Causal Reasoning about Illness: A Comparison between European- and Vietnamese-American Children

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ABSTRACT

These studies examine children’s understanding of the causes of illness cross-culturally. In Study 1, European- and Vietnamese-American 4- to 5-year-olds, 6- to 7-year-olds, and adults were asked to make causal attributions for a series of illness-related stories. In Study 2, European- and Vietnamese-American 6- to 7-year-olds and adults were asked about the causes and remedies of illness. The results show that biological causality was the dominant form of reasoning about illness across the different ages and cultural groups, although there was some acceptance of magical causality among the Vietnamese-Americans (children and adults) and the European-American children. These results are discussed in terms of the coherence of illness beliefs.

Children’s reasoning about biological phenomena has been an area of much interest among researchers in the field of cognitive development. The theory-theory view proposes that children’s reasoning about biology is organized into a coherent folk or commonsense theory. Unlike the traditional domain-general approaches to children’s reasoning (e.g., Piaget’s stages of cognitive development), this view reflects the notion that children’s reasoning is domain-specific and theory-driven (see Wellman & Gelman, 1992, 1997, for a review). One form of the theory-theory view is that

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young children initially reason about biology in terms of a psychological theory (e.g., desires, feelings), which eventually develops into a distinct biological theory in later childhood (Carey, 1985; see also Au & Romo, 1999). Another form of this view is that young children initially reason about biology with a theory that is uniquely biological, which includes the understanding of the distinction between living and nonliving things, biological processes, and causal mechanisms (e.g., Hatano & Inagaki, 1994; Keil, 1992). Despite the differences between these two forms of the theory-theory view, there is underlying agreement that the developmental endpoint is ultimately a biological theory.

As a window onto children’s biological theory, researchers have examined various aspects of children’s biological reasoning and knowledge. Empirically, the view that children develop a biological theory is well supported. For example, research has found that children distinguish plants and animals from artifacts (e.g., Inagaki & Hatano, 1996). Children also understand the concepts of growth (e.g., Rosengren, Gelman, Kalish, & McCormick, 1991), inheritance (e.g., Springer & Keil, 1989), reproduction (e.g., Hickling & Gelman, 1995; Springer, 1995), illness (e.g., Kalish, 1996; Keil, 1992), and death (e.g., Nguyen & Gelman, 2002).

While the view that children develop a biological theory is well supported, there has been increased recognition that additional cross-cultural research is needed to determine the generalizability of a biological theory (e.g., Coley, 2000). Although the majority of developmental research in the domain of biology has examined European-American children from upper-middle class backgrounds, a few studies have examined children from varying cultural backgrounds. Because this research is still scarce, it is difficult to draw conclusions regarding the development of a biological theory cross-culturally. On the one hand, some of this cross-cultural research reveals similarity in children’s biological reasoning. For example, some researchers have found that both Japanese (Hatano & Inagaki, 1994) and Australian (Morris, Taplin, & Gelman, 2000) children believe that organs have a vital force or energy that explains how biological processes work. In addition, Diesendruck and colleagues (1998, 2001) found that Brazilian and American children believe that nonobvious properties (e.g., blood), but not obvious properties (e.g., size), determine the identity of an animal. On the other hand, some researchers have reported dissimilarities
in children’s biological reasoning across cultures. For example, Hatano and colleagues reported differences in the manner in which children from Israel, Japan, and the United States reason about living and nonliving things (Hatano, Siegler, Richards, Inagaki, Stavy, & Wax, 1993). In addition, Ross, Medin, Coley and Atran (2003) have found that Native-American children are less likely than European-American children to attribute properties of living things to other entities based on their resemblance to humans.

Our present studies are couched in the theory-theory view and compare biological reasoning across two groups of children from different cultural backgrounds. These studies make two novel contributions to the existing literature. The first is that it focuses on children’s concept of illness, which has not been examined extensively among children from varying cultural backgrounds (see also Raman, 2003). Within the theory-theory literature, several researchers have found that European-American children (and adults) reason about illness using distinctly biological forms of reasoning.¹ For example, Springer and Ruckel (1992) reported that 4- to 5-year-olds reject that illness is due to people’s misbehaviors or immanent justice (e.g., a boy is sick from eating a stolen apple). Rather, children accept that germs and poisons lead to sickness (e.g., a boy is sick from eating dirty food). In addition, Keil (1992, 1994) found that preschoolers readily distinguish biological- (e.g., viruses) from nonbiological-disease causing agents (e.g., poisons). Kindergartners and school-aged children also appear to know some properties of biological agents. For example, when children are told that a “thing” causes illness by entering the human body, children predict that the “thing” is alive, has insides, can move autonomously, and is devoid of mental processes (Keil, 1992, 1994).

