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### Epistemologies in the Text of Children's Books: Native- and non-Native-authored books

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# Epistemologies in the Text of Children's Books: Native- and non-Native-authored books

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An examination of artifacts provides insights into the goals, practices, and orientations of the persons and cultures who created them. Here, we analyze storybook texts, artifacts that are a part of many children's lives. We examine the stories in books targeted for 4–8-year-old children, contrasting the texts generated by Native American authors versus popular non-Native authors. We focus specifically on the implicit and explicit 'epistemological orientations' associated with relations between human beings and the rest of nature. Native authors were significantly more likely than non-Native authors to describe humans and the rest of nature as psychologically close and embedded in relationships. This pattern converges well with evidence from a behavioral task in which we probed Native (from urban inter-tribal and rural communities) and non-Native children's and adults' attention to ecological relations. We discuss the implications of these differences for environmental cognition and science learning.

**Keywords:** *Cultural artifacts; Early childhood cognition; Epistemology; Children's books; Science education; Native American*

## Introduction

Storybooks are a part of many children's lives. When children enter school, the prevalence of books increases and they become a tool highly relied upon for learning. As early as 15 months of age, infants are able to learn novel words from pictures of objects and extend them to objects; they also successfully extend a novel word,

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introduced with an object, to a picture of that object (Ganea, Bloom-Pickard, & DeLoache, 2008; Geraghty, Waxman, & Gelman, 2011). Therefore, it is not surprising that educational and social scientists have paid considerable attention to the content in children's books (Fletcher & Rees, 2005; Mar & Oatley, 2008) and that the role of early childhood cognition in early literacy development is a robust field of study. Literacy scholars have developed theories and evidence-based claims about the structures for books that most effectively support literacy (Pappas, 1986; Poulsen, Kintsch, Kintsch, & Premack, 1979; Reutzel & Fawson, 1991). Moreover, recent evidence reveals that even preschool-aged children learn biological information from children's books and extend it to their reasoning about real situations involving living animals (Ganea, Ma, & DeLoache, 2011). Young children are also able to learn science vocabulary when they engage in joint book reading (Gonzalez et al., 2011).

Children's books are also cultural artifacts. There is now substantial evidence that cultural products both reflect and affect cultural orientations (Morling & Lamoreaux, 2008). There is a long history of scholarship which argues that artifacts—tools—are critical mediators of thought (for an overview see Cole & Engström, 1993). Cultural–historical theorists view cultural artifacts as both material and symbolic (language being the master tool in this view) and theorize that they mediate interactions with one's environment and oneself (Cole & Engström, 1993, p. 9). Empirical work on this topic permits educators and researchers alike to identify cultural differences and to examine the role of cultural artifacts in maintaining them.

There is increasing evidence that media (including children's books) often reflect cultural differences in conceptual organization and preferred styles of cognitive processing. For example, Tsai, Miao, Seppala, Yeung, and Fung (2007) reported that popular storybooks from the USA were more likely than those from Taiwan to depict characters in excited (versus calm) states. They also found that across cultures, presenting exciting (versus calm) storybooks influenced children's activity preferences and perceptions of happiness.

Masuda, Gonzalez, Kwan, and Nisbett (2008) reported cultural differences (Japanese versus American) in the psychological distance, inclusion of context, and individuals' preferences in paintings and photographs. These findings converge with evidence that Japanese college students attend more to context and relationships than do their American counterparts (Masuda & Nisbett, 2001, 2006) and with cultural differences in individuals' tendencies to spontaneously adopt another person's point of view (Leung & Cohen, 2007; Wu & Keysar, 2007).

In the current study, we examine children's books to see if cultural differences between Native American and European American samples are evident in the text of children's books. Our goal is to examine the content of the stories in children's books in an effort to discover which *epistemological orientations* are embedded within them. Why might this investigation matter for science education? The use of literature from diverse cultures in schools is a well-rehearsed need, as are empirical studies that demonstrate cultural differences in narrative patterns (Heath, 1983). The present study demonstrates that there are important differences in portrayals of the natural world and the relationships of humans to it in children's literature.

*Epistemological Orientations*

Attention to context and relationships, perspective taking, and psychological distance are basic components of both observation and the determination of what is relevant. For the past decade or so, our research team has focused on the role of culture, cultural practices, and related epistemological orientations in the development of knowledge of and reasoning about the natural world (Bang, Warren, Rosebery, & Medin, 2012; Herrmann, Waxman, & Medin, 2010; Medin & Bang, 2013; Wolff, Medin, & Pankratz, 1999). The phrase 'epistemological orientation' has been used in closely related but varying ways in philosophy, anthropology (Bird-David, 1999; Ingold, 1999), and education (Hammer, 1994; Hammer & Elby, 2003).

We use epistemological orientations to refer to decisions, processes, and practices that determine what phenomena are worthy of attention and in need of explanation as well as the associated practices that influence the nature of observation, the kinds of hypothesis that are likely to be considered and notions of what constitutes a satisfactory explanation. Epistemology also transparently encompasses a number of science-related practices. In brief, we see the cultural differences reviewed above as reflecting differences in epistemological orientations. Before describing our application of this framework to the analysis of children's books, we first review and discuss related work.

