

Bewitchment, Biology, or Both: The Co-Existence of Natural and Supernatural Explanatory Frameworks Across Development

Cristine H. Legare, Susan A. Gelman

Department of Psychology, University of Michigan

Received 19 April 2007; received in revised form 9 July 2007; accepted 13 July 2007

Abstract

Three studies examined the co-existence of natural and supernatural explanations for illness and disease transmission, from a developmental perspective. The participants (5-, 7-, 11-, and 15-year-olds and adults; $N = 366$) were drawn from 2 Sesotho-speaking South African communities, where Western biomedical and traditional healing frameworks were both available. Results indicated that, although biological explanations for illness were endorsed at high levels, witchcraft was also often endorsed. More important, bewitchment explanations were neither the result of ignorance nor replaced by biological explanations. Instead, both natural and supernatural explanations were used to explain the same phenomena, and bewitchment explanations were highest among adults. Taken together, these data provide insight into how diverse, culturally constructed belief systems about illness co-exist across development.

Keywords: Theoretical co-existence/coherence; Explanatory frameworks; Illness concepts; Naïve biology; Causal reasoning; Understanding AIDS; South African children

When he had first interviewed her, about a year before, she'd taken mild offense at his questions about sorcery. She'd been one of the few to deny she believed in it. She stated, "I'm not stupid. I know tuberculosis comes from people coughing germs." She'd taken all her medicines. She'd been cured. But now, a year later, when he asked her again about sorcery, she said that of course she believed in it. "I know who sent me my sickness, and I'm going to get her back," she told him. "But if you believe that," he cried, "why did you take your medicines?" "*Cheri,*" she said, "*eske-w pa ka kon-prann bagay ki pa senp?*" The Creole phrase *pa senp* means "not simple," and implies that a thing is freighted with complexity, usually of a magical sort. So, in free translation, she said to Farmer, "Honey, are you incapable of complexity?" (Tracy Kidder, 2003, p. 35, describing a discussion between Dr. Paul Farmer and an elderly Haitian patient).

1. Introduction

A fundamental task for all humans is explaining why things happen. Considerable research exists on the development of causal reasoning in natural domains including naïve physics, biology, and psychology (Keil, 2006; Wellman & Gelman, 1992, 1998). Furthermore, children's causal explanations are surprisingly early achieved (Callanan & Oakes, 1992; Hickling & Wellman, 2001). What is less well understood is the development of supernatural (including magical and religious) concepts (but, see Boyer & Walker, 2000; Woolley, 2000). Recent theory on the development of supernatural reasoning suggests that intuitive biology may not *replace* supernatural thinking. Rather, framework biological and psychological theories may afford the development of supernatural concepts (Boyer & Walker, 2000; Rosengren & Hickling, 2000) and constrain their interpretation (Barrett & Keil, 1996). For example, according to Boyer and Walker, supernatural concepts are memorable because they violate intuitive principles of physics, psychology, and biology.

In addition, children may conceptualize unobservable natural and supernatural entities in similar ways (Harris & Koenig, 2006)—that is, children learn about the ontological status of both empirically verifiable and non-verifiable concepts from cultural input, often conveyed through language. For example, many scientific entities (viruses and molecules) and non-scientific, supernatural entities (witches and spirits) are widely acknowledged as real, although they cannot be readily observed and verified by first-hand observation. There is currently considerable interest in the extent to which such testimony contributes to children's beliefs (Harris & Koenig, 2006; Harris, Pasquini, Duke, Asscher, & Pons, 2006; Woolley, Boerger, & Markman, 2004).

The issue of how children (and adults) coordinate natural and supernatural belief systems is a broad one that, we propose, is of universal concern. On the one hand, there is no society we are aware of that wholly excludes supernatural beliefs. Even within highly educated, industrialized modern communities, at least some individuals endorse supernatural beliefs ranging from God, to ghosts, to astrology (Evans, 2000). On the other hand, there is no society we are aware of that wholly excludes natural beliefs. Even within highly traditional, non-industrialized communities, at least some individuals endorse folk-biological beliefs (e.g., regarding inheritance; Astuti, Solomon, & Carey, 2004). Thus, access to multiple explanatory frameworks is a universal psychological experience, and resolving these multiple belief systems is a general cognitive problem. People in all societies are faced with the task of conceptualizing potentially contradictory belief systems about biological phenomena.

How do intuitive natural (including scientific) explanatory systems co-exist with non-scientific, supernatural explanatory frameworks? There are several broad possibilities. One is that the natural and supernatural realms remain distinct, alternative views of the world recruited to explain distinct phenomena, contexts, and events. For example, regarding illness, natural explanations may be used to explain transient illnesses such as colds, and supernatural explanations may be used to explain severe illnesses such as AIDS. A second possibility is that natural and supernatural frameworks are used jointly to explain the same phenomena. On this latter possibility, the integration of the frameworks might be quite loose (a person may appeal to both natural and supernatural explanations, but without consideration of how they would interact), or instead may combine precisely (a person may treat natural causes

as proximate, but supernatural causes as distal; e.g., contaminated blood causes illness, but bewitchment causes a person to come into contact with the contaminated blood).

A further, related issue is how reasoning about multiple frameworks changes with age. There is controversy concerning whether children are more or less likely than adults to endorse supernatural explanations. For example, traditional accounts of young children's explanations of illness described children as appealing to immanent justice explanations and, therefore, lacking a biological framework for interpreting illness (Kister & Patterson, 1980). More recent research has demonstrated that even young children have complex and often elaborate beliefs about biological processes (Inagaki & Hatano, 2002; Keil, 1992; Wellman, Hickling, & Schult, 1997). Given that children have access to biological explanations at young ages, how do they reason about and accommodate seemingly inconsistent non-biological (supernatural) explanations for illness?

2. Illness concepts

One approach to investigating the co-existence of explanatory frameworks is to focus on a content area in which both natural and supernatural explanations are prevalent (Evans, 2001). An especially informative domain for these purposes is that of serious illness. Most diseases are caused by an amalgamation of several factors (Thagard, 1998). Anthropological evidence from both industrialized and developing countries indicates that illness is not always interpreted exclusively in biological terms (Green, 1999). Instead, a combination of biological, social, and magical explanations are available to explain the process of illness transmission (Brandt & Rozin, 1997; Shweder, Much, Mahapatra, & Park, 1997). Likewise, contagion can be physical, spiritual, mental, or moral in nature. For humans, the transfer of illness typically involves a human vector and can, therefore, be interpreted as interpersonal as well as biological (Nemeroff & Rozin, 2000). Because the transmission of illness in humans occurs through both socio-structural mechanisms (e.g., unequal access to nutritional and medical resources) and biological mechanisms (e.g., transmission of pathogens), it is plausible that causal explanations for illness might include both physical and social–interpersonal factors.

Poverty and inequality may also shape the cultural beliefs concerning causal explanations for illness (Ashforth, 2005; Farmer, 1999). Due to the awareness of malicious human action in promoting suffering, especially in contexts of oppression and inequality, people look for human causes of illness. Among deeply impoverished groups, those who break out of that status are likely to be accused of witchcraft, especially if they are “inside outsiders” or originally of the same class. In many regions of sub-Saharan Africa and the Caribbean, anthropological reports suggest that witchcraft and biomedicine are both used as explanatory frameworks for illness (Ashforth, 2005; Farmer, 1999).

2.1. *Supernatural explanations for illness: Witchcraft attributions in South Africa*

The co-existence of natural and supernatural belief systems can be investigated most clearly in cultural settings where these belief systems are juxtaposed. The AIDS crisis in South Africa

provides such a context. In 2005, a national survey documented that 30.2% of pregnant women in South Africa were HIV positive, among the highest rates of HIV infection in the world (Department of Health, 2005). In this context, multiple approaches to illness are available including traditional medicine, faith healing, and modern biomedical services (Schlebusch & Ruggieri, 1996). We investigated causal reasoning and illness understanding in South Africa to understand how children and adults reason about seemingly conflicting biological and supernatural theories about illness causation.

Perhaps the most prominent supernatural explanation for AIDS in South Africa is that of witchcraft, or the practices of persons with malicious intent to cause harm through the use of harmful substances and invisible supernatural forces (Ashforth, 2005). Witchcraft is often associated with *muthi* (*sejeso* in Sesotho), or the malicious manipulation of herbs and other substances, and is believed to cause a wide variety of misfortunes ranging from unemployment and interpersonal discord to illness and death. The civilizing agenda of both the colonial and apartheid regimes viewed any beliefs and practices associated with witchcraft as irrational and primitive. Education based on Western science and Christianity was viewed as a necessary prerequisite for ameliorating and replacing such beliefs. However, it is now recognized that belief in witchcraft does not necessarily disappear with modernization or education (Ashforth, 2005; Nemeroff & Rozin, 2000; Niehaus, 2001). In South Africa, there are nearly 500,000 traditional health practitioners, healers, and prophets working outside the formal biomedical system. They serve to interpret and counteract perceived cases of witchcraft, and provide indirect evidence that millions of South Africans attribute misfortunes to witchcraft (Ashforth, 2001, 2005; Niehaus, 2001).

Numerous characteristics of AIDS and AIDS-related death may invoke explanatory frameworks traditionally associated with witchcraft. Most of the people infected with HIV and dying of AIDS are young adults in what should be their most fertile and productive years. Symptoms associated with illness attributed to witchcraft, such as skin abnormalities, wasting, intestinal problems, and chronic coughing, are also common symptoms of AIDS (Ashforth, 2005; Stadler, 2003). The similarities between AIDS and other illnesses contribute to the uncertainty and ambiguity regarding AIDS diagnosis.

The processes of diagnosing AIDS and witchcraft have much in common. Both require the use of circumstantial, indirect evidence (Stadler, 2003). Due to its mysterious and shameful status in many South African communities, AIDS is often highly secretive (Stadler, 2003), and some ways of using *muthi* are also said to kill in a manner similar to AIDS (Ashforth, 2005). In addition, the language of “attack” and “defense” used in AIDS awareness discourse is the same as the language used in discourse about witchcraft (Ashforth, 2005).