However, other bodies of literature outside of psychology have revealed that a biological theory is not always invoked when individuals, particularly adults, reason about illness. Throughout the history of medicine there have been many claims that illness has mystical or spiritual underpinnings; it was

¹We recognize that some researchers have recently attacked this evidence, including Au and Romo (1999) and Solomon and Cassimatis (1999). However, the mainstream view remains that European-American children’s understanding of illness is biological and we use this view to make a comparison with Vietnamese-American children’s understanding of illness.
not until the nineteenth century that the biological germ theory of illness was developed (see Keil, Levin, Richman, & Gutheil, 1999 for a review). Despite the emergence of a biological germ theory of illness, the medical anthropology literature still reveals evidence of a belief in supernatural causes such as spirits or magic in some nonWestern cultures (e.g., Arieli, 1970; Edman & Kameoka, 1997; Murdock, 1980; Wikan, 1989). There is also evidence that individuals in some nonWestern cultures hold both biological and supernatural beliefs in the causes of illness (Green, Jurg, & Dgedge, 1993; Mull & Mull, 1994).

The second novel contribution of the current studies is that it draws a comparison between two groups of children that currently reside in the United States, but that have different cultural backgrounds, namely European-American and Vietnamese-American children. As described earlier, research on European-American children has found that these children explain illness in terms of germs (e.g., Kalish, 1996; Keil, 1992, 1994; Springer & Ruckel, 1992). Yet, research on Vietnamese-American children is still lacking. Research on Vietnamese-American adults, however, has shown that these individuals reason about illness using both biological and magical forms of explanation. Vietnamese-Americans have been reported to believe in a mixture of biological and magical causes and remedies of illness. These beliefs are thought to stem from philosophical and religious origins (e.g., Buddhism and Taoism).\(^2\) Vietnamese-American adults have been found to cite germs, evil spirits, and magic spells as among potential causes of illness and physicians, healers, and sorcerers with magical powers as potential remedies of illness (Calhoun, 1986; Rutledge, 1992). The findings that Vietnamese-Americans hold steadfast to their cultural traditions, teaching their children about traditional Vietnamese culture, sharing folk stories, and speaking Vietnamese in the home would suggest that these beliefs are transmitted to their children as well (Rutledge, 1992). However, to our knowledge, no studies to date have systematically examined the nature of Vietnamese-American children’s beliefs about illness.

\(^2\)We use the term “magic” to refer to an alternative form of causal reasoning that involves supernatural forces. We make this distinction in order to distance our use of this term from others who have used the term in a derogatory manner to refer to anyone who does not adhere to the adult Western scientific view of causality. For a thorough discussion of the uses of the word “magic” see Rosengren, Johnson, and Harris (2000).
Comparing illness beliefs among Vietnamese- and European-American children enable us to examine different sets of hypotheses regarding the development of their biological knowledge. In the present studies, children were asked to make causal attributions for illnesses. If children’s reasoning about biology is organized around a biological theory, then we expect these children to reason about biological phenomena in similar ways. That is, we expect both Vietnamese- and European-American children to use biological reasoning to explain illness. If this is not the case, then we expect to find differences in the way young children from diverse cultures reason about illness. That is, we expect that Vietnamese-American children, but not European-American children, use biological and magical reasoning to understand illness. We do not expect that European-American children use magical explanations to explain illness because parents of these children typically only support magical beliefs for a relatively short period of time (between the ages of 3 and 6 years) and typically reserve the label of “magic” for particular entities (Johnson & Harris, 1994) and particular nonnatural phenomena (Rosengren & Hickling, 1994, 2000).

The potential presence of both biological and magical reasoning promises to provide insights into the way in which different forms of reasoning are represented in the minds of these children. Subbotsky (2000), for example, has argued for a “coexistence model” of reasoning in which multiple modes of reasoning (e.g., scientific and unscientific modes) coexist in the minds of individuals. According to this model, which mode of reasoning an individual chooses to invoke is highly dependent upon the context of the situation. For example, Walker (1992) found that the Yoruba of Nigeria have a “supernatural theory of biology.” Individuals in this culture report that animals can transform their identities within a ritual context, such as during a sacrifice, but not in a nonritual context, such as at the market. If multiple modes of reasoning about illness coexist in children, then we should expect that they maintain relatively distinct biological and magical explanatory frameworks, using either one or the other, depending upon context. However, if multiple modes of reasoning are blended into a unitary explanatory framework, then we should expect that children combine their biological and magical explanations (e.g., “Germs are magic”).
In summary, the goal of the present study was to investigate biological reasoning among children from two diverse cultural backgrounds. To this end, two studies investigated the concept of illness among European-American and Vietnamese-American children.

**Study 1**

Study 1 included European- and Vietnamese-American 4- to 5-year-olds, 6- to 7-year-olds, and adults. Participants were asked to provide explanations for illness-related stories that varied in the type of causal information provided about illness (e.g., biological and magical). We varied the type of causal information provided in the stories because past research suggests that different contexts may invoke different explanatory frameworks in individuals (e.g., Subbotsky, 2000; Walker, 1993). Although it would be useful to examine even younger children in the present study, given that much of the past research on children’s biological knowledge has focused on the age range of four- to seven-years, we felt this was an appropriate age to begin our investigation.