*Native American Communities in Research*

In our own work, we have focused specifically on epistemologies and knowledge in two Native American communities in the Midwest of the USA. One is an inter-tribal community in Chicago and the other is the Menominee Tribe of Wisconsin. Our work is informed by an understanding of appropriate research methods for working with American Indian communities. There is a long history of research in American Indian communities that has often not been in their best interest, a legacy that has made many Native communities suspect of research. Over the years Indigenous researchers themselves have worked to develop appropriate research methods and criteria (Archibald, 2006; Battiste & Henderson, 2000; Hermes, 1999, Kovach, 2010; Mihesuah, 1998; Smith, 1999; Wilson, 2009) that we strived to incorporate into our methods.

Our project is a collaborative effort involving the American Indian Center of Chicago, various institutions on the Menominee reservation in Wisconsin, including the Menominee tribal school and the Menominee Language and Culture Commission, Northwestern University, and the University of Washington (Bang & Medin, 2010). The current project emerges from a much larger 'community-based design research' project in the Chicago inter-tribal Indian community and the Menominee reservation community.

In our previous, related work on culture and relationships with nature we have found that Native American child and adult participants are more likely to adopt the perspective of non-human animals and are more likely to favor a relational,

ecological conceptual organization over a taxonomic conceptual organization than are European American participants (Medin, Ross, & Cox, 2006; Unsworth et al., 2012).

More generally our focus has been on implicit and explicit cultural practices that reflect and likely support epistemological orientations toward the natural world. For example, Bang, Medin, and Atran (2007) reported that (1) urban and rural Native American children and adults are more likely than their rural European American counterparts to engage in outdoor practices in which nature is foregrounded (e.g. forest walks and berry picking) and less likely to engage in practices in which nature is backgrounded (e.g. playing baseball), (2) rural European American parents and grandparents say they want their children (grandchildren) to respect nature and take care of it; in contrast, urban and rural Native American parents and grandparents emphasize that they want children to realize that they are a part of nature, and (3) when asked to tell a story about a recent or memorable time fishing European American adults mention the goal (fish caught) on a median of the 27th word; in contrast, urban and rural Native American adults are more likely to provide background information, describe relationships, and mention the goal on an median of the 83rd word. In further related work (Unsworth et al., 2012), we interviewed 5–7-year-old rural Native American Menominee and European American children about species relations (both animal/animal and animal/plant relations). Menominee children are reliably more likely than European American children to talk about ecological relationships, to mimic the sounds of non-human species, and to talk about personal utility associated with nature. Both groups are equally likely to mention animal–animal and animal–plant food chain relations, but Menominee children are reliably more likely to mention relationships between biological kinds and natural inanimates (e.g. water, sun, and soil). Overall, Native American participants are more likely than European American groups to take a relational/ecological perspective where humans are a part of rather than apart from nature.

Given that there are more than 560 federally recognized tribes, it would be speculative to claim that these results will hold for all Native American samples who live in very diverse cultural and environmental contexts. At the same time, our findings accord well with scholarly writings about Native versus Western Science (Cajete, 1999; Pierotti, 2010).

#### *Native Epistemological Orientations: Relationships Matter*

Native scholars have argued that Indigenous thought is foundationally based on constructions and meanings of relationships (Cajete, 1999; Kawagley, 2006; Pierotti, 2010). A body of work on ecological knowledge organization and reasoning patterns among Indigenous populations in Guatemala and the USA is consistent with these ideas (Atran & Medin, 2008; Bang et al., 2007). Our ongoing investigations of the texts and illustrations in children's books reveal that Native illustrations are reliably more likely than European Americans to show scenes as psychologically close and more likely to use devices to invite the reader to take an actor's perspective (often

an animal's) and to pay attention to the context (Libby, Shaeffer, & Eibach, 2009; Libby, Shaeffer, Eibach, & Slemmer, 2007; Lozano, Hard, & Tversky, 2008; Tversky & Hard, 2009). These outcomes converge well with the Masuda and Nisbett results mentioned earlier.

### *Identifying Epistemological Orientations in the Text of Children's Books*

In this project, we are not looking at books, from either source, as science texts, per se. Rather, we look at the text in the books to identify whether, and in what ways, the stories presented to young children from different communities themselves tell (children) different 'stories' about nature and orientations to nature. The books that we selected provide a window into informal science learning, not curriculum-based instruction. We ask if Native American stories differ from European American stories and in what ways. We then consider, how these different kinds of stories might differentially shape/influence children's thinking/reasoning/feeling about the natural world.

In preliminary attempts to assess relational orientations, we employed a coding scheme that required raters to make judgments about units of text of a sentence or longer, but establishing inter-rater reliability proved to be an intractable problem. Therefore, we decided to accept a tradeoff between richness of content and reliability by shifting the focus to individual words. In this paper, we report two measures based on word count. We describe both coding schemes and the predictions we derived for them in our 'Methods' section.