3. Present studies

There are three objectives of the present studies. The primary objective is to investigate the extent to which witchcraft coexists with biology as explanatory systems in the South African context, where both traditional healing frameworks (including supernatural witchcraft explanations) and Western biomedical frameworks are increasingly available. Furthermore,

this is a cultural context in which most children have direct experience with and are directly affected by deadly disease. Thus, reasoning about illness for these children is not a hypothetical abstraction but an important means of making sense of their daily reality.

One possibility is that biological knowledge supplants witchcraft explanations, which exist only in the absence of accurate biological explanations. In this case, witchcraft exists as a “placeholder” for biological information, which, once acquired, replaces witchcraft explanations for illness (Mitchell, 1965). Another possibility is that witchcraft beliefs persist, even when one has sufficient knowledge of the biological processes involved in illness transmission. In other words, we examine whether bewitchment is a default, to be used only in the absence of any other explanatory system, or whether witchcraft is a persisting belief system that exists alongside other explanations. We predict that natural and supernatural belief systems will not be treated as inconsistent with one another, and in fact might each provide distinct, complementary causal information. For example, biological mechanisms may provide an immediate, proximate cause, whereas bewitchment provides a more distal explanatory system.

Our second objective is to determine whether AIDS is uniquely understood to be a special case or consequence of bewitchment, or whether AIDS has been integrated into the existing explanatory framework for other illnesses. One possibility is that due to its urgency, AIDS is more likely than other illnesses to invite witchcraft explanations and multiple explanatory frameworks (Ashforth, 2005; Raman & Gelman, 2004). Due to the high level of awareness of HIV in the South African context, it is very possible that children differentiate AIDS from other illnesses to a greater extent than in other cultural settings. On the other hand, because witchcraft beliefs preceded AIDS, they may not be targeted specifically to that disease (Niehaus, 2001; Stadler, 2003). Determining which illnesses yield witchcraft explanations is a useful means of learning which factors underlie their use.

The final objective is to examine developmental differences in the co-existence of both witchcraft and biological explanations. One possibility is that children will become more accurate with age: Biological explanations may increase, and witchcraft explanations may decrease as participants gain knowledge and experience. This first possibility would be consistent with most standard theories of development that predict increasing knowledge and accuracy with age. In contrast, a second possibility is that young children may actually provide *more* biological explanations and *fewer* witchcraft explanations than older children and adults, consistent with the idea that biological explanations are a default and supplemented only gradually as children acquire culturally specific explanatory models (Harris & Gimenez, 2005; Raman & Gelman, 2004; Raman & Winer, 2004). Finally, a third possibility is that witchcraft explanations for AIDS may decrease with age (due to direct educational programs in school), but then rise again as participants are further removed from their years in school. This would result in a U-shaped curve (Raman & Winer, 2002), with witchcraft explanations decreasing among older children and adolescents and increasing again among adults.

In order to accomplish these objectives, we investigated the development of beliefs about AIDS and illness from two methodological perspectives. In Studies 1 and 2, we directly probed children’s and adults’ endorsement of a variety of causal mechanisms, using a forced-choice methodology that allowed participants to endorse or reject both biological and non-biological beliefs, including bewitchment and moral explanations. The illnesses under investigation were

AIDS (of primary interest) and the flu (as a comparison case of a transient illness). We also investigated what participants understood about the unobservable nature of these illnesses, and the relation between symptoms and disease, in order to better understand the causal frameworks for illness in this sample.

Study 3 investigated how contextual information concerning illness influences the kinds of explanations that adolescents and children generate for AIDS (and unspecified, fatal illness generally). We predicted that contextual information would influence whether biological or bewitchment explanations were provided, and help clarify the factors contributing to the co-existence of biology and witchcraft explanatory systems.

4. Study 1

Study 1 presented three tasks: (a) *causal explanations task* in which participants were asked to endorse which causal factors account for a character's illness; (b) *hidden nature task* in which participants were asked whether one can have an illness without knowing it; and (c) *symptoms/disease task* in which participants were asked whether symptoms cause disease or vice versa. In order to determine if participants reasoned differently about AIDS versus a less serious, transient illness (flu), we also systematically varied whether the characters in the tasks were labeled as suffering from AIDS or the flu.

Our primary interest was in the causal explanations task in which multiple explanatory systems (biological, bewitchment, and moral) were investigated. However, the additional two tasks are also important for examining participants' overall knowledge of the illnesses under investigation, and to determine how bewitchment beliefs relate to other important beliefs about disease.

In the causal explanations task, the research design permitted participants to identify more than one causal explanation for each illness under investigation. The choices included biological explanations (e.g., being infected by blood; being sneezed on), bewitchment explanations (e.g., curses, spells), moral explanations (e.g., punishment for wrongdoing), and irrelevant explanations (e.g., wearing a blue sweater). Although our primary focus is on biological and bewitchment explanations, moral explanations provide an interesting contrast case, given their salience in the literature (e.g., Turiel, 2006). Irrelevant explanations provide a control to determine if any participants are simply endorsing any option presented to them.

The hidden nature task assessed what participants know about the unobservable or "hidden" nature of illness. In the case of contagious disease, the cause of illness is microscopic and not readily observable. Furthermore, there is an incubation period after infection that prevents the opportunity to observe an immediate cause-effect relation (Kalish, 1999). This is especially true in the case of AIDS, where the incubation period can be extraordinarily long. Given that children lack a detailed understanding of the biological mechanisms that underlie illness (Au, Romo, & Dewitt, 1999), and have difficulty understanding the incubation period of illness (Kalish, 1996; Raman & Gelman, 2007), they may have difficulty appreciating their hidden nature. To address this issue, participants were provided with vignettes designed to assess the understanding that a person can be sick and not show symptoms, and that a person can be infected with an illness and not know it. Existing literature on developmental differences in

illness understanding suggests that young children may be less likely than older children to appreciate non-observable signs of illness and physical injury (Peltzer & Promtussananon, 2003).

The symptoms/disease task examines participants' understanding that having a particular disease leads to its symptoms, and not vice versa. Peltzer and Promtussananon (2003) proposed that young South African children tend to confuse strategies for preventing illness with procedures for relieving symptoms. However, that work was based on informal, open-ended interview questions that required considerable verbal skills. In contrast, the present study used a forced-choice task, thereby allowing young children to demonstrate their understanding without having to articulate it explicitly.

4.1. Method

4.1.1. Participants

Participants included 5-, 7-, 11-, and 15-year-old Sesotho-speaking children living in a peri-urban settlement outside of Johannesburg in the Gauteng province of South Africa ($n = 32$ per age group, total $N = 128$). Participants all attended local schools in their community; Grades 0, 1, 5, and 9, respectively. For comparison purposes, a sample of 10 adults was also interviewed. The age range for the adults was 29 years old to 51 years old ($M = 38$ years old). Although the adults were not the children's parents, the adults were members of the same community as the children, and all had fewer than 3 years of formal education.

Equal numbers of male and female participants were included. The age ranges were 4.8 to 5.8 ($M = 5.4$) for the 5-year-olds, 6.7 to 7.9 ($M = 7.3$) for the 7-year-olds, 10.4 to 12.3 ($M = 11.3$) for the 11-year-olds, and 14.8 to 16 ($M = 15.4$) for the 15-year-olds. The participants came from very low-income homes with parents who have very little Western-style education. Due to the lack of opportunity for South African Blacks to attend school prior to 1994, the vast majority of the parents of the participants interviewed for this study had little or no formal education.

The peri-urban township of Orange Farm is located in the southwest of the Gauteng province. The participants came from a community located in the southwest corner of this township. There is very limited economic development in this area, and livelihoods are dependent almost entirely on the informal business sector, pensions, and small child welfare grants. According to the census taken in 2001 (Stats Online, 2005), at the provincial level, only 54% of the total workforce in Gauteng was employed, and monthly incomes were less than R1600 (US \$230) for 62% of households.

The Gauteng province has the third-highest HIV prevalence in South Africa. In 2005, a national survey conducted by the South African Department of Health found that HIV prevalence among pregnant women attending public antenatal clinics in Gauteng was 32.4% (Department of Health, 2005).

Collapsing across ethnic groups, the literacy rate in Gauteng is approximately 75% (Stats Online, 2005), although this rate should probably be regarded as an overestimate. Estimates for the literacy rate vary considerably, from 50% to 93%. In addition, literacy rates are most often based on self-report data or years of education. At the provincial level, 8% of the population have no formal education, 11% have some primary education, 6% have completed primary

school, 34% have some secondary education, and 28% have completed grade 12 (Stats Online, 2005).

4.2. *Materials and procedures*

The interviews were conducted in Sesotho, the native language of the participants. The questionnaire was initially translated into Sesotho from English by native speakers of Sesotho, who were fluent in English, and then back-translated by additional bilingual research assistants to check for reliability. Discrepancies with the translation were resolved using a team of bilingual, native Sesotho speakers. Interviews were conducted by bilingual research assistants that are members of the same ethnic and cultural group as the participants.

For the causal explanation task, each participant was presented with four vignettes describing symptoms of illness. For each vignette, following a description of a character with the illness, response choices were provided as potential causal explanations. There were five causal explanations for each vignette: Two were biological, two were non-biological, and one was irrelevant. Participants were asked to endorse or reject each individual explanation and could, therefore, accept or reject any or all of the explanation types. Both the four vignettes and the causal explanations within each vignette were presented in a random order, with separate random orders for each participant. Biologically based explanations included both a biological casual contagion explanation (e.g., playing with someone who is sick) and a biological blood explanation (e.g., blood mixing). The non-biologically based choices included moral explanations (i.e., illness as punishment for wrongdoing), bewitchment explanations (i.e., witchcraft resulting from jealousy and ancestral displeasure), and irrelevant explanations (e.g., getting dressed; see Table 1). After responding to the forced-choice questions, the participants were given an opportunity to explain their choices.