**Method**

*Participants.* The participants were twenty-eight 4- to 5-year-olds: 15 European-Americans (M = 4;9; range = 4;5 to 5;6; 6 boys and 9 girls) and 13 Vietnamese-Americans (M = 5;1; range = 4;2 to 5;7; 6 boys and 7 girls). There were also twenty-four 6- to 7-year-olds: 12 European-Americans (M = 6;8; range = 6;0 to 8;0; 8 boys and 4 girls) and 12 Vietnamese-Americans (M = 6;9; range = 6;1 to 7;9; 5 boys and 7 girls). Eight European-American adults and eight Vietnamese-American adults also participated in the study.

The European-American children were American children of Euro- pean descent and their families had lived in the U.S. for several generations. In contrast, the Vietnamese-American adults and the parents of the Vietnamese-American children had lived in the U.S. for approximately 5 years (range = 1-10 years). In particular, the children were recruited from schools with bilingual classrooms with teachers who spoke both Vietnamese and English whereas the Vietnamese-American adults were recruited from refugee centers that had helped them resettle the United States. The initial and primary language of the Vietnamese-American children and adults at
the time of testing was Vietnamese. All of the participants were recruited from a community located in the Midwestern United States.

**Materials.** There were 12 illness-related stories in which the people in the stories became ill (see Appendix). There were three types of stories: The first type included biological causal information, the second type included magical causal information, and the third type included both biological and magical causal information. The causal information presented in the stories carry similar meaning in both Vietnamese and European cultures. For example, germs map onto natural, biological causal agents whereas magic spells map onto supernatural, nonbiological ones for both English and Vietnamese speakers. Stories also included a fact about the color of clothing that was irrelevant to the cause of sickness. This information was included to see if participants were merely reciting the details of the stories when asked how the individuals became ill.

A researcher who was fluent in both English and Vietnamese languages created the stories. She initially created an English version of the materials and then translated them into Vietnamese. To ensure that the English and Vietnamese versions of the stories were equivalent, we had two Vietnamese language instructors who were fluent in both Vietnamese and English check the accuracy of the translation by translating and back-translating the materials. The instructors did not report any significant problems.

The stories were illustrated with colorful drawings on 8.5 × 11 inch paper. There were 2 sets of drawings; one set for the European-Americans and one set for the Vietnamese-Americans. The depictions were identical except that the people depicted in the drawings for the European-American set were European-American and the people depicted in the drawings for the Vietnamese-American set were Vietnamese-American.\(^3\)

**Procedure.** Children were interviewed individually in their native language by one of two researchers at home or in a school setting. The duration of each interview was approximately 15 to 20 minutes. The 12 stories

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\(^3\)Using these different sets of stimuli raises the interesting issue of whether Vietnamese-Americans may think that magical causality is real, but only applicable to other Vietnamese-Americans, not European-Americans. While this is a possibility, such a finding would not weaken our findings since the main question of interest is whether there is any evidence of magical causality among Vietnamese-American children to begin with.
were presented in one of two random orders. After hearing each story, the child was asked what caused the individual in the story to get sick. The researcher then wrote down the child’s responses verbatim in the language used by the child. Adults participated in a paper-pencil version of the interview. A researcher fluent in both English and Vietnamese later translated the Vietnamese-American data into English.

**Coding.** Three main coding categories were generated. Enclosed in parentheses are examples of the codes that participants provided. The biology code included biological causal agents (e.g., “The germs were inside her body”), illnesses (e.g., “The flu”), and actions or events related to biology (e.g., “His hands were dirty and he ate food”). The magic code was used for magical causal agents (e.g., “The magic got inside her body”) and actions or events associated with magic (e.g., “Because of the witch”). Responses related to the details of the stories were coded as irrelevant (e.g., “Because she was wearing pink”). Responses were coded with 1s and 0s. For example, “The germs got inside her body” received a 1 for the biology code and 0s for all other codes. It was also possible for an explanation to receive multiple codes. For example, “Magic spells have germs” was given a 1 for both the biology and magic codes.

**Results**

Two researchers independently coded all of the responses with 1s and 0s. The overall percentage of inter-rater reliability between the two researchers was 98%. Cohen’s Kappa was also calculated for 25% of the data and was 0.94. Disagreements were also later discussed and resolved.

In order to examine the influence of age and culture on participants’ responses we conducted three separate ANOVAs for each of the three story types. These separate analyses enabled us to examine how participants responded when only biological information was provided, when only magical information was provided, and when both biological and magical information was provided. Each ANOVA was a 3 (age: 4- to 5-year-olds, 6- to 7-year-olds, and adults) × 2 (culture: European-American and Vietnamese-American) ANOVA with participants’ biological and mag-
The irrelevant responses were dropped from these subsequent analyses because of their infrequency, indicating that participants were not merely reciting details of the story. Since there were 4 instances of each story type, the range for the responses was 0 to 4. (However, since participants could provide more than one response, the maximum number could conceivably be larger).