## **Materials and Methods**

### *Book Selection*

The selection of books for this project was challenging because of the systematic and deep under-representation of Native-authored children's books and the ways in which children's literature selections have been shown to privilege white authors in mainstream entities (Kurz, 2012; McNair, 2008). The few studies on trade books and science education selected books from the National Science Teachers Association list of Outstanding Science Trade Books, and the American Library Association's Choices lists (Rearden & Broemmel, 2008; Smolkin, McTigue, Donovan, & Coleman, 2008). Other researchers interested in the accessibility of books to teachers and children selected books from public libraries (Ford, 2006; Schroeder, Mckeough, Graham, Stock, & Bisanz, 2009). In selecting a sample of books for analysis, we sought those that were accessible to young children and their families in Native and non-Native communities and were written by Native American authors. Our research team has focused on young children's science learning with everyday artifacts and their interactions in non-school settings; for this reason, we did not select books that were explicitly about science. Unlike other studies we are not looking at books (from either source) as science texts, per se. Rather, we are interested in whether

the discourse or narrative in storybooks that are accessible to young children from different communities vary in orientations to nature. The books that we selected provide a window into informal science learning, not curriculum-based instruction.

### *Sampling Procedure*

For the non-Native authored and illustrated books, we first sampled the 65 highest selling children's books listed on Amazon.com. For the Native books, we sampled from the Native-authored books recommended at Oyate.com, a website of a Native-operated literacy organization whose efficacy is supported by research (Taylor & Patterson, 2000). We started with 80 books, aiming for books representing a wide range of tribes. Of course, we necessarily ended up with a modest subset of the more than 560 federally recognized tribes and the more than 100 tribes that are either state recognized or unrecognized. From this larger sample of candidate books, we selected a subset for this study, based on several criteria. We selected books that (a) included both illustrations and narrative or text, (b) were targeted at 4–8-year-old children, (c) included non-human animals, and (d) excluded self-help books, counting and naming books, 'science' books or non-fiction intentionally early science books, and special occasion, seasonal, or holiday books. We avoided having more than two books by any given author. The final set included 44 Native- and 44 non-Native-authored books by 35 different Native authors and 41 different non-Native authors. See Appendix 1 for a complete list of books used in our analysis.

It is important to note again that, although we refer to Native- and non-Native American-authored books, we recognize that this collapses significant cultural and historical experiences among distinct tribal nations and distinct non-Native groups. However, we believe that there are shared implicit epistemic dimensions across Native nations (as Pierotti, 2010 argues). Our goal in doing so is to focus on a grain size that neither minimizes these important differences nor makes claims that require it.

### *Coding Categories and Associated Predictions*

The studies reviewed in the introduction to this paper support the idea that Native American children and adults have a relational orientation toward the rest of nature and view themselves as a part of nature rather than apart from it. Our focus in this research was on word categories that might reflect and maintain this relational epistemology. Our general prediction is that Native-authored books will have a higher frequency for these categories than books not authored by Native Americans. In that regard our focus is somewhat asymmetrical and we do not attempt to specify a non-Native epistemology other than by contrast with a Native one. Our predictions focus on the dimensions of context, relations, kinds, and processes.

We report on the analysis of two coding scheme measures based on word count. The first is the Linguistic Inquiry and Word Count (LIWC; Tausczik & Pennebaker, 2010). The LIWC employs different categories of words (e.g. pronouns, past tense,



and cause) and returns a frequency count for each category. These categories have proven to be useful in social psychology (Pennebaker, 2011) but they were not developed with epistemologies in mind. Nonetheless for our initial analysis, we adapted this categorization scheme to our purposes.

The complete list of predictions to capture anticipated differences in epistemological orientation for both the LIWC categories and our derived categories is summarized in Table 1. Whenever we could make a straightforward connection between LIWC categories and a relational epistemological orientation, we relied on LIWC. For example, our studies of Indigenous scholarship suggest that Native texts should be more likely to establish context. Two ways of doing so are to give background information, which often requires the use of *Past tense* and to describe relations by using (primarily spatial) *Prepositions*. Hence, several of the LIWC categories were relevant and appropriate. For example, a straightforward prediction is that Native text would focus more on relationships, which should lead to greater use of *Kin terms* (especially words related to extended family), even for non-human actors.

We then developed a novel coding scheme for a secondary, more in-depth analysis. Building on our previous work, we created a number of new categories that could be connected to epistemological orientations. We followed the LIWC practice of allowing a given word to appear in more than one category. In addition to context and relationships, we predicted that Native-authored books would be more likely to include (1) a wider range of living kinds (plants and animals) and natural kinds (e.g. rocks and water) and (2) a focus on cycles and events. To develop these independent categories we compiled a list of all the words in the books of each group. In Stage 1 of the category development, three research assistants went through the list independently, identifying the words that fell into the following categories: natural inanimate, non-human animal, plant, and primary (nuclear family) and secondary kin terms. For natural events and cycles categories, two research assistants went through the list to select exemplars. There was very high agreement, and minor inconsistencies

Table 1. Predictions for anticipated differences in Native epistemological orientation

Category	Example terms
Past (LIWC)	Went, ran, and had
Cause (LIWC)	Because, effect, and hence
Prepositions (LIWC)	To, with, and above
Natural inanimate	Rock, bay, and ice
Kin terms-second order	Aunt, uncle, and grandmother
Natural events	Blaze, downpour, and sunset
Cycles-seasons	Spring, summer, and winter
Cycles-birth-death	Birth, and death
Native animals	Ant, crow, and bullfrog
Plants	Tree, alder, and rose

Note: In each case, the predictions are that the category will be more frequent for Native books than for non-Native books.

between the coders were resolved after discussion. In Stage 2, the wordlist for each group and its corresponding category assignments were merged. The complete list of words we used for our categories is given in Appendix 2. We then developed predictions from these lists (Table 1).