In order to determine if participants reasoned differently about AIDS versus other illnesses, we also systematically varied whether the characters in the vignettes were labeled as suffering from AIDS or the flu. The symptoms described were identical for the AIDS and the flu versions of the vignettes. Illness type was a between-subject variable; one half of the participants responded to the AIDS vignettes and one half to the flu vignettes.

Table 1
Study 1: Sample causal explanation vignette

Question	Possible Explanation
I know a person named Lerato. She is not feeling well/feeling sick. She has been feeling sick for a few days. Her body aches and she has a runny nose. She doesn't feel like eating and feels tired all the time. Lerato has AIDS. Why do you think Lerato got AIDS?	<ul style="list-style-type: none"> • (Biological blood) Lerato went to an inyanga who used a razor with someone else's sick blood on it to make some cuts in her hand, is that why she got AIDS? Why? • (Biological casual contagion) Lerato played with another girl was sick, is that why she got AIDS? Why? • (Moral) Lerato lied to her mother, is that why she got AIDS? Why? • (Bewitchment) Lerato has been bewitched by a neighbor who is jealous of her, is that why she got AIDS? Why? • (Irrelevant) Lerato drew a picture on some paper, is that why she got AIDS? Why?

Vignettes designed to assess children's beliefs concerning the hidden nature and symptoms/disease relationship of AIDS were presented following the causal explanation questions. There were two hidden nature and two symptom/disease vignettes; the four vignettes were presented in random order. One of the hidden nature vignettes asked about the character's ability to detect his or her own illness, and the other asked about the character's ability to detect someone else's illness. For the AIDS condition, each symptom/disease vignette asked about two different perceptible symptoms of AIDS: red spots on the skin and weight loss. For the flu condition, each symptom/disease vignette asked about two different perceptible symptoms of the flu: runny nose and cough. A sample hidden nature vignette is the following:

Here are two people I know, Thabang and Moshe, and they have different ideas about AIDS. Thabang says that you can always tell if someone has AIDS. Moshe says you can't always tell if someone has AIDS. Who do you think is right, Thabang who thinks that you can always tell if someone has AIDS or Moshe, who thinks that you can't always tell who has AIDS? Why?

A sample symptom/disease vignette is the following:

Here are two people I know, Mpho and Paul, and they have different ideas about AIDS. Mpho says that when people have AIDS they get very thin. Mpho says that the AIDS illness makes people become thin. Paul says that when people are very thin, they get AIDS. Paul says that being very thin makes people get AIDS. Who do you think is right, Mpho who thinks that AIDS makes people thin or Paul who thinks that being thin makes people get AIDS? Why?

The hidden nature questions were designed to assess whether children understand that one can be sick or have AIDS and not know it, and that you cannot always tell if someone else is sick or has AIDS. The symptom/disease questions were designed to investigate whether children understand that illness results in symptoms and not the other way around. The participants who received the AIDS illness vignettes for the first part of the interview received the AIDS hidden nature and symptom/disease vignettes in the second section of the interview. Those who received the flu illness vignettes for the first part of the interview received the flu hidden nature and symptom/disease vignettes in the second section of the interview.

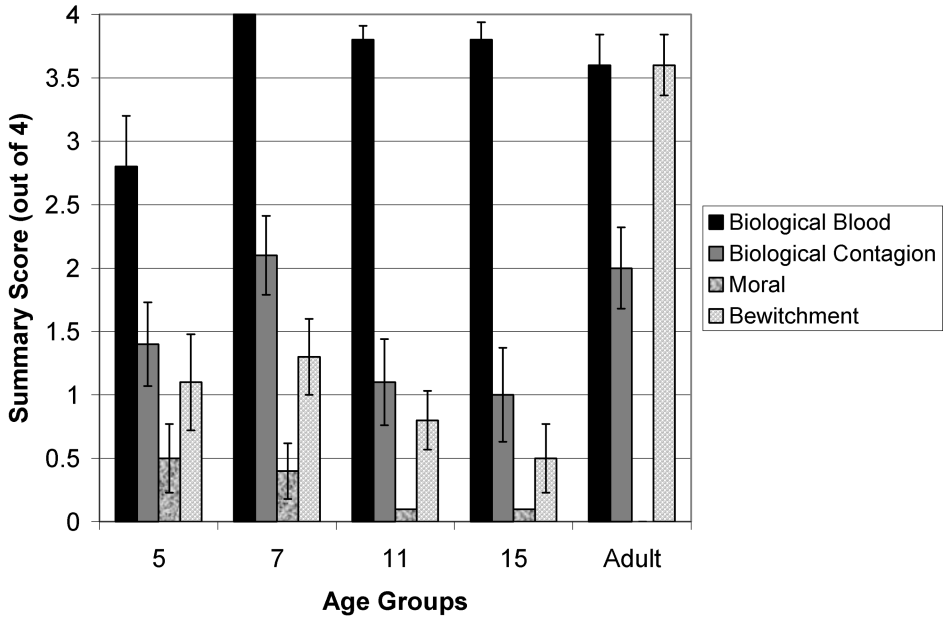
4.3. Results

The results of the causal explanation measure are presented first, followed by the results of the symptom/disease and hidden nature measures.

4.3.1. Causal explanation task

We investigated the kinds of causal explanations endorsed by South African children and adults to study the co-existence of diverse causal beliefs concerning illness. We were also interested in whether the endorsement of causal explanation types varied by age group and illness. Fig. 1a presents the mean number of causal explanations by age group for the AIDS condition, and Fig. 1b presents the mean number of causal explanations by age group for the flu condition. We conducted an Age Group \times Illness Type \times Causal Explanation Type repeated measures analysis of variance (ANOVA) with causal explanation type as a within-subjects factor, and age group and illness type as between-subject factors. The number of "yes"

(a)



(b)

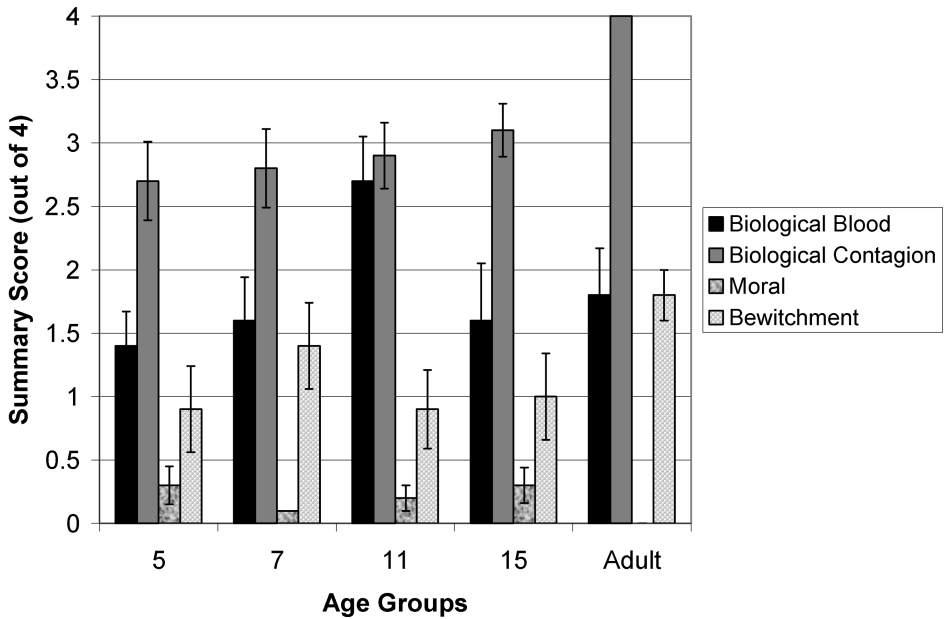


Fig. 1. (a) Study 1: Mean number of causal explanations by age group for the AIDS condition. (b) Study 1; Mean number of causal explanations by age group for the flu condition.

responses to each kind of explanation type (ranging from 0–4, because there were 4 vignettes total) was the dependent variable. We obtained a main effect for explanation type, $F(4, 512) = 208.82$, $p < .001$, indicating that overall biological explanations (biological blood and biological casual contagion explanations) were endorsed more often than non-biologically based explanations (bewitchment and moral explanations). Post-hoc tests using Bonferroni's correction revealed significantly higher endorsement of biologically based explanations than non-biologically based explanations for all explanation types ($p < .001$).

There was also a significant Explanation Type \times Illness interaction, $F(4, 512) = 57.49$, $p < .001$. For the AIDS condition, biological blood explanations were most frequently endorsed, followed by biological contagion, bewitchment, and moral explanations (see Fig. 1a; $ps < .001$). In contrast, for the flu condition, biological contagion explanations were most frequently endorsed, followed by biological blood, bewitchment, and moral explanations (see Fig. 1b; $ps < .001$).

There was a significant Explanation Type \times Age Group interaction, $F(16, 512) = 3.38$, $p < .001$. At all ages, with the exception of the adults, biologically based (blood and contagion) explanations were preferred. Adults strongly endorsed both biologically based explanations and bewitchment explanations. Although younger children endorsed bewitchment less than biological explanations, at nearly every age bewitchment was endorsed significantly more than either moral explanations (7-, 11-, 15-year-olds, and adults) or irrelevant explanations (all age groups).

The three-way Explanation Type \times Illness \times Age Group interaction was also significant, $F(16, 512) = 2.06$, $p < .01$. The Illness \times Explanation Type interaction was significant within each age group ($ps < .001$). Furthermore, although there were no differences between illnesses in bewitchment explanations for children, adults endorsed bewitchment explanations significantly more often for AIDS ($M = 3.6$) than flu ($M = 1.8$), $p < .05$. All participants of all age groups endorsed biologically based explanations (biological blood, biological casual contagion, or both) for at least one of the vignettes. Although bewitchment endorsement scores were not as frequent as biologically based explanations, 47% of 5-year-olds, 59% of 7-year-olds, 47% of 11-year-olds, 34% of 15-year-olds, and 100% of adults endorsed at least one of the bewitchment explanations. Table 2 provides an overview of the percentage of participants in each age group that endorsed both biological and bewitchment explanations within the same vignette. There were significant differences by age group, $F(4, 137) = 4.42$, $p < .01$. Adults were significantly more likely to endorse both biological and bewitchment explanations within the same vignette than 5-, 11-, and 15-year-olds ($ps < .05$).