**Stories with Only Biological Information.** The analysis of the stories where biological information regarding illness was provided revealed only a significant interaction of age and response type, $F(2, 62) = 5.2$, $MSE = 1.38$, $p < .05$. Figure 1 reveals that that 4- to 5-year-olds provided fewer biological responses than the 6- to 7-year-olds and adults, $p$’s $< .05$. The 6- to 7-year-olds and adults did not differ. Magical responses were quite rare with only the 4- to 5-year-olds providing any of this response type for the biological stories. No effect of culture was obtained for the stories where only biological information was provided.

**Stories with Only Magical Information.** The analysis of the stories where magical information regarding illness was provided also revealed a significant

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4We realize that these ANOVAs are not entirely independent. However, the participants could provide multiple explanations for each story and could also provide different types of responses.
Figure 2. Study 1. Mean number of biological and magical responses by age for the stories with magical information only.

age by response type interaction, $F(2, 62) = 6.0, MSE = 16.9, p < .01$. Figure 2 shows that 6- to 7-year-olds and adults provided significantly more biological responses than 4- to 5-year-olds for these stories, $p$’s < .01. The mean number of biological responses provided by the 6- to 7-year-olds was not significantly different from the other two age groups. Figure 2 also shows that 4- to 5-year-olds and 6- to 7-year-olds provided significantly more magical responses than adults, $p$’s < .01. There was not a significant difference between the two child age groups. We also compared the mean number of responses within each age group. Six- to 7-year-olds provided a similar amount of biological and magical responses, but 4- to 5-year-olds provided a larger amount of magical than biological responses, $p < .01$. Adults, however, provided a larger amount of biological responses than magical ones, $p < .01$.

A significant culture by response type interaction was also obtained for the stories containing magic elements, $F(1, 62) = 10.6, MSE = 29.8, p < .01$. Figure 3 demonstrates that overall, European-Americans provided more biological responses than magical ones, whereas Vietnamese-Americans provided more magical responses than biological ones.

Stories with Both Biological and Magical Information. The results obtained from the stories that contained both biological and magical information were quite similar to those obtained from the stories that contained only magical
information. Specifically, there were both an age by response type interaction, $F(2, 62) = 4.9$, $MSE = 3.1$, $p < .05$, and a culture by response type interaction, $F(1, 62) = 8.0$, $MSE = 5.1$, $p < .01$. Figure 4 reveals that the dominant response was biological when both biological and magical information was provided. Specifically, 4- to 5-year-olds, 6- to 7-year-olds, and adults provided significantly more biological than magical responses, although 6- to 7-year-olds and adults provided more biological responses than the 4- to 5-year-olds, $p$’s < .01. There was not a significant difference between the 6- to 7-year-olds and adults. Figure 5 shows that although Vietnamese-Americans did provide significantly more magical responses to these stories than European-Americans, these responses were significantly less common than biological responses for both the Vietnamese-Americans and the European-Americans, $p$’s < .01.

**Biological-Magical Responses.** Although the results suggest a dominant biological explanatory framework, magical explanations for illness were still offered by some individuals. In order to examine whether biological and magical explanations are kept relatively distinct for these individuals, we conducted an additional analysis that focused on responses that received both a biological and magical code (e.g., “Magic spells have germs”). If biological and magical explanatory frameworks are kept distinct, then we should expect to see relatively few blended biological-magical responses.
Indeed, such responses were rare across cultures and ages. Overall, there were significantly more biological ($M = 8.4$, $SD = 2.4$) responses than blended biological-magical responses ($M = 1.2$, $SD = 1.2$), $t(67) = 18$, $p < .01$. There were also significantly more magical responses ($M = 2.2$, $SD = 1.8$) than blended biological-magical responses, $t(67) = 3$, $p < .01$. 

Figure 4. Study 1. Mean number of biological and magical responses by age for the stories with both biological and magical information.

Figure 5. Study 1. Mean number of biological and magical responses by culture for the stories with both biological and magical information.
Discussion

There are a number of important findings from Study 1. First, when biological information is provided, either alone or in conjunction with magical information, the majority of the responses were biological in nature. These results suggest that the dominant form of reasoning about illness is biological for European- and Vietnamese-Americans. When only biological information is provided, Vietnamese-Americans and European-Americans provide similar types of biological explanations. A typical illustration of this uniformity is the strong similarities in the specific biological causes that these two groups provided. For example, a European-American 6- to 7-year-old said that an individual in one of the test stories became ill “from germs ‘cause germs can spread pretty easily.” A Vietnamese-American 6- to 7-year-old provided a similar explanation for this test story: “He got germs on his body.” Biological responses, however, increased with age such that adults and 6- to 7-year-olds provided more of this type of response than 4- to 5-year-olds.

It is unlikely that the biological focus of the Vietnamese-Americans’ answers merely reflect their assessment of what the appropriate answers would be in an American research setting. In Study 1, participants were interviewed in their native language and were shown drawings of individuals of their own cultural background.