One of the selection requirements for our sample of books was that animals be included in them. For animal terms, we examined those that appeared at least once in the 88 books and classified them as Native (to North America), domestic, or exotic. Most ambiguous cases (e.g. bunny and goat) were treated as Native, though horse and pig were considered domestic, even though wild horses and wild pigs are found in North America. None of the results hinge on decisions made concerning these borderline cases. Given the importance of local context, however, we predicted that Native books would be more likely to mention non-exotic, non-domestic animals—that is, *Native animals* (Native to North America). We also expected that Native books would be more likely to mention birds, fish, and snakes at the genus level than at the lifeform level (e.g. ‘robin’ rather than ‘bird’, ‘salmon’ rather than ‘fish’, and ‘rattlesnake’ rather than ‘snake’). Note that lifeform terms can refer to Native, exotic, or domestic species.

In the case of *Kin terms*, we drew a distinction between first order or nuclear family terms such as brother and mother and second order or extended family kin terms such as grandmother and uncle. We expected that cultural differences in second-order kin terms would be especially pronounced, favoring greater frequency in Native-authored books. In the next few paragraphs, we describe other categories we employed and the rationale for them.

One key aspect of epistemologies is their explicit assumptions about what is worthy of attention and given attention, and how abstractly what is being attended to is described. One can call attention to an individual by mentioning a ‘person’, a ‘relative’, an ‘aunt’, or even ‘Aunt Florence’. For example, in Native books, we expected that the text would be more likely to mention *Natural inanimates* (e.g. ‘sun’, ‘moon’, ‘rocks’, ‘mountain’, and ‘ground’), more likely to mention *plants* (e.g. ‘bush’, ‘grass’, ‘cedar’, and ‘cactus’), and to name them more specifically (e.g. ‘pine tree’ rather than ‘tree’). In short, naming, and using more specific levels of categorization when doing so, elevates attention to objects and events.

Additional categories were created corresponding to *Processes and events in nature* (e.g. rain, snow, fire, wind, sunrise, sunset, birth, and death) and *Cycles and seasons* (summer, winter, spring, fall, birth, and death). Based on previous findings that Native American are more likely to reason ecologically and attend to processes, cycles and events in nature we predicted that Native books would have more words falling into these categories.

Given the focus on processes, we also predicted that Native books would have more examples of the LIWC category, *Cause*. This prediction was based on examining the individual words that LIWC assigns to this category, which often link entities and events (e.g. ‘because’, ‘when’, ‘while’, ‘again’, and ‘hence’) or describe ongoing activities (e.g. ‘was VERB-ing’).

*Processing Text*

We first extracted the text of each book into a separate file. There are a variety of ways to process text, many of which require judgment and interpretation on the part of the coder and therefore present a challenge to establishing reliability. To avoid these potential problems, all of our analyses were at the level of individual words, in which using LIWC or a program written by the first author, we performed automated word counts on each document, and assigned the words in the documents to specific linguistic categories. Therefore, human coding reliability is not an issue. The default dictionary of LIWC2007 includes 4,500 words that make up its 76 different linguistic categories. The software program written by the first author used the categories our research team developed rather than LIWC linguistic categories. The output of both programs for a document (the extracted book text) is the total number of words in each category normalized by the total number of words in the document. For purposes of statistical analysis, we followed the conservative strategy of treating each book as an individual.

**Results**

First, we report the results from LIWC and then from our derived categories for the predictions summarized in Table 1. Then, we consider their relevance to Native versus non-Native epistemological orientations.

The results of our analysis are summarized in Table 2. For LIWC categories, as predicted, words in several categories were more frequent in Native than non-Native storybooks: *Cause*,  $t(86) = 2.038$ ,  $p = 0.045$ ; *Past tense*,  $t(86) = 2.692$ ,  $p = 0.008$ ; and *Prepositions*,  $t(86) = 2.076$ ,  $p = 0.041$ .