Note that all of the participants who endorsed bewitchment also endorsed biologically based explanations. Therefore, it is not the case that participants appeal to bewitchment because they *lack* an appreciation of biological explanations. Rather, bewitchment and biological causes co-exist within individuals. In contrast, no more than 15% of participants in any age group endorsed either moral explanations or irrelevant explanations at least once.

In addition to the quantitative analyses above, data from the open-ended questions were coded. Responses that acknowledged that bewitchment, supernatural intervention, or both could be responsible for illness, misfortune, bad luck, or death were coded as endorsing bewitchment. Interrater reliability was 91%. A total of 90% of participants provided at least one explanation following the forced-choice questions. The results indicated that 72% of the

Table 2

Studies 1 and 2: Percentage of participants in each age group endorsing both biological and bewitchment explanations within the same vignette

Age Groups	One Vignette	Two Vignettes	Three Vignettes	Four Vignettes	Total
Study 1					
5-year-olds	22	3	13	9	47
7-year-olds	13	22	25	0	59
11-year-olds	19	22	3	3	47
15-year-olds	13	9	6	6	34
Adults	0	0	10	90	100
Study 2					
5-year-olds	21	8	21	13	58
7-year-olds	4	25	26	13	67
11-year-olds	17	17	12	8	54
15-year-olds	13	13	12	0	38
Adults	10	13	15	12	50

participants spontaneously endorsed bewitchment at least once (59% of 5-year-olds, 84% of 7-year-olds, 78% of 11-year-olds, 69% of 15-year-olds, and 70% of adults). Overall, these data indicate that the yes–no questions may have underestimated participants' endorsement of bewitchment as an explanation for causing illness. The explanations following the yes–no questions often indicated that children intended to reject the specific example, not the more general concept of bewitchment. For example, some children disagreed with the example of jealousy described in the vignette, but still reported that bewitchment could play a role in contracting illness in some other way. One 11-year-old girl said, after rejecting a specific bewitchment explanation involving anger on the part of ancestors, "Only jealous people who hate you would try to bewitch you; the ancestors can't hear you."

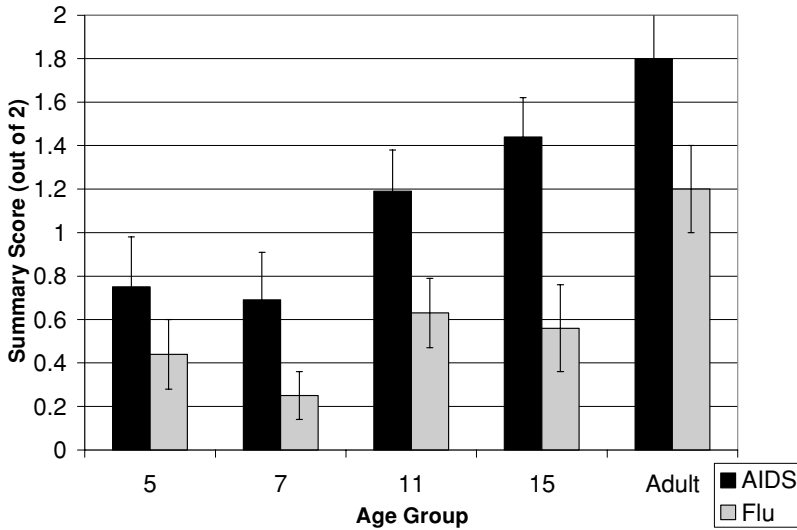
4.3.2. Hidden nature task

In order to investigate how children and adults think about the hidden nature of AIDS and the flu, a univariate ANOVA was conducted, with age and illness as between-subject factors. The dependent variable was the number of trials (out of 2) on which participants reported that illness was not perceptible through observation. We found a main effect for age group, $F(4, 128) = 5.29, p < .001$, indicating that there was a developmental increase in understanding the hidden nature of illness; that is, that one can be sick without knowing it. We also found a main effect for illness type, $F(1, 128) = 5.19, p < .05$, indicating that participants were more likely to acknowledge the undetectable nature of AIDS than the flu (see Fig. 2a). When comparing responses within each age group and illness condition against chance, we found that for the AIDS condition, only 15-year-olds and adults were above chance ($ps < .05$). For the flu condition, adults were above chance ($p < .05$), and all other age groups were below chance.

4.3.3. Symptom/disease task

In order to investigate beliefs concerning the relationship between illness and symptoms (i.e., whether illness precedes symptoms or symptoms precede illness), a univariate ANOVA was conducted, with age and condition as between-subject factors. The dependent variable

(a)



(b)

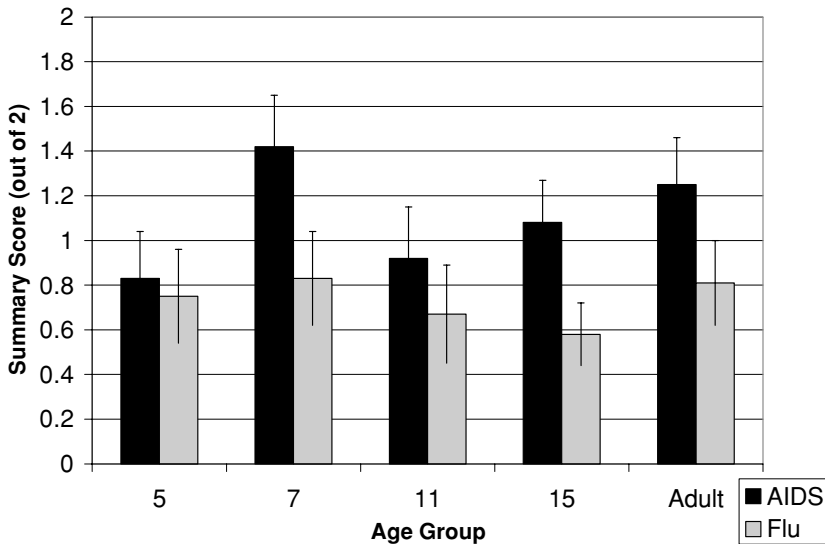


Fig. 2. (a) Study 1: Mean hidden nature scores by age group and illness type. (b) Study 2: Mean hidden nature scores by age group and illness type.

was the number of trials (out of 2) on which participants ordered the illness before the symptoms. There were no significant effects. We compared responses within each age group and illness condition against chance, and found that each age group was significantly above chance ($p < .001$). Thus, children in all age groups understand that for both AIDS and flu, infection precedes physical symptoms (see Table 3).

Table 3

Studies 1 and 2: Mean number of trials (out of 2) on which participants reported that illness precedes physical symptoms

Age Group	AIDS Condition		Flu Condition	
	M	SD	M	SD
Study 1				
5 years	1.72	.45**	1.50	.63**
7 years	1.81	.40**	1.75	.45**
11 years	1.78	.45**	1.69	.60**
15 years	1.77	.42**	1.87	.50**
Adults	2.00	.00**	2.00	.00**
Study 2				
5 yrs	0.92	.51	1.08	.90
7 yrs	0.92	.79	1.42	.67
11 yrs	1.25	.62	1.50	.67*
15 yrs	1.64	.50**	1.77	.44**
Adults	1.00	.82	1.25	.68

* $p < .05$ (compared to chance). ** $p < .001$ (compared to chance).

In a supplementary analysis, we investigated whether endorsement of bewitchment explanations is related to whether participants were correct on the hidden nature and symptom/disease task. Two univariate ANOVAs indicated that endorsing bewitchment does not significantly predict whether participants were correct on the hidden nature or symptom/disease task, indicating that belief in bewitchment does not correspond to ignorance about disease.

4.4. Discussion

The primary objective of this study was to examine the co-existence of causal explanations for illness in the South African context, where multiple explanatory frameworks are available. We were also interested in whether and how children reason differently about AIDS versus other illnesses (such as the flu). Further, we wished to investigate the development of beliefs about the hidden nature and symptom/disease relationship of AIDS and the flu.

Overall, in this South African sample, biological causes were most prominent at all ages, and moral explanations were rarely endorsed (similar to what has been found in U.S. samples). The rejection of moral explanations for illness is interesting and demonstrates that immanent justice reasoning is not a universal phenomenon. However, the most important novel result was that bewitchment explanations were endorsed fairly often (especially among adults), alongside the biological explanations. For example, one woman explained, "Witchcraft is like germs in some ways, but witchcraft is also different. It (witchcraft) makes people get sick and die, or go crazy, or have bad luck by using muthi and herbs mixed with evil spirits."

Several aspects of the data suggest that bewitchment explanations truly *co-existed* with biological explanations, and did not serve as a default explanatory framework when accurate biological knowledge was lacking. First, participants of all age groups correctly identified

the symptom/disease relationship of both AIDS and the flu, indicating an understanding that illness precedes symptoms. Even those participants who endorsed bewitchment demonstrated this understanding. Second, understanding the hidden nature of disease increased steadily with age, but we do not see a corresponding decrease with age in bewitchment beliefs. Indeed, at the age that understanding of hidden nature is highest (adulthood), participants are most likely to endorse bewitchment. Put somewhat differently, to the extent that acknowledging the hidden nature of illness is indicative of general biological knowledge of illness, increasing knowledge about disease does *not* correspond to decreasing endorsement of bewitchment (or vice versa). Finally, participants were more likely to endorse the physical undetectability of AIDS than the flu, but bewitchment beliefs were no lower for AIDS than the flu (and in some instances were higher for AIDS). Thus, in several respects, increased understanding of the biological nature of disease is independent of endorsement of bewitchment.