A second main finding was when only magical information was provided in the stories, participants provided more magical responses. This was true for children who provided significantly more magical responses than the adults and for Vietnamese-Americans who provided significantly more magical responses than European-Americans. This result suggests that contextual information plays an important role in determining the causal explanations that are used for these two groups. These results suggest that even though participants’ default response may be biological in nature, some participants, notably children and individuals from a Vietnamese-American background are willing to endorse magical causality when a magical situation is implied. Previous research on children’s magical explanations suggests that magical explanations are rarely provided spontaneously for explaining natural phenomena (Rosengren & Hickling, 2000). Rather magical explanations are typically reserved to explain phe-
nomena where a causal expectation has been violated or where a magical context has been provided.

The presence of magical explanations in addition to biological explanations also afforded us the opportunity to explore the degree to which these explanatory frameworks coexist in the minds of individuals. The results of Study 1 reveal that biological and magical explanations are rarely blended. The average number of responses that combined biology and magic together was only 1.2. In contrast, participants provided seven times as many biological responses and almost twice as many magical responses. These results show that some individuals use biological and magical explanatory frameworks separately to explain illness, although the former tends to dominate over the latter. These results are corroborated by several Vietnamese-American adults who spontaneously reported that they have some beliefs regarding illness that are operative in particular contexts. For example, these individuals suggested that there are certain beliefs (mainly magical) that are operative in a “Vietnamese” context (e.g., when speaking in the Vietnamese language). Overall, the findings of Study 1 are consistent with Subbotsky’s (2000) suggestion that while alternative forms of reasoning may coexist in the minds of some individuals, there is a “fight for dominance” among these forms of reasoning. The issue of the influence of context is further explored in Study 2.

**Study 2**

In Study 2, we explored in greater detail the influence of magical contexts on reasoning about illness. Specifically, in one task we included stories without any mention of causal information because we were interested in examining what type of spontaneous or default responses would be provided when there was no mention of any magical or biological entities. A second task included stories about specific illnesses in order to begin looking at children’s explanations of both the causes and remedies of illnesses. Finally, a third task asked children whether illness could be caused by specific biological and magical causes and remedies. By including this task, we were able to examine specific biological and magical entities that children invoke when reasoning about illness.
Method

Participants. The participants were thirty-four children: 17 European-American ($M = 6;4;\ range = 5;3\ to\ 7;9$) and 17 Vietnamese-American children ($M = 6;9;\ range = 5;1\ to\ 7;7$). Thirty-three adults were also included: 18 European-American and 15 Vietnamese-American adults. None of these participants were in Study 1. We also did not include younger children in Study 2 because there was not a significant difference between the Vietnamese-American 4- to 5-year-olds’ and 6- to 7-year-olds’ magical responses in Study 1. Participants were recruited in the same way as in Study 1 and shared similar demographic information.

General cause/remedy generation task. The general cause/remedy generation task was designed to examine children’s spontaneous or default explanations for the causes and remedies of illness in general. This task included four color drawings of people who were described as sick. Two questions accompanied these pictures: “What do you think made this person sick?” and “What do you think could make the person better?”

Specific cause/remedy generation task. The specific cause/remedy generation task was similar to the previous task except that questions were asked about a cold, chickenpox, and stomachache. This task was designed to investigate spontaneous or default explanations children may have for specific common illnesses. To ensure that children were familiar with these common illnesses, children were initially asked the following test questions: “Do you know what _____ is?” “Have you ever had _____?” “Do you know other people who have had _____?” Then, children were asked the following questions: “If a person is sick with _____, what do you think could have caused that person to get sick?” “What could make the person better?”

Specific cause/remedy endorsement task. Finally, the specific cause/remedy endorsement task was designed to complement the two previous tasks that relied on children’s spontaneous generation of causes and remedies. This task used close-ended questions to investigate specific causes and remedies of illness. There were two sets of questions. The causal questions were phrased as follows: “Do you think a person could ever get sick from...?” The biological causes included germs and poison whereas the magical causes included exposure to an unlucky object, a bad wish, bad magic
spell, and bad spirits. The remedy questions were phrased as follows: “Do you think a person could ever get better by...?” The biological remedies included washing away germs and taking medicine whereas the magical remedies included exposure to lucky objects, good wishes, good magic spells, and good spirits.

For all three tasks, we followed the same procedures as in Study 1 for checking the translation from English to Vietnamese and vice versa.

**Procedures.** The study was conducted in the children’s native language. Children were interviewed individually for approximately 15-20 minutes. Children’s responses were written down verbatim. For the Vietnamese-American children, their responses were written in Vietnamese and later translated into English. The interview was comprised of three tasks presented in a fixed order: general cause/remedy generation; specific cause/remedy generation for common illnesses; and specific cause/remedy endorsement. Adults participated in a paper and pencil version of the task. The items within each of the parts were presented in 1 of 2 random orders for both children and adults.