In other LIWC categories that we did not have a priori predictions for, non-Native books used words in the following categories more frequently: *You*,  $t(86) = 2.914$ ,  $p = 0.005$ ; *Home*,  $t(86) = 2.254$ ,  $p = 0.0267$ ; *Question mark*,  $t(86) = 2.398$ ,  $p = 0.019$ ;

Table 2. Results for LIWC and non-LIWC categories

Category	Native storybooks		Non-Native storybooks	
	Mean	SD	Mean	SD
Past (LIWC)	6.216	3.104	4.285	3.608
Cause (LIWC)	1.155	1.064	0.758	0.762
Prepositions (LIWC)	12.607	1.510	11.470	3.305
Natural inanimate	4.213	2.049	2.519	2.272
Kin terms-second order	0.242	0.512	0.041	0.119
Natural events	0.334	0.537	0.091	0.190
Cycles-seasons	0.262	0.487	0.010	0.050
Cycles-birth-death	0.010	0.032	0.000	0.003
Native animals	2.066	2.031	1.180	2.040
Plants	0.839	1.094	0.391	0.767

Table 3. Ratio of specific animal/plant terms to lifeform terms

Category	Native storybooks		Non-Native storybooks	
	Mean	SD	Mean	SD
Animals	2.663	3.320	1.008	1.171
Plants	0.878	0.999	0.206	0.475

and *Apostrophe*,  $t(86) = 2.086, p = 0.040$ . As we anticipated based on the Tsai et al. study, word count for *exclamation points*,  $t(86) = 2.799, p = 0.006$ , were higher for non-Native books than Native book. There also was a higher frequency of use of words in the *Food*,  $t(86) = 2.297, p = 0.024$ , and *Human artifact*,  $t(86) = 3.264, p = 0.002$  categories in the non-Native books. Native books also had higher word count in the LIWC *Word > 6 Letters*,  $t(86) = 2.28, p = 0.028$ , and *They*,  $t(86) = 3.667, p < 0.001$ , categories. One must use caution in interpreting these differences as often the category labels may give a misleading picture of the words comprising the category. For example, the category *Home* mainly consists of artifacts.

For categories that we developed around notions of relational epistemologies, as predicted, words in the following categories were more frequent in Native than non-Native storybooks: *Natural Inanimate*,  $t(86) = 3.666, p < 0.001$ ; *Natural events*,  $t(86) = 2.834, p = 0.006$ ; *Cycles-birth-death*,  $t(86) = 1.971, p = 0.052$ ; *Cycles-seasons* (spring, summer, and winter),  $t(86) = 3.417, p = 0.001$ ; *Plants*,  $t(86) = 2.224, p = 0.029$ ; and *Native animals*,  $t(86) = 2.041, p = 0.044$ . Non-Native books had a (marginally) higher word count in the *Domestic animal* category  $t(86) = 1.672, p = 0.098$ . There was no significant difference for *Kin terms-first degree* between the two groups,  $t(86) = 0.778, p = 0.438$ . However, Native books used *Kin terms-second-degree* terms significantly more often than non-Native books,  $t(86) = 2.25, p = 0.013$ .

We also identified another difference, one relating to the level of specificity with which natural kinds are described in Native and non-Native children’s books. Table 3 shows the ratio of frequency of specific animal type terms (e.g. trout) to lifeform terms (e.g. fish). We found that the Native books use more specific terms than did non-Native books when mentioning both animals,  $t(86) = 3.119, p = 0.002$  and plants,  $t(86) = 4.031, p < 0.001$ .

**Discussion and Conclusions**

The current results document that cultural differences in epistemological orientations of Native Americans and European Americans are evident in the children’s books in Native- and non-Native-authored books. We identified differences along four main dimensions: context, relations, kinds, and processes. First, we found that Native storybooks are more likely to use words that are related to establishing context (past tense and prepositions). The difference in past tense in Native-authored

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children's books suggests that these books shape attentional focus on 'past' or may connect 'past' with present more than the non-Native books.

The second major set of findings is that Native books offered greater depth and breadth of information about the natural world. Native books were reliably more likely than non-Native books to mention *Natural Inanimates*, *Animals*, and *Plants*. When mentioning animals, Native books were more likely to name Native species than domestic or exotic species. Furthermore, when animals and plants were mentioned, they were given more specific category labels (*trout* rather than *fish*). Overall, Native storybooks provided a wider range of kinds as well as more specificity of the kinds that were named.

Third, we observed clear differences in the kinds of references made to humans. Native books were more likely than non-Native books to mention *second-degree Kin terms*. This outcome likely reflects Native Americans' inter-generational focus, respect for elders, and more generally, a greater focus on relationships.

A fourth important set of findings focused on processes and events. Native-authored books focused to a greater extent than non-Native-authored books on terms linking entities to events (cause). More specifically, as predicted, Native storybooks mentioned natural processes and events more and paid greater attention to seasons and cycles in nature. Overall, these analyses of text show that, with respect to engagement with the natural world, Native storybooks are more intimately engaged with the rest of nature than non-Native books.

One way of conceptualizing our results is to frame them less as an attempt to determine what ideas a group or culture has, than as an effort to see what groups or cultures a set of idea has. The former invites a focus on population parameters and the prevalence of these sorts of ideas within a culture. The latter sees cultural contexts as fertile ground where ideas may thrive and be supported. In our work, we have consistently found that certain sets of ideas and practices (which we gloss as a relational, psychologically close link between humans and the rest of nature) are associated especially strongly with Native American participants. To be sure, there likely are identifiable subsets or samples of European Americans that also have a relational orientation.