Although adults often endorsed bewitchment beliefs, children were much less likely to do so. One possible explanation for this sharp developmental increase is that children in a peri-urban setting are more exposed to AIDS education programs. Explicit information that AIDS is *not* attributable to witchcraft is provided to school children during health education classes and media-based public health education programs. Likewise, the overall high endorsement of biological explanations could be a function of the greater urbanization of the sample in Study 1. We therefore wished to study these beliefs in a rural setting, with less exposure to such programs and less exposure to Western medical practices. Study 2 tests this possibility directly by investigating causal explanatory frameworks for AIDS and the flu in a rural Sesotho-speaking community.

In addition, we wished to study beliefs about two distinct kinds of bewitchment: ancestral displeasure and (interpersonal) jealousy. Evidence from the anthropological literature suggests that both kinds of bewitchment are believed to be associated with misfortune, death, and illness (Ashforth, 2005). Due to the complexity and contextual specificity associated with bewitchment explanations, we reasoned that the opportunity to endorse (or reject) an increased number of bewitchment explanations would provide us with more detailed information about the kinds of bewitchment explanations associated with AIDS and illness.

5. Study 2

Study 2 examined causal explanations for illness in a rural community, in order to enable a comparison with the peri-urban community in Study 1. By selecting a community with the same cultural and linguistic background as the participants in Study 1, we can determine whether we replicate the findings from Study 1 (in particular, the endorsement of bewitchment beliefs, with developmental changes in their frequency). Due to the small sample of adults in Study 1 ($n = 10$), a larger sample of adults was recruited for Study 2. In addition, by selecting a community with less access to Western-style medicine or formal AIDS education programs in the schools, we can investigate potential differences in endorsements of biological and bewitchment explanations (Schlebusch & Ruggieri, 1996). One possibility is that biological explanations would be less frequently endorsed in a rural sample due to reduced access to

biological explanations for illness, and correspondingly, that bewitchment explanations would be more frequently endorsed. Another possibility is that biological explanations serve as a default explanatory framework and therefore would be strongly endorsed in all samples, with bewitchment explanations next most frequently endorsed.

5.1. Method

5.1.1. Participants

Participants included 5-, 7-, 11-, and 15-year-old Sesotho-speaking children and adults living in the former Bantustan (Black homeland) of Qwa-Qwa in the northeastern region of the Free State province of South Africa ($n = 24$ per age group for the children, $n = 32$ adults, total $N = 128$). The interviews were conducted in Sesotho, the native language of the participants. Approximately 48% of the participants were male.

The age ranges were 5.0 to 6.1 ($M = 5.6$) for the 5-year-olds, 6.8 to 8.1 ($M = 7.5$) for the 7-year-olds, 10.6 to 11.9 ($M = 11.3$) for the 11-year-olds, and 14.9 to 16.1 ($M = 15.5$) for the 15-year-olds. The age range for the adults was 21 years old to 73 years old ($M = 53$ years old). The adults were members of the same community as the children, and had on average about 3 years of formal education. With the exception of the adult sample, participants all attended local schools in their community.

The former Bantustan of Qwa-Qwa was developed for the Basotho (Sesotho-speaking) ethnic group as part of the “separate development” policy of the apartheid government. The participants came from a very low-income community in the rural areas on the edge of the more densely populated city of Phuthaditjaba. There is very limited economic development in this area, and livelihoods are dependent almost entirely on the informal business sector, pensions, and small child welfare grants. According to the census taken in 2001 (Stats Online, 2005), only 23% of the total workforce in Maluti-a-Phofung is employed, and monthly incomes are less than R500 (US\$80) for 69% of people.

Cohort differences in access to formal education are very dramatic in South Africa due to apartheid policies of racial inequality, especially in formerly Black homelands. The literacy rate in the Free State province is reported as approximately 59%. According to the census taken in 2001, at the provincial level, 16% of persons aged 20 years and older have no formal education, 22% have some primary education, 8% have completed primary education, and an additional 31% have completed some high school education. Only 23% of the population has completed Grade 12 (high school; Stats Online, 2005).

Due to the lack of opportunity for South African Blacks to attend school prior to 1994, the amount of education of the adults and adolescents interviewed for this study varied from 1 year of schooling to a high school diploma. The adults were members of the same community as the children, and on average had fewer than 4 years of formal education.

The Free State province has the fifth-highest HIV prevalence in South Africa. In 2005, a national survey conducted by the South African Department of Health found that HIV prevalence among pregnant women attending public antenatal clinics in the Free State province was 30.3% (Department of Health, 2005). Up to 35% of the population residing in the Maluti-a-Phofung municipality is infected with HIV.

5.2. Materials and Procedures

As in Study 1, for the causal explanations task, each participant was presented with four vignettes describing symptoms of illness. For each vignette, following a description of a character with the illness, response choices were provided as potential causal explanations. The vignettes and causal explanations used in Study 2 were identical to those of Study 1, with the exception of an additional category of bewitchment explanation in Study 2. A total of four additional bewitchment explanations were added to the vignettes in Study 2: two based on ancestral displeasure and two based on jealousy:

Ancestral displeasure: “Thandeka has been cursed by her ancestors for doing things that displeased them. Could that be why she got HIV/AIDS?”

“Andani was bewitched by her ancestors for not doing proper rituals for them. Could that be why he got HIV/AIDS?”

Jealousy: “Moshe has been bewitched by his jealous mother-in-law who used muthi to put a curse on him. Could that be why he got HIV/AIDS?”

“Sipho had a curse put on him because he was very stingy and never shared with others. Could that be why he got HIV/AIDS?”

Due to the addition of two separate kinds of bewitchment explanations, there were six causal explanations for each vignette: Two were biological, two were bewitchment, one was moral, and one was irrelevant. Participants were asked to endorse or reject each individual explanation and could, therefore, accept or reject any or all of the explanation types. As in Study 1, one half of the participants were interviewed using vignettes that discuss people with AIDS, and one half of the participants were interviewed using vignettes that discuss people who have the flu. Other than the label of having AIDS or having the flu, the vignettes were identical.

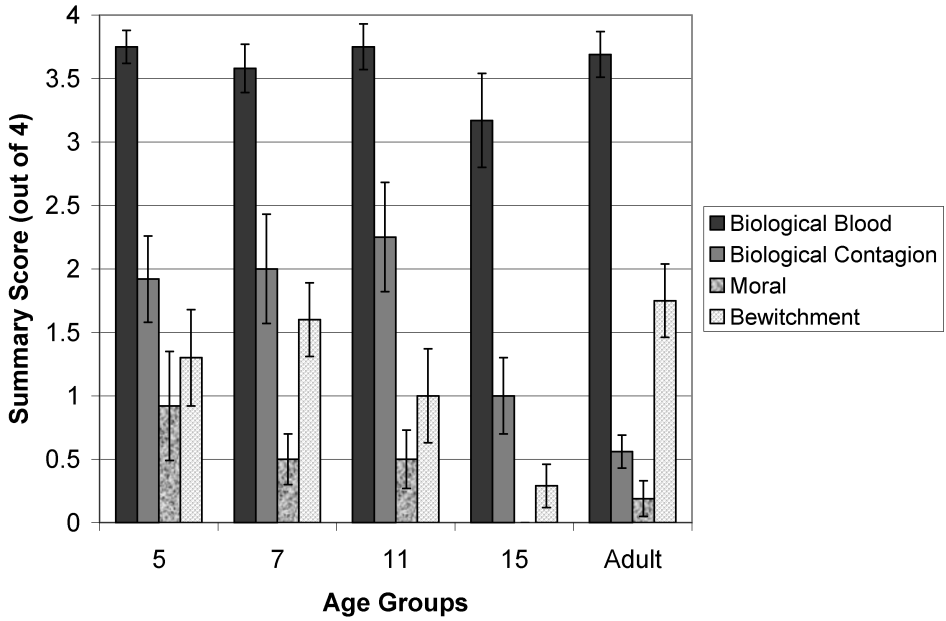
5.3. Results

The results of the causal explanation measure are presented first, followed by the results of the hidden nature and symptom/disease tasks, and then a comparison of the results of Studies 1 and 2.

5.3.1. Causal explanation task

We investigated the kinds of causal explanations endorsed by South African children and adults in a rural community, in order to assess the generalizability of the results of Study 1. We were also interested in whether the endorsement of causal explanation types varied by age group and illness. Fig. 3a presents the mean number of causal explanations by age group for the AIDS condition, and Fig. 3b presents the mean number of causal explanations by age group for the flu condition. We conducted an Age Group \times Illness Type \times Causal Explanation Type repeated measures ANOVA, with causal explanation type as a within-subjects factor, and age group and illness type as between-subject factors. Preliminary analyses indicated that endorsements of bewitchment beliefs based on ancestral displeasure were not consistently

(a)



(b)