**Coding.** We coded answers to the general cause/remedy generation task and the specific cause/remedy generation for common illnesses task using a coding scheme similar to the one used in Study 1. Two independent coders gave a 1 or 0 to each biological, magical, and/or irrelevant response. The answers to the cause/remedy endorsement task were simply coded as 1 for “Yes” and 0 for “No.” The overall inter-rater agreement was 98%. Cohen’s Kappa was also performed on 25% of the coded responses and was 0.96. Disagreements were later discussed and resolved. Irrelevant responses were rare and so were dropped from the subsequent analyses.

**Results**

**General cause/remedy generation task.** The primary purpose of this task was to explore in greater detail spontaneous responses to questions about the causes and remedies of illness. To examine this issue we summed the causes and remedies across the four trials into separate magic and biology scores for each participant. The range for these scores was 0 to 8 (although it could be higher if participants provided more than one response per trial). Then we conducted a 2 (age: children and adults) × 2 (culture:
European- and Vietnamese-American) by 2 (response type: biological, magical) ANOVA. Children provided significantly more responses than adults as indicated by a significant main effect of age, $F(1, 63) = 6.5$, $MSE = 16$, $p < .01$. This result was due to the fact that a number of adults suggested that there was not enough information to determine the cause or the remedy of illness in the pictures. We also obtained a significant main effect of response type, $F(1, 63) = 475$, $MSE = 1154$, $p < .01$. Participants provided significantly more biological responses ($M = 5.5$, $SD = 1.3$) than magical ones, which were quite rare ($M = 0.1$, $SD = 0.04$). There was not a main effect of age, culture, or an interaction between age, group, and culture.

Because participants rarely provided magical responses in this task, we did not examine the extent to which biological and magical explanations were kept relatively distinct for these individuals, as in Experiment 1.

**Specific cause/remedy generation task.** In order to examine spontaneous responses to questions regarding common illnesses, we summed the causes and remedies for the three common illnesses into a magical and biological score for each participant. The range for the scores was 0 to 6 (although the maximum score could be higher since participants could provide more than one response per question). We conducted a 2 (age: children, adults) $\times$ 2 (culture: European-, Vietnamese-American) $\times$ 2 (response type: biological, magical) ANOVA. A significant age effect was obtained, $F(1, 63) = 9.5$, $MSE = 6.74$, $p < .01$. Adults provided significantly more responses ($M = 5.6$, $SD = 1.2$) than children ($M = 4.7$, $SD = 1.0$). A significant main effect of response type was also obtained, $F(1, 63) = 853$, $MSE = 707$, $p < .01$. As was the case for the general cause/remedy task, participants provided significantly more biological responses ($M = 4.8$, $SD = 1.3$) than magical ones. Once again, the magical responses were quite infrequent ($M = 0.2$, $SD = 0.6$). No main effect of culture was obtained.

There were also a number of significant interactions. Specifically, there was a significant interaction between response type and age, $F(1, 63) = 17$, $MSE = 14.7$, $p < .01$. Follow-up analyses revealed that children and adults did not differ significantly in their number of magical responses ($M$’s $= 0.3$, $0.1$, $SD$’s $= 0.6$, $0.5$). Adults, however, provided significantly
more biological responses ($M = 5.4, SD = 1.0$) than children ($M = 4.3, SD = 1.2$), $p < .01$.

A significant response type by culture was also obtained, $F(1, 63) = 20$, $MSE = 17.2$, $p < .01$. Follow-up analyses showed that European-Americans provided more biological responses ($M = 5.3$, $SD = 0.9$) than Vietnamese-Americans ($M = 4.4$, $SD = 1.4$), $p < .01$. However, Vietnamese-Americans provided significantly more magical responses ($M = 0.5$, $SD = 0.8$) than European-Americans, who provided no magical responses. Although, the occurrence of magical responses was still rare, even among Vietnamese-Americans.

**Specific cause/remedy endorsement task.** Finally, we examined the endorsement of specific causes and remedies of illness. Recall there were 2 biological causes, 2 biological remedies, 4 magical causes, and 4 magical remedies. We created two summary scores for the different causes and remedies of illness by summing the biological causes and remedies into one score and the magical causes and remedies into another score. Because there were twice as many magical causes and remedies, we equated the biological and magical summary scores by dividing the magical summary score by 2. Then, we conducted a 2 (age: children, adults) × 2 (culture: European-, Vietnamese-American) × 2 (response type: biological, magical) ANOVA on these data. The analyses revealed that adults endorsed more causes and remedies overall than children ($M$’s = 5.5, 4.3 out of 8; $SD$’s = 1.2, 1.2, $F(1, 63) = 15$, $MSE = 11.2$, $p < .01$). Also, Vietnamese-Americans endorsed more causes and remedies overall than European-Americans, ($M$’s = 5.4, 4.4 out of 8; $SD$’s = 1.4, 1.1, $F(1, 63) = 10$, $MSE = 7.62$, $p < .01$). Finally, more biological causes and remedies were endorsed than magical ones ($M$’s = 3.6, 1.3 out of 4, $SD$’s = 0.5, 1.2), $F(1, 63) = 275$, $MSE = 177$, $p < .01$.