The significant differences across the four main dimensions of differences examined here further specify relational ideas and practices noted in other studies and extend them to artifacts—in this case children's books. We suggest that the dimensions of a relational epistemology we have described may affect the degree and form of engagement of students with science and promote scientific literacy. Pearson, Moje, and Greenleaf (2010) recently noted that there have been two dominant approaches for understanding scientific literacy: (1) a broad focus on the content of science in the form of familiarity with key concepts, principles, and ways of thinking and (2) the explicit connection between the language of science, peoples' engagement with various scientific texts and representations, and the resulting knowledge. They argue that much of the work from this second point of view focuses on the need to help students develop proficiencies for making meaning with texts—oral and written language representations—that are parts of the overall construction of scientific knowledge and public discourse.

Currently, there is very little direct science instruction in preschool classrooms. Instead, children are exposed to different natural phenomena in informal ways. For example, teachers often use jello-making as a science activity (to highlight changes in physical state) but children may see the activity as just making jello. Increasingly, researchers, educators, and parents are looking for innovative instructional tools to support science learning across settings. While both science textbooks and story books have been criticized for the presence of embedded misconceptions and anthropocentric relationships within both text and images, a number of researchers contend that with appropriate supports storybooks may provide opportunities to both introduce scientific concepts and vocabulary (Peterson & French, 2008; Sackes, Trundle, & Flevaris, 2009), to promote a love of place and nature (Wason-Ellam, 2010), and to help young learners become familiar with the discourse of science, including causal explanations (Smolkin et al., 2008). In short, trade books may be an important resource for inquiry-science, though additional classroom research is needed to establish how this resource may be expressed.

To build effective curricula, it is essential that we know what knowledge, assumptions and systems of organization artifacts convey. Repeated exposure to different artifacts may shape attentional focus and expectations, not only about the content but also on the structure of that content. Native storybooks embody more complex and intimate attention to animals, plants, and natural kinds, correlated with events and processes as well as human relationships interwoven with them. These ideas form coherent clusters that guide observation and support attention to relationships, which are important science-related practices. Importantly, they are not inseparably bound to Native American cultural settings but consist of ways of positioning readers that could be readily transported to other contexts and student populations. The inclusion of Native-authored storybooks in elementary science inquiry units could foster the development of relational thinking about the natural world, regardless of a child's background.

As previously mentioned, epistemological orientations shape what people attend to and can consequently influence science learning. Given this, we speculate that the epistemological orientations embedded within the text of storybooks may influence young children's scientific thinking including the kind and quality of explanations they generate. The next logical step in pursuing the suggestion that epistemologies embedded in text can affect science learning is to create two parallel sets of materials, one embodying text categories associated with relational epistemologies and the other not, and then assess the cognitive and motivational consequences of exposure to the same content with the two differing genres. We are currently pursuing this step.

Our findings suggest a new way to conceptualize the ways in which texts and representations shape meaning-making. Children's storybooks figure centrally in current configurations of schooling in which children develop narratives and explanations about perceived events in nature. Just as children's storybooks are cultural artifacts, with epistemological orientations embedded in them, so are they mediators of knowledge, shaping children's attentional focus, and exposing them to particular explanatory or narrative forms about the natural world. Native storybooks may

shape attention to the natural world in productive ways for science learning because they call attention to complex natural events, process, and relationships.

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**Appendix 1. Books Used**


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Non-Native books	Author
Alexander and the Terrible, Horrible, No Good, Very Bad Day	Judith Viorst
Big Words For Little People	Jamie Lee Curtis
Blueberry Girl	Neil Gaiman
Brown Bear, Brown Bear, What Do You See?	Bill Martin
Caps for Sale	Esphyr Slobodkina
Cars and Trucks and Things That Go	Richard Scarry
Cloudy With a Chance of Meatballs	Judi Barrett
Corduroy	Don Freeman
The Country Bunny and the Little Gold Shoes	Dubose Heyward
Don't Let the Pigeon Drive the Bus	Mo Willems
Everyone Poops	Taro Gomi
First the Egg	Laura Vaccaro
From Caterpillar to Butterfly	Deborah Heiligman
The Giving Tree	Shel Silverstein
Goodnight Moon	Margaret Wise Brown
The Grouchy Ladybug	Eric Carle
Harold and the Purple Crayon	Crockett Johnson
The House in the Night	Susan Marie Swanson
If You Give a Cat a Cupcake	Laura Numeroff
The Kissing Hand	Audrey Penn
Knuffle Bunny	Mo Willems
The Little Mouse, the Red Ripe Strawberry and the Big Hungry Bear	Don Wood
Llama Llama Misses Mama	Anna Dewdney
Llama Llama Red Pajama	Anna Dewdney
Love You Forever	Robert N Munsch
Make Way for Ducklings	Robert McCloskey
The Monster at the End of this Book	Jon Stone
Oh, the Places You'll Go!	Dr. Seuss
Olivia	Ian Falconer
On the Night You Were Born	Nancy Tillman
One Fish Two Fish Red Fish Blue Fish	Dr. Seuss
The Paper Bag Princess	Robert N Munsch
Purplicious	Victoria Kann
Richard Scarry's What Do People Do All Day?	Richard Scarry
Sheep in a Jeep	Nancy E Shaw
The Story about Ping	Marjorie Flack
Tear Soup	Pat Schweibert
Tikki Tikki Tembo	Arlene Mosel
The True Story of the Three Little Pigs	Jon Scieszka
The Very Hungry Caterpillar	Eric Carle
We're Going on a Bear Hunt	Michael Rosen
What Do You Do with a Tail Like This?	Robin Page
Wheels on the Bus	DK Publishing
Where the Wild Things Are	Maurice Sendak
Native books	Author
Alice Yazzie's Year	Ramona Maher
Brave Wolf and the Thunderbird	Joe Medicine Crow
Buffalo Song	Joseph Bruchac
Ch'askin: A Legend of the Sechelt People	Donna Joe