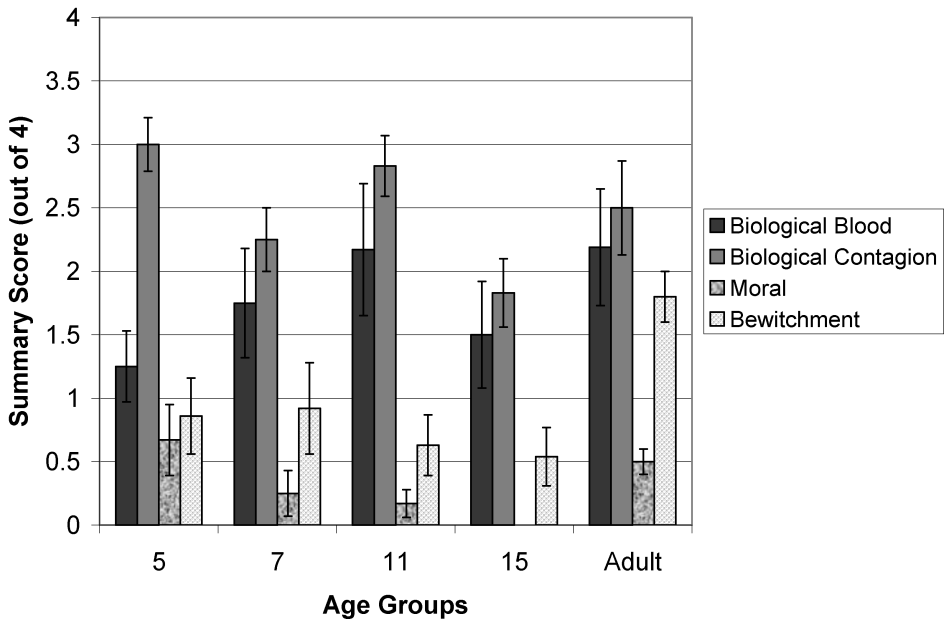


Fig. 3. (a) Study 2: Mean number of causal explanations by age group for the AIDS condition. (b) Study 2: Mean number of causal explanations by age group for the flu condition.

different from endorsements of bewitchment beliefs based on jealousy; therefore, we collapsed the two kinds of bewitchment explanations together and divided by 2. The number of “yes” responses for each kind of explanation (ranging from 0–4) was the dependent variable. We obtained a main effect for explanation type, $F(4, 472) = 206.56$, $p < .001$, indicating that, overall, biological explanations (biological blood and biological casual contagion) were endorsed more often than non-biological explanations (bewitchment, moral, and irrelevant). Post-hoc tests using Bonferroni’s correction revealed significantly higher biological than non-biological explanations for all explanation types ($p < .001$). Bewitchment explanations were the next most frequently endorsed, especially by adults and 5- and 7-year-olds. In addition, post-hoc tests confirm that, overall, participants endorsed both kinds of bewitchment explanations more than either the moral or irrelevant explanations ($p < .001$).

There was a significant Explanation Type \times Illness interaction, $F(4, 47) = 43.03$, $p < .001$. As in Study 1, analyses indicated that biological blood explanations were endorsed significantly more often for AIDS (see Fig. 3a) than for the flu (see Fig. 3b; $p < .001$) whereas biological casual contagion explanations were endorsed significantly more often for the flu than for AIDS ($p < .001$). There were no significant differences between illnesses in moral explanations or between illnesses in bewitchment explanations.

The Explanation Type \times Age Group interaction was also significant, $F(16, 472) = 4.18$, $p < .001$. Biological contagion explanations were endorsed more often in 5- and 11-year-olds than in 15-year-olds and adults ($ps < .05$). It is interesting to note that, as in Study 1, bewitchment endorsements decreased among 11- and 15-year olds, followed by an increase among adults. Both 7-year-olds and adults endorsed bewitchment explanations significantly more than moral and irrelevant explanations ($p < .001$), whereas 11- and 15-year-olds endorsed bewitchment, moral, and irrelevant explanations to the same (low) extent. In addition, although 5-year-olds endorsed bewitchment explanations more than irrelevant explanations (as in Study 1), they endorsed bewitchment and moral explanations to the same extent. Unlike Study 1, the Age Group \times Illness Type \times Causal Explanation Type interaction was not significant.

All but 2 participants (1 adult, one 15-year-old) endorsed biologically based explanations (biological blood, biological casual contagion, or both) for at least one of the vignettes. Although bewitchment endorsement scores were not as high overall as biologically based explanations, 58% of 5-year-olds, 67% of 7-year-olds, 54% of 11-year-olds, 38% of 15-year-olds, and 50% of adults endorsed at least one of the bewitchment explanations. Table 2 provides an overview of the percentage of participants in each age group that endorsed both biological and bewitchment explanations within the same vignette. There were significant differences by age group, $F(4, 127) = 3.72$, $p < .01$. Adults were significantly more likely to endorse both biological and bewitchment explanations within the same vignette than were 15-year-olds ($p < .01$).

All of the participants who endorsed bewitchment also endorsed biologically based explanations. Therefore, it is not the case that participants appeal to bewitchment because they lack an appreciation of biological explanations. Rather, bewitchment and biological causes co-exist within individuals.

As in Study 1, data from the open-ended questions were also coded. Responses that acknowledged that bewitchment or supernatural intervention, in general, could be responsible

for illness, misfortune, bad luck, or death were coded as endorsing bewitchment. Interrater reliability was 94%. Overall, possibly due to the lack of experience many participants had with one-on-one questioning by a non-family member, fewer of the children and adolescents in Study 2 gave explanations to the open-ended portion of this study than in Study 1. However, of the 60% of participants who gave an explanation following their yes–no response to a vignette, 75% of them spontaneously mentioned bewitchment at least once. Analyzed by age group, of the participants who gave an explanation, 67% of 5-year-olds, 78% of 7-year-olds, 63% of 11-year-olds, 63% of 15-year-olds, and 80% of adults spontaneously acknowledged bewitchment at least once. These data provided further evidence of the salience of bewitchment explanations, as well as their context specificity. As in Study 1, often when participants rejected a specific bewitchment explanation, they nonetheless went on to endorse bewitchment. For example, according to an 11-year-old girl, “People can bewitch you because they hate you but ancestors won’t hurt you. You do special things for them so they can help you.”

5.3.2. *Hidden nature task*

In order to investigate how children and adults think about the hidden nature of AIDS and the flu, a univariate ANOVA was conducted with age and illness as between-subject factors. The dependent variable was the number of trials (out of 2) on which participants reported that illness was not detectable through observation. We found a main effect for illness type, $F(1, 128) = 7.84, p < .01$, indicating that participants were more likely to acknowledge the undetectable nature of AIDS than the flu, as was also found in Study 1. However, unlike Study 1, the main effect of age group was not significant, reflecting lower scores for both children and adults in this study (see Fig. 2b).

5.3.3. *Symptom/disease task*

In order to investigate beliefs concerning the relationship between symptoms and disease (i.e., whether illness precedes symptoms or symptoms precede illness), a univariate ANOVA was conducted with age and condition as between-subject factors. The dependent variable was the number of trials (out of 2) in which participants ordered the illness before the symptoms. We found main effects for age group, $F(4, 118) = 3.99, p < .005$ and condition, $F(1, 118) = 4.59, p < .05$, indicating that accuracy was higher among 15-year-olds than either 5-year-olds or adults ($ps < .05$). Overall, accuracy of the symptom/disease relationship was higher for the flu than for AIDS (see Table 3). When comparing responses within each age group and illness condition against chance, we found that 11-year-olds were above chance for the flu condition ($p < .05$), and only 15-year-olds were above chance for both the AIDS and flu conditions ($p < .001$).

5.4. *Comparing Studies 1 and 2*

To compare the kinds of causal explanations endorsed by South African children living in peri-urban and rural areas, we conducted a statistical analysis comparing the results of Studies 1 and 2. The extra causal explanation items used in Study 2 that were not used in Study 1 were dropped for the purposes of this analysis to make the two studies comparable. Specifically, we

conducted an Age Group \times Illness Type \times Causal Explanation Type \times Study (1 or 2) repeated measures ANOVA, with causal explanation type as a within-subjects factor, and age group and illness type as between-subject factors. The number of “yes” responses (ranging from 0–4) was the dependent variable. Here we report only those significant results involving study as a factor. The Explanation Type \times Study (1 or 2) interaction was significant, $F(4, 984) = 2.73$, $p < .05$. Post-hoc tests indicate that moral explanations were more frequently endorsed in Study 2 than in Study 1 ($p < .05$). In addition, although irrelevant explanations were endorsed very infrequently in both studies, they were endorsed relatively more frequently in Study 1 than in Study 2. The three-way Explanation Type \times Age Group \times Study interaction was also significant, $F(16, 984) = 2.00$, $p < .01$. Post-hoc tests indicate that 5-year-olds endorsed moral explanations significantly more frequently in Study 2 than in Study 1. In addition, both 15-year-olds and adults endorsed biological casual contagion explanations more frequently in Study 1 than in Study 2 ($ps < .05$).

We compared performance on the hidden nature task between the two populations in Studies 1 and 2; conducting a univariate ANOVA with age group, condition, and Study (1 or 2) as between-subject factors. The dependent variable was the number of trials (out of 2) on which participants reported that illness was not detectable through observation. We found a main effect for study, $F(1, 246) = 3.98$, $p < .05$, indicating that performance on the hidden nature task was higher in Study 1 than in Study 2. The Age Group \times Study interaction, $F(4, 246) = 3.17$, $p < .01$, and the Condition \times Study interaction, $F(1, 246) = 12.82$, $p < .001$, were also significant. Post-hoc tests indicate that 11-year-olds, 15-year-olds, and adults performed better in Study 1 than in Study 2 ($ps < .05$). Unlike the general trend, 7-year-olds performed better in Study 2 than in Study 1 ($ps < .05$). In addition, performance was higher for the AIDS condition in Study 1 than in Study 2 ($p < .001$). There were no significant differences in performance in the flu condition across studies.

We next compared performance on the symptom/disease task between the two populations in Studies 1 and 2; conducting a univariate ANOVA with age group, condition, and Study (1 or 2) as between-subject factors. The dependent variable was the number of trials (out of 2) in which participants ordered the illness before the symptoms. We found a main effect for study, $F(1, 246) = 46.08$, $p < .001$, indicating that performance on the symptom/disease task was higher in Study 1 than in Study 2. The Age Group \times Study interaction, $F(4, 246) = 2.67$, $p < .05$, and the Condition \times Study interaction, $F(1, 246) = 4.06$, $p < .05$, were also significant. Post-hoc tests indicate that 5-year-olds, 7-year-olds, 11-year-olds, and adults performed better in Study 1 than in Study 2 ($ps < .05$). In addition, performance was higher for both the AIDS and the flu condition in Study 1 than in Study 2 ($p < .001$).