These main effects were mediated by significant interactions between response type and age group, $F(1, 63) = 18$, $MSE = 12$, $p < .01$, as well as between response type and culture, $F(1, 63) = 9.1$, $MSE = 5.9$, $p < .01$. Figure 6 shows that children endorsed significantly more magical causes and remedies than adults, $p < .01$, but that there was not a significant difference between their endorsement of biological causes and remedies. In addition, Figure 7 shows that Vietnamese-Americans endorsed more magical causes and remedies than European-Americans, $p < .01$,
although there was not a significant difference between the two cultural groups’ endorsement of biological causes and remedies.

These results suggest that European- and Vietnamese-American children and adults endorse biological causes and remedies at a similar rate. However, children tended to endorse more magical causes and remedies than adults from these cultures. Also, Vietnamese-American children
and adults endorsed more magical causes and remedies than European-Americans.

Discussion

There are a number of important findings from Study 2. First, when no contextual information is provided about an individual’s general illness, European- and Vietnamese-Americans provide high and equivalent levels of biological explanations. In contrast, few magical responses were provided to explain illness when no context or specific details of the illness were provided.

When participants were required to explain a specific illness, a slightly different pattern of results was obtained. Although biological responses were the most frequent overall, European-Americans provided more biological responses than Vietnamese-Americans in response to specific illnesses. In this task, European-Americans never provided magical responses. Although magical responses were still relatively rare among Vietnamese-Americans, they were still provided by a number of these participants to explain specific illnesses. The results from the general and specific illness tasks suggest that biological responses are predominant for children and adults from both European-American and Vietnamese-American backgrounds.

The final task of Study 2 asked individuals whether specific biological or magical causes/remedies could cause/cure specific illnesses. No difference in the endorsement of biological causes and remedies was found across age or culture. But, children were more likely than adults to endorse magical causes and remedies. Vietnamese-Americans were also more likely to do so than European-Americans. This result suggests that while the dominant form of reasoning about illness may be biological in nature for both European-American and Vietnamese-American children and adults, magical causality is also accepted, but to a lesser degree, by some individuals.

General Discussion

The goal of the present studies was to investigate the form of reasoning children use to explain illness. Taken together, the results of the present studies suggest that the dominant form of reasoning about illness is biological for European- and Vietnamese-Americans. Across a variety of
different tasks, some of which provided magical as well as biological information, participants generally provided biological explanations regarding the causes and remedies of illness. This was true for situations when no information was provided about the cause of an illness, when only biological information was provided in the context of the illness stories, and when biological information was provided along with magical information. Specifically under these circumstances, biological responses were very common and magical ones were extremely rare. This result may indicate that the “core” explanatory framework for reasoning about illness is biological for European- and Vietnamese-Americans (see also Raman, 2003 for similar findings regarding children from the United States and South Asia).

An important cultural difference was also obtained in these studies. Vietnamese-Americans were significantly more likely than European-Americans to provide magical explanations. These results are consistent with past research on Vietnamese-American adults (Calhoun, 1986; Rutledge, 1992). One way to interpret these results is to say that Vietnamese-Americans are a part of a special culture in which magical causality is acceptable. Yet another compatible way to interpret these results is to say that European-Americans are a part of a special culture in which children are trained from an early age to reject magical explanations (Johnson & Harris, 1994; Rosengren & Hickling, 1994, 2000). Nemeroff and Rozin (2000) have found that “magical contagion,” the belief that an essence is transmitted from a contagious source to a recipient through contact, is widely and commonly used to explain illness-related phenomena. Thus, it may be that European-Americans are special in that unlike many other individuals, they explicitly reject such magical explanations (see Park, 1992; Shweder, Much, Mahapatra, & Park, 1997). Gelman and Raman (2002) have suggested that illness might elicit such magical, nonscientific explanations due to several reasons: illnesses can arise from multiple causes; illnesses are relatively unpredictable in their onset; typically there is some delay between the exposure and the onset of illnesses; and illnesses often involve unseen causal entities (germs).

While these properties of illness may increase the likelihood of nonscientific (biological) explanations for illness, our results also suggest that there are specific contexts that increase such explanations. In general, when biological information or little or no information is provided regarding the
cause of an illness, participants generally only provided biological explanations. Biological explanations were also predominate when biological information was provided along with magical information. It was only in the case where magical information alone was provided in the stories or when individuals were asked about the possibility of magical causes and remedies that magical explanations became present. Even in these situations, magical explanations were mainly used by children and individuals from a Vietnamese-American background. These findings are consistent with past research that suggests the importance of context in eliciting different explanatory frameworks in individuals (e.g., Walker, 1992).

