a realistic way (eating, rubbing or scraping) versus an unrealistic way (being at the top of the tree).

There are a number of ways to deepen and extend these initial observations. One is to look at parent-child dyads interacting together with the diorama. Analyses of dyads from our three sample groups are currently under way. Another key extension would be to include human beings in our forest diorama. In the work presented here, we did not include humans; this was an intentional decision, chosen to conform to the implicit assumption that in at least some communities, humans are not considered a part of ecosystems (Medin & Bang, 2014). In future work it would be interesting to both add humans as potential actors and to include human artifacts (e.g., a house, a road) as part of the diorama. It is possible that the "rules for play" change when humans are introduced, though in related work we find that Native American adults think of humans as a part of nature (Bang et al., 2007).

Finally these results raise important questions about the forms of play and early science learning that are designed in early childhood learning environments. Increasing opportunities for children to engage in realistic ecological play may affect the kinds of early science learning that occurs. Many early childhood classrooms include plastic toy animals. When children begin to learn about the biological world, it may matter whether or the biological kinds they play with have been abstracted from natural settings like the diorama represents. Taking away context may encourage taxonomic over ecological thought. The development of ecological reasoning is increasingly a goal in K-2 science education. Evolving the forms of play in early childhood

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towards realistic ecological play could be an important innovation in early childhood science education.

Conclusion

By considering children's open-ended interactions with a 3-dimensional forest diorama, we were able to ask, for the first time, whether children's exploratory play was correlated with cultural community or potential expertise differences. In that regard our results are more notable for their similarities across samples than their differences. All three samples showed close engagement with the diorama in both talk and action and forms of play that indicate knowledge of ecological relationships. The closest to an exception was the greater overall engagement by rural Menominee four-year-olds than by the urban samples and the greater degree of perspective taking by the Native American children. We hope that our present results provide encouragement for further research on children's exploration of representations of natural scenes and ecological cognition more broadly.

[1] Note that this definition of imaginary play also is potentially limited in that it implicitly assumes that children know which animals are found together (see Strommen, 1995 for some evidence to the contrary). This means that there is some possibility that children may be conceptualizing their play as realistic (whatever that might entail) but it would be scored as imaginary. If this situation arises substantially more often for urban non-Native American children then they might show what appears to be relatively more imaginary play.

Table 1. Complete list of objects represented in the diorama

moveable		fixed	
Animals	Trees	Trees	Other
bear	deciduous (2)	deciduous	pond
deer	evergreen (2)	evergreen	logs
eagle			rocks
turtle			
cow			
gorilla			
zebra			

Table 2. Sample coding scenarios

Code	Input: A child puts the turtle in the pond and says, “the turtle is in the pond."	A child puts the turtle in the tree and says nothing.	A child has the turtle swim in the pond, while saying, "I like to swim!"
Turtle	Talk, Action	Action	Action, Perspective
Water	Talk, Action		Action
Tree		Action	
Behavior realistic			Turtle-action
Behavior imaginary			
Relations realistic	Animal-NK for Talk and Action		Animal-NK for Action
Relations imaginary		Animal-Plant for Action	

Table 3. Number of Talk and Action codes per time segment for each community

	Talk Codes	Action Codes	mean
rural Native	3.14	5.69	4.42
urban Native	2.19	4.57	3.38
urban non-Native	2.10	4.37	3.24

Table 4. Mean Talk and Action codes per time segment for each moveable item by community.

Talk

	Bear	Deer	Eagle	Turtle	**Native mean**	Cow	Zebra	Gorilla	**Non-native mean**	Deciduous	Evergreen
rural Native	0.18	0.21	0.23	0.18	**0.20**	0.15	0.14	0.21	**0.18**	0.12	0.21
urban Native	0.15	0.17	0.18	0.17	**0.17**	0.19	0.16	0.15	**0.15**	0.13	0.09
urban non-Native	0.16	0.15	0.15	0.15	**0.15**	0.11	0.11	0.08	**0.09**	0.17	0.12
mean	0.17	0.18	0.19	0.17	**0.17**	0.15	0.13	0.15	**0.14**	0.14	0.15

Action

	Bear	Deer	Eagle	Turtle	**Native mean**	Cow	Zebra	Gorilla	**Non-native mean**	Deciduous	Evergreen
rural Native	0.32	0.37	0.37	0.29	**0.34**	0.30	0.32	0.36	**0.34**	0.22	0.46
urban Native	0.31	0.37	0.33	0.33	**0.33**	0.35	0.39	0.27	**0.33**	0.41	0.35
urban non-Native	0.27	0.33	0.33	0.24	**0.29**	0.27	0.32	0.23	**0.28**	0.52	0.41
mean	0.30	0.36	0.35	0.29	**0.32**	0.31	0.34	0.30	**0.32**	0.37	0.41

Table 5. Mean instances of realistic and imaginary play per time segment in each community

Talk	Realistic	Imaginary	Action	Realistic	Imaginary
rural Native	0.80	0.43	rural Native	1.42	0.76
urban Native	0.37	0.22	urban Native	0.67	0.45
urban non-Native	0.44	0.33	urban non-Native	0.66	0.44
mean	0.56	0.34	mean	0.96	0.57

Table 6. Mean attribution of human talk and activity per time segment to animals for each community

	Talk	Action
rural Native	0.06	0.05
urban Native	0.02	0.01
urban non-Native	0.04	0.01
mean	0.04	0.03

Table 7. Mean Realistic and Imaginary Animal Interactions per time segment for each community.

Talk

	realistic			imaginary		
	animal	plant	natural kind	animal	plant	natural kind
rural Native	0.05	0.17	0.14	0.13	0.06	0.01
urban Native	0.01	0.09	0.08	0.07	0.04	0.00
urban non-Native	0.01	0.10	0.07	0.10	0.05	0.01
mean	0.03	0.12	0.10	0.10	0.05	0.01

Action

	realistic			imaginary		
	animal	plant	natural kind	animal	plant	natural kind
rural Native	0.07	0.31	0.22	0.19	0.15	0.03
urban Native	0.02	0.17	0.16	0.14	0.08	0.01
urban non-Native	0.02	0.17	0.13	0.13	0.13	0.01
mean	0.04	0.22	0.18	0.16	0.12	0.02

Table 8. Typical and atypical ecological relationships for talk and for action

Talk

	Typical			Atypical		
	Eagle Tree	Turtle Water	Total	Eagle Water	Turtle Tree	Total
rural Native	0.76	0.95	1.71	0.52	0.52	1.04
urban Native	0.44	0.94	1.38	0.13	0.06	0.19
urban non-Native	1.00	0.65	1.65	0.06	0.24	0.30
Mean	0.74	0.85	1.59	0.26	0.30	0.56

Action

	Typical			Atypical		
	Eagle Tree	Turtle Water	Total	Eagle Water	Turtle Tree	Total
rural Native	2.38	1.67	4.05	1.19	1.48	2.67
urban Native	1.69	1.63	3.32	0.25	0.38	0.63
urban non-Native	2.53	1.41	3.94	0.35	1.18	1.53
Mean	2.22	1.57	3.79	0.65	1.06	1.71

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