5.5. Discussion

Overall, the data from Study 2 replicate the results of Study 1 indicating that children and adults endorse both biological and bewitchment explanations for illness. The data also reveal considerable similarities between peri-urban and rural Sesotho-speakers in their explanatory belief systems. As in Study 1, we found that biological explanations were endorsed more frequently than bewitchment explanations, even though the rural sample had less formal education about the biological mechanisms associated with illness. However, most participants

endorsed bewitchment at least once, suggesting that bewitchment beliefs exist alongside the biological accounts. Additional support for co-existence of these explanatory systems is that a substantial percentage of participants of each age group endorsed both biological and bewitchment beliefs.

We had originally predicted that the rural sample would show greater endorsement of bewitchment than the peri-urban sample, but this was not found to be the case. Why was bewitchment not endorsed more frequently in Study 2? One clue can be found in the fact that bewitchment was offered more in spontaneous justifications than as endorsement of the vignettes we provided. Indeed, a substantial portion of the participants who provided explanations spontaneously mentioned bewitchment. Often when participants rejected a specific bewitchment explanation, they were rejecting that specific example or case of bewitchment, not the concept of bewitchment more generally. These data suggest that acceptance or rejection of bewitchment explanations may depend heavily on the context and details of how bewitchment is instantiated. This issue is addressed more directly in Study 3.

Our data also replicated another interesting age-related effect found in Study 1; namely, a decrease in bewitchment explanations among adolescents and a subsequent increase in bewitchment explanations among adults. We suspect that the explicit information children receive in school regarding witchcraft (that it is *not* a cause of AIDS) has a temporary effect but not a lasting impact. Overall, adults have more experience interpreting and reasoning about witchcraft-related practices than adolescents do. Witchcraft-related discourse is considered dangerous and highly secretive and is, therefore, not a casual topic of conversation. Thus, greater experience interpreting serious illness in this cultural context may supplement biological explanations for illness with non-biological explanations, not replace them. Decreased exposure to health education information coupled with increased experience with witchcraft-related belief systems would explain the U-shaped curve in the developmental data, with witchcraft explanations decreasing among older children and adolescents and increasing again among adults.

One notable difference between Studies 1 and 2 was that the rural population scored lower on the hidden nature and symptom/disease measures than did the peri-urban population. Performance on the hidden nature task was lower for 5- and 7-year-olds in the rural community than in the peri-urban community; and, with the exception of the 15-year-olds, performance on the symptom/disease measure was also lower for participants from the rural community across age groups. One possibility is that younger children living in the rural community have less access to health-related information in school. Nonetheless, despite the overall lower scores in the rural sample, participants in Study 2 endorsed biological explanations to the same extent as participants in Study 1 and were not, overall, more likely to endorse bewitchment explanations.

Based on the results of Studies 1 and 2, we suspect that bewitchment explanations may be highly dependent of the context of the illness (or misfortune)—that is, determining that witchcraft is involved in an illness may be based largely on the interpersonal and behavioral circumstances of the illness event. For example, background information about a person's status in the community, past behavior, and character are all relevant when determining whether to attribute illness or misfortune to witchcraft. This may require considerably more

contextual information than was available for the necessarily brief vignettes used in Studies 1 and 2. Therefore, we designed Study 3 to provide more detailed contextual priming. We based these vignettes on prior ethnographic data (Ashforth, 2005; Niehaus, 2001; Stadler, 2003) to determine more specifically the kinds of contexts that might be associated with bewitchment.

6. Study 3

We suspect that the process of determining when to attribute an unfortunate event to witchcraft is a very complex, contextually bound task. Assessing whether witchcraft is involved in illness, death, or both may require considerable background information about the person in question (Ashforth, 2005; Niehaus, 2001; Stadler, 2003). For example, not only are diagnoses of witchcraft typically determined retrospectively, but they require substantial information about the social context of the illness or misfortune in question (details of the individuals' behavior, motivations, interpersonal relationships, status in the community, past fortunes and misfortunes, etc.). Therefore, the kind of contextual information given should influence the kinds of explanations adolescents and children generate for AIDS (and unspecified, fatal illness generally). More specifically, we expected that the kind of contextual information given would influence whether participants generate biological or bewitchment explanations, and therefore would provide information about whether biological and witchcraft explanatory frameworks cohere in meaningful ways.

Our first objective in Study 3 was to investigate cultural belief systems concerning biological and non-biological explanations for AIDS and other illness, using a methodology that provided additional contextual information for participants to reason about, as well as an opportunity to provide their own explanations (as opposed to endorsing explanations provided in the interview). In order to do so, we used a priming technique (Harris & Gimenez, 2005). We created four different priming conditions that varied in the extent to which the context of the narrative primed biological risk-taking and bewitchment explanations.

Our second objective was to investigate whether AIDS was uniquely seen as linked to bewitchment, or whether bewitchment explanations are used more generally for any mysterious, unexpected serious illness. We included both AIDS and an unspecified, fatal illness as the illness types under investigation. Other than the illness labels, the priming conditions were exactly the same across the two illness types. Recall that Studies 1 and 2 revealed differences in participants' reasoning about AIDS versus the flu. In Study 3, we chose to compare AIDS to an unspecified illness (rather than a less serious illness such as the flu) in order to determine if the AIDS label had a unique impact on the kinds of explanations given. Although there is consensus in the anthropological literature that witchcraft is part of the repertoire of available causal interpretations for illness and misfortune in this cultural context, there is disagreement about whether witchcraft is targeted at AIDS specifically, or whether witchcraft is used to explain misfortune and illness more generally (Ashforth, 2005; Niehaus, 2001; Stadler, 2003). Although there are many intriguing similarities between diagnosing AIDS and making witchcraft attributions, witchcraft beliefs predated AIDS and, therefore, are likely to be used for a variety of illnesses.

6.1. Method

6.1.1. Participants

Participants in this study included five adult samples: ages 15 to 19 ($M = 17$), 20 to 29 ($M = 25$), 30 to 39 ($M = 35$), 40 to 49 ($M = 43$), and 50 to 75 ($M = 59$) years old ($n = 22$ per age group, total $N = 110$). None of the participants in this study participated in Studies 1 or 2, but all were members of the same community as in Study 2. Approximately 45% of the sample was male. Because the tasks in Study 3 discussed adult content and required participants to provide extensive explanations following lengthy descriptions of the vignettes, we chose to interview only older adolescents and adults. None of the adults were attending school.

6.2. Materials and procedures

Participants were presented with vignettes from four different priming types (2 vignettes per priming type, total of 8 vignettes). The vignettes provided background information about different fictional characters living in areas familiar to the participants, based on ethnographic data on cultural belief systems about illness (Ashforth, 2005; Niehaus, 2001). For each vignette, contextual information was given about the character's behavior and background, followed by information about the character becoming very sick, being treated (unsuccessfully) by both a medical doctor and a traditional healer, and finally dying of the illness. The four priming types were as follows: neither biological nor bewitchment primes ("neither" condition), both biological and bewitchment primes ("both" condition), biological primes only ("bio-only" condition), and bewitchment primes only ("bewitchment-only" condition). The biological primes were based on behavior known in the community to be risky (e.g., having relationships with more than one partner; frequenting *sheebens* [bars]). The bewitchment primes were based on behaviors that violate expectations for social reciprocity and generosity believed in this community to be associated with attracting witchcraft (e.g., attracting jealousy, lack of charity); see the Appendix. All participants responded to all four types of vignettes, which were blocked by condition and counterbalanced.

In order to investigate whether the kinds of explanations given would vary based on the type of illness, one half of the participants responded to vignettes that labeled the illness as AIDS, and one half of the participants responded to vignettes that left the disease unspecified. Otherwise, the vignettes were identical. The following follow-up questions were asked following each vignette: (a) Why do you think (character, e.g., Thabo) got sick (AIDS)? (b) What caused it? (c) Why did he get it and not someone else? Interviews were conducted in Sesotho, the language of the participants. The priming vignettes were initially translated into Sesotho from English by native speakers of Sesotho, who were fluent in English, and then back-translated by additional bilingual research assistants to check for reliability. Discrepancies with the translation were resolved using a team of bilingual, native Sesotho speakers.

Participants' explanations were coded for biological risk-taking and bewitchment explanations. Examples of responses coded as biological risk taking include explanations that mention unprotected sex, promiscuity, and lack of fidelity among partners. Examples of responses coded as bewitchment include explanations that attribute illness to witchcraft due to jealousy on the part of neighbors, lack of generosity, sending illness through spells or

poison, and specific forms of witchcraft. There was one primary coder who coded all explanations. A trained research assistant coded explanations from 25% of the participants. Interrater reliability was 92%.

For the biological explanation variable, each vignette was coded for whether participants gave at least one biological risk-taking explanation (to any of the 3 questions) for a possible score of 0 or 1. For the bewitchment explanation variable, each vignette was coded for whether participants gave at least one bewitchment explanation (to any of the 3 questions) for a possible score of 0 or 1. The scores for each vignette (0 or 1) were summed across the two vignettes in each priming type yielding possible scores per priming type of 0 to 2.

6.3. Results

Our objective in Study 3 was to understand how differences in the cultural context of illness influence the coexistence of biological and bewitchment explanations for both AIDS and unspecified deadly illness in Sesotho-speaking communities. In order to do so, we investigated how different kinds of priming (biological and bewitchment) would influence the kinds of explanations given. See Fig. 4 for the mean number of biological and bewitchment explanations by priming type.