However, the results from the present studies do not suggest that the information provided in the stories merely served to prime certain types of responses. If this were the case, than an equal number of magical and biological responses should have been obtained for the stories containing both biological and magical information. Rather, participants provided mainly biological responses to these stories. What this result does suggest is that for children and Vietnamese-Americans the possibility of magical causality is not completely ruled out. Given that these individuals generally provided biological explanations, this result suggests that while these individuals view magical causality as a possibility, they do not view magical causality as the best explanation for illness.

Given that children and Vietnamese-Americans tended to use and endorse both biological and magical explanations it is important to consider whether these different forms of causality “coexist” (Subbotsky, 2000) or are blended into a single unifying framework. The results of our investigation provide some insights into this question. In Study 1, we found relatively few examples of “blended” explanations. For example, one Vietnamese-American child declared that “magic has germs,” suggesting some sort of blended form of causality. However, it may be the case that this child merely views germs as magical. Given the invisible nature of germs it seems quite possible that they could be viewed as magical. More detailed investigations of children’s understanding of germs should be conducted in order to examine whether germs are treated as a magical entity.

In our view, it is more likely that these two different forms of causality “coexist” rather than become blended into a single uniform theory. If there was a blended form of explanation we would expect to see many
more cases were magical and biological entities were mentioned in the same explanation and we would expect to find a greater frequency of magical responses. The occurrence of blended responses was in fact quite rare and magical explanations were generally only provided when some sort of magical context was provided. These findings are consistent with Subbotsky’s (2000) “coexistence model” in which individuals are said to employ multiple modes of reasoning (e.g., scientific and unscientific modes) that are context sensitive. Future research should also consider the difference between the acceptance of proximate and ultimate causes of illness (e.g., biological causes as proximate and magical causes as ultimate).

The issue of coherence in explanatory frameworks of illness and disease is clearly in need of further examination. It may be the case that the individuals vary to the extent that they attempt to maintain some causal coherence to their reasoning. Our results suggest that while for some individuals biological and magical explanatory frameworks may coexist, they do not share equal footing. Rather, the biological or more scientific explanations appear to have a somewhat more prominent place.

**Author Note**

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Appendix

Biological Stories from Study 1

1) This is Jim. This is Jane. Jim made a big sneeze. He sneezed all of his germs onto Jane. Jane is wearing a purple barrette in her hair. The next morning, Jane was sick. How do you think Jane got sick? Why do you think that?

2) This is Molly. This is Molly’s mom. She gave Molly a big kiss and put all her germs on Molly. Molly is wearing a yellow dress. The next morning, Molly was sick. How do you think Molly got sick? Why do you think that?

3) This’s Michael. Michael dropped his whistle in the dirty garbage can. He put it back in his mouth after he took it out of the garbage. Michael is wearing an orange shirt. The next morning, Michael was sick. How do you think Michael got sick? Why do you think that?

4) This is Tom. Tom dropped his candy in the dirt. After he picked it up, he ate it. Tom is wearing red pants. The next morning, Tom was sick. How do you think Tom got sick? Why do you think that?

Magical Stories from Study 1

5) This is Jenny. This is Lisa. Lisa broke Jenny’s favorite toy. Jenny told Lisa that she was going to put a magic spell on her. Lisa is wearing a blue ring. The next morning, Lisa was sick. How do you think Lisa got sick? Why do you think that?

6) This is Sarah. Sarah broke a mirror. Everyone knows that if you break a mirror that you will be cursed by a magic spell. Sarah is wearing a green watch. The next morning, Sarah was sick. How do you think Sarah got sick? Why do you think that?

7) This is John. John is pretending there’s a mean witch in his closet. John is wearing yellow pajamas. The next morning, John was sick. How do you think John got sick? Why do you think that?

8) This is Steven. Steven is playing with an unlucky toy. Steven is wearing an orange hat. The next morning, Steven was sick. How do you think Steven got sick? Why do you think that?

Stories Containing Both Biological and Magical Information from Study 1

9) This is Adam. Adam has germs on his hands from playing near the spooky graveyard. Adam forgot to wash his hands before eating lunch. Adam is wearing white tennis shoes. The next morning, Adam was sick. How do you think Adam got sick? Why do you think that?

10) This is Sam. Sam ate a cookie with germs on it. He found the cookie on the floor of a haunted house. Sam is wearing blue socks. The next
morning, Sam was sick. How do you think Sam got sick? Why do you think that?

11) This is Amy. This is Henry. A dirty bug crawled onto Amy’s candy and she ate it. Henry said that he was going to put a magic spell on her for not sharing the candy. Amy has a pink skirt on. The next morning, Amy was sick. How do you think Amy got sick? Why do you think that?

12) This is Kathy. This is Matthew. Kathy is telling Matthew a story about ghosts. Matthew coughed on Kathy. Everyone knows that if you talk about ghosts, you will be cursed by a magic spell. Kathy is wearing a purple skirt. The next morning, Kathy was sick. How do you think Kathy got sick? Why do you think that?

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