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*Continued*

**Appendix A1.** (Continued)

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Coyote and the Sky	Emmett 'Shkeme' Garcia
Coyote Sings to the Moon	Thomas King
Crazy Horse's Vision	Joseph Bruchac
Crossing Bok Chitto	Tim Tingle
First Fire	Marijo Moore
First Nations Technology	Karin Clark
Gift Horse	S.D. Nelson
How Chipmunk Got His Stripes	Joseph and James Bruchac
How the Robin Got its Red Breast: A Legend of the Sechelt People	Sechelt Nation
I Can't Have Bannock But the Beaver Has a Dam	Bernelda Wheeler
The Ice Man	Marijo Moore
Kwulasulwut: Stories From the Coast Salish	Ellen White
Jack Pine Fish Camp	Tina Umpherville
The Legend of the Caribou Boy	John Blondin
The Little Duck	Beth and Stan Cuthand
Mary Quequesah's Love Story	Pete Beaverhead
Mayuk the Grizzly Bear: A Legend of the Sechelt People	Sechelt Nation
My Kokum Called Today	Iris Loewen
Nanabosho and the Woodpecker	Joseph McLellan
Nanabosho, Soaring Eagle and the Great Sturgeon	Joseph McLellan
Napi	Antonio Ramirez
Napi Goes to the Mountain	Antonio Ramirez
The Old Man with the Otter Medicine	John Blondin
Onkwehonwe-Neha	Sylvia Miracle
Raccoon's Last Race	Joseph and James Bruchac
Salmon Boy: A Legend of the Sechelt People	Donna Joe
Shi-shi-etko	Nicola L. Campbell
Skysisters	Jan Bourdeau Waboose
Songs of Shiprock Fair	Luci Tapahonso
The Sugar Bush	Winona LaDuke
Thanks to the Animals	Allen Sockabasin
Whale Girl	Diane Silvey
When the Shadbush Blooms	Carla Messinger
When the Turtle Grew Feathers	Tim Tingle
Why Coyote Has Best Eyes	Klamath-Trinity Joint Unified School District Indian Education Program
The Wish Wind	Pete Eyvindson
Yamozha and His Beaver Wife	Vital Thomas
Yetsa's Sweater	Sylvia Olsen
Zinnia: How the Corn Was Saved	Patricia Ruby Powell
Zipitio	Jorge Argueta

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**Appendix 2. List of Words Used in Our Derived Categories**

*Animals domestic:* bunny, bunny, calf, cat, dog, goat, goldfish, pig, and sheep.

*Animals Native:* alligator, ant, aphid, armadillo, bear, beaver, bee, beetle, black-snake, buffalo, bullfrog, butterfly, caribou, caterpillar, chameleon, chipmunk, clam, cocoon, coyote, crayfish, cricket, crow, deer, doe, duck, eagle, fawn, firefly, fox, frog, gator, grizzly, hawk, heron, hummingbird, jackfish, jackrabbit, ladybug, lizard, maggot, mallard, mice, mink, minnow, mountain goat, moose, mouse, otter, owl,

pelican, perch, pheasant, pigeon, porcupine, prairie, rabbit, raccoon, rattlesnake, raven, robin, salmon, scorpion, seagull, seal, shrimp, skunk, sparrow, spider, squirrel, stork, sturgeon, sunfish, swan, tadpole, termite, thunderbird, trout, turkey, turtle, whale, wolf, woodpecker, and worm.

*Cycles-birth–death*: birth and death.

*Cycles-seasons*: spring, summer, and winter.

*Kin terms-first degree*: brother, father, mother, and sister.

*Kin terms-second degree*: aunt, cousin, grandfather, grandmother, and uncle.

*Natural events*: blaze, dawn, downpour, fire, hail, hailstorm, hurricane, lightning, rain, snowstorm, storm, sunrise, sunset, sunshine, thunder, and tornado.

*Natural inanimate*: air, ashes, ashore, avalanches, bay, beach, beaches, blaze, blizzard, blood, bluffs, bone, bones, boulder, boulders, branch, branches, breath, breeze, brush, brushes, bubble, buckskin, buffalo-skin, burrow, burrs, canyon, canyons, cave, cliff, cliffs, cloud, clouds, cloudy, coal, coals, coast, coastal, cocoon, coral, cornfield, cotton, countryside, creek, creeks, crop, current, darkness, dawn, day, days, daytime, desert, deserts, dew, dirt, ditches, downstream, drizzle, dusk, dust, earth, eddy, eggshell, embers, feather, feathers, fibres, field, fields, fire, fire, fires, flames, fleece, fleeces, fog, forest, forests, fossils, goatskin, gold, grease, ground, hailstones, hailstorm, handprint, harbor, hay, hill, hills, hillside, horizon, hurricane, ice, icicles, island, jungle, lake, lakes, land, lands, landslide, leather, ledge, ledges, lightning, linen, log, logs, meadow, meadows, moisture, mold, moon, moonlight, moons, morning, mound, mountain, mountains, mud, mussel-shells, nest, night, nightfall, nights, ocean, oceans, oil, outback, pacific, pasture, pastureland, pastures, pearl, pearls, pebble, pebbles, pee, pelt, pit, plain, plains, poison, pond, ponds, poop, poops, prairie, prairies, quarry, quills, rain, rainbow, rainbows, rainwater, river, riverbank, rivers, rock, rocks, rockslides, salts, sand, sap, savannahs, sea, seal-skin, seashells, seashore, sea-water, seed, seeds, shade, shadow, shadows, sharkskin, sheepskin, shell, shells, shore, shoreline, silver, skull, sky, sleet, slope, smoke, snow, snowball, snowbanks, snowdrifts, snowflakes, snowstorm, soil, soot, spring, springtime, star, stars, steam, stick, sticks, stone, stones, storm, storms, straw, stream, streams, stump, summer, summers, sun, sunlight, sunrise, sunset, sunshine, swamp, swamps, sweat, tear, teardrops, tears, thunder, thunderbolts, thunderstorm, timber, trail, treetops, tropics, underground, undergrowth, valley, valleys, water, waterfall, waters, wave, waves, weather, web, whirlpool, whirlwind, wind, windy, winter, wood, woods, wool, and yangtze.

*Non-Kin person*: actors, adults, agent, agents, anishinaabeg, anyone, apache, artists, baaaby, babies, baby, baker, bakers, bandit, beggars, blacksmith, boy, boys, British, builder, builders, bum, captain, captors, carpenter, carpenters, champion, cheyenne, chief, chiefs, child, children, chinese, chippewa, choctaw, choctaws, clowns, competitor, conductor, council, creator, cree, crybaby, customers, dancers, dentist, doctor, doctors, dr, driver, drivers, drummers, elder, elders, eldest, electrician, enemies, enemy, engineer, everybody, everyone, explorers, farmer, fellow, female, fighters, fire-fighters, fireman, firemen, fisherman, fishermen, fliers, foe, folks, foresters, French, friend, friends, gang, girl, girls, golfers, graders, grocer, group, grown-up, grown-

ups, guard, guards, guest, guests, guide, guy, headman, helmsman, helper, helpers, hitchhiker, host, human, humans, hunter, hunters, Indian, Indians, jerk, keeper, kid, kiddo, kids, kids, killer, king, knight, ladies, lady, lakota, lakotas, leader, line-dancers, loggers, lumberjack, lumberjacks, magician, magicians, maid, mailman, male, males, man, mason, master, mate, mayors, men, Mexican, miller, mistress, mr, mrs, Native, navajo, navajos, neighbor, neighbors, 9-year-old, nobody, nurse, officer, operator, orphan, orphans, owner, owners, participants, passengers, patient, patients, peddler, people, peoples, person, pilgrims, pilot, pirate, player, playmate, plumber, police, policeman, policemen, porter, postman, postmaster, postmen, preacher, priest, priests, prince, princess, princesses, prisoner, ranger, rascal, reporters, rider, riders, robbers, runaway, runner, runners, sailors, saleslady, salesman, salish, Santa, scavenger, scavengers, settler, settlers, singer, singers, sir, sissies, slave, slaves, sleepyhead, soldiers, somebody, someone, stranger, strangers, struggled, struggling, students, surveyor, sweepers, sweetie, Swiss, switchman, tailor, teacher, teachers, team, teenage, teenager, teenagers, thieves, townspeople, tribe, villagers, visitor, visitors, waiter, wardens, warrior, warriors, watchman, winner, witch, woman, women, worker, workers, workmen, and youngest.

*Plants:* alder, alders, alfalfa, arbor, balsam, blooms, blossom, blossoms, bonsai, branch, branches, buckeye, bullrushes, burdock, bush, bushes, cedar, cedar-root, ceiba, columbine, cornstalks, cottonwood, evergreen, fern, ferns, fir, fireweed, flower, flowers, grass, grasses, hemlock, herbs, irises, kelp, kumquat, laurel, lawn, lawns, leaf, leafy, leaves, maple, moss, oak, palm, petals, pine, pines, pinyon, plankton, plant, plants, poplar, pumpkin, pumpkins, reeds, root, roots, rose, rosebud, roses, sage, salmonberry, saplings, seaweed, seedlings, shadbush, shrub, shrubs, sprouts, spruce, stalks, tansi, thistle, tobacco, tree, trees, tree-trunk, twig, twigs, vines, weed, weeds, wheat, willow, yucca, and zinnia.