We conducted a Biological Priming (yes, no) \times Bewitchment Priming (yes, no) \times Explanation Type (biological risk taking, bewitchment) \times Age Group (adolescent, 20s, 30s, 40s,

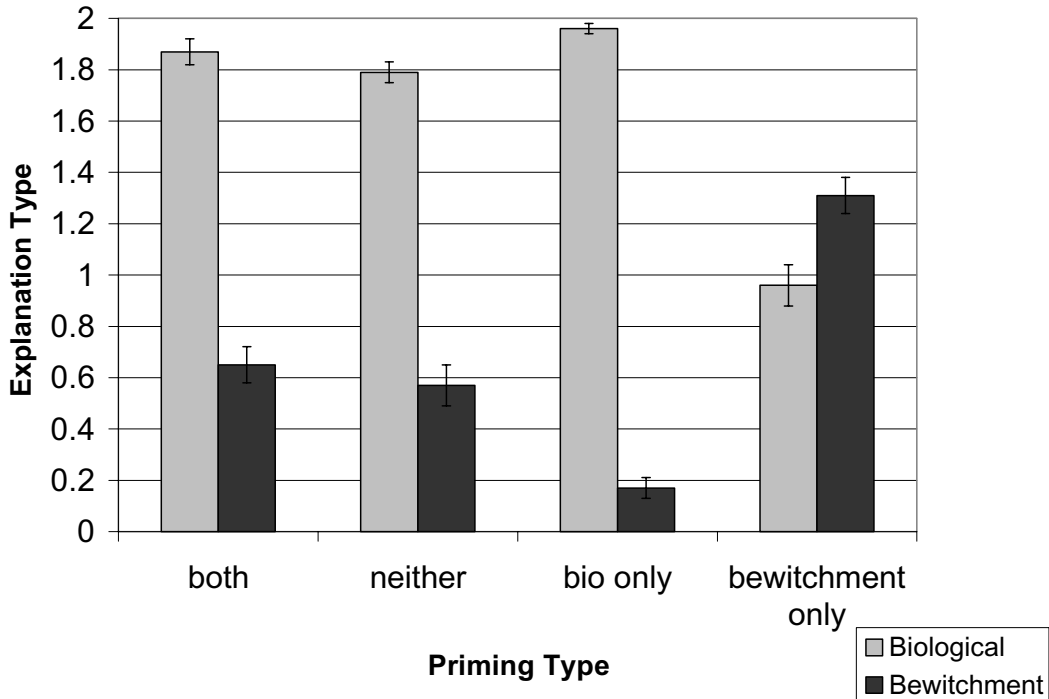


Fig. 4. Study 3: Mean number of biological and bewitchment explanations by priming type.

older) \times Illness Type (AIDS vs. sick) repeated measures ANOVA, with age group and illness as between-subject factors. There were two dependent variables: biological and bewitchment explanations. Overall, both biological and bewitchment explanations were very common. All participants gave at least one biological explanation, and 93% of participants gave at least one bewitchment explanation during the interview. We obtained a main effect for explanation type (biological and bewitchment), $F(1, 100) = 267.19, p < .001$, indicating that overall biological explanations were more common than bewitchment explanations. The main effect for bewitchment priming, the Biological Priming \times Bewitchment Priming interaction, and the Biological Priming \times Bewitchment Priming \times Age Group interaction were also significant ($ps < .05$). However, these effects must be interpreted within the context of the higher order interactions involving explanation type.

The Biological Priming \times Explanation Type interaction was significant, $F(1, 100) = 180.26, p < .001$. Post-hoc tests indicate that biological explanations were given more often when biological explanations were primed than when not primed. Conversely, bewitchment explanations were less common when biological explanations were primed than when they were not ($ps < .001$). The Bewitchment Priming \times Explanation Type interaction was also significant, $F(1, 100) = 112.34, p < .001$. Post-hoc tests show that participants gave significantly more bewitchment explanations when they were primed, and gave fewer biological explanations when bewitchment explanations were primed than when they were not ($ps < .001$).

The three-way Biological Priming \times Bewitchment Priming \times Explanation Type interaction was significant, $F(1, 100) = 180.26, p < .001$. As predicted, when biological explanations were primed and bewitchment explanations were not, participants gave significantly more biological ($M = 1.96$) than bewitchment explanations ($M = 0.17$), $p < .001$. Conversely, when bewitchment explanations were primed and biological explanations were not, participants gave significantly more bewitchment explanations ($M = 1.31$) than biological explanations ($M = 0.96$), $p < .01$. This finding is important because it indicates that given the appropriate contextual support/circumstances, bewitchment explanations are used to a greater extent than biological explanations. What happens when both biological and bewitchment explanations are primed? In that condition, participants gave significantly more biological ($M = 1.87$) than bewitchment explanations ($M = 0.65$), $p < .001$. Similarly, when neither biological or bewitchment explanations were primed, participants gave more biological than bewitchment explanations ($p < .001$). The high levels of biological explanations when both biological and bewitchment explanations were primed and when neither biological nor bewitchment explanations were primed suggests that biological explanations serve as a default explanatory framework. Explanatory patterns were largely consistent across illness type and age group; neither of these main effects was significant.

There was also a significant four-way interaction of Biological Priming Type \times Explanation Type \times Age Group \times Illness interaction, $F(4, 100) = 2.48, p < .05$, which was subsumed within the significant five-way interaction of Biological Priming Type \times Bewitchment Priming Type \times Explanation Type \times Age Group \times Illness interaction, $F(4, 100) = 3.61, p < .01$ (see Table 4). Overall, in three of the four priming types, biological explanations were given more frequently than bewitchment explanations ($ps < .01$). The only exception to this pattern was that in the sick condition, when both biological and bewitchment explanations were primed,

Table 4
 Study 3: Mean scores (out of 2) for biological and bewitchment explanations by priming type

Age	Bio Only		Bewitchment Only		Both		Neither	
	Biological	Bewitchment	Biological	Bewitchment	Biological	Bewitchment	Biological	Bewitchment
Adolescents								
AIDS	1.91 (0.30)	0.36 (0.51)	1.00 (0.89)	1.27 (0.79)	2.00 (0.00)	0.82 (0.87)	1.82 (0.41)	1.09 (0.70)
Sick	1.91 (0.30)	0.46 (0.52)	1.00 (0.89)	1.27 (0.91)	1.82 (0.41)	1.00 (0.89)	1.73 (0.65)	0.82 (0.41)
20-yr-olds								
AIDS	2.00 (0.00)	0.18 (0.41)	0.64 (0.51)	1.55 (0.52)	2.00 (0.00)	0.64 (0.92)	1.91 (0.30)	0.55 (0.93)
Sick	2.00 (0.00)	0.18 (0.41)	1.09 (0.83)	1.18 (0.87)	1.56 (0.82)	1.00 (0.89)	1.73 (0.47)	0.73 (0.47)
30-yr-olds								
AIDS	2.00 (0.00)	0.00 (0.00)	1.64 (0.51)	0.73 (0.79)	2.00 (0.00)	0.36 (0.67)	1.82 (0.41)	0.56 (0.82)
Sick	2.00 (0.00)	0.18 (0.41)	0.73 (0.79)	1.36 (0.81)	2.00 (0.00)	0.73 (0.91)	2.00 (0.00)	0.64 (0.81)
40-yr-olds								
AIDS	2.00 (0.00)	0.18 (0.41)	0.91 (0.70)	1.56 (0.52)	1.67 (0.67)	0.67 (0.81)	1.82 (0.41)	0.27 (0.47)
Sick	1.82 (0.60)	0.00 (0.00)	0.73 (0.79)	1.56 (0.82)	1.82 (0.41)	0.27 (0.47)	1.73 (0.65)	0.27 (0.47)
Over 50 yrs								
AIDS	2.00 (0.00)	0.00 (0.00)	1.27 (0.79)	1.09 (0.83)	1.91 (0.30)	0.55 (0.69)	1.73 (0.65)	0.36 (0.67)
Sick	2.00 (0.00)	0.18 (0.41)	0.55 (0.82)	1.55 (0.69)	2.00 (0.00)	0.46 (0.82)	1.64 (0.51)	0.46 (0.69)

Note. Standard deviation scores are in parentheses.

20-year-olds gave biological and bewitchment explanations to the same extent. The bewitchment-only priming type was the notable exception in that, in nearly every case, either bewitchment explanations were given to a greater extent than biological explanations (among 20- and 30-year-olds in the AIDS condition and adults older than 50 years old in the sick condition) or to the same extent as biological explanations (among adolescents and 40-year-olds in both illness conditions, among 20- and 30-year-olds in the sick condition, and among adults older than 50 years old in the AIDS condition). The only exception to this was that among 30-year-olds in the AIDS condition, participants gave more biological than bewitchment explanations.

6.4. Analyses of co-existence

We next turned to the key question of whether and how bewitchment explanations co-existed with biological explanations. A total of 93% (102 out of 110) of the participants gave both a biological *and* a bewitchment explanation at least once across all the vignettes. In order to provide a more direct test of how biological and bewitchment explanations co-exist and change with different priming types, co-existence scores were calculated. Co-existence scores were based on whether participants gave at least one biological explanation *and* at least one bewitchment explanation for a given vignette, yielding a score of 0 or 1 per vignette, or 0 to 2 per priming type. We conducted an Age Group \times Illness (AIDS or sick) \times Priming Type (neither, both, bio-only, bewitchment-only) repeated measure ANOVA, with age group and illness as between-subject factors. The dependent variable was the co-existence score. We found a main effect for priming type, $F(3, 300) = 11.63$, $p < .001$. Pairwise post-hoc tests revealed that co-existence scores were lowest in the bio-only condition ($M = 0.17$, $p < .001$), whereas the other three conditions did not differ from one another (neither, $M = 0.46$; both, $M = 0.41$; bewitchment-only, $M = 0.47$).

The Illness (AIDS vs. sick) \times Priming Type interaction was also significant, $F(3, 300) = 3.28$, $p < .05$. Post-hoc tests revealed that co-existence scores for the bewitchment-only priming type were higher in the AIDS condition ($M = 0.58$) than in the sick condition ($M = 0.36$), $p < .05$.

Explanations were also analyzed for *how* co-existence was displayed. There was one primary coder who coded all explanations. A trained research assistant coded explanations from 25% of the participants. Interrater reliability was 94%. We found evidence for three distinct ways that participants talked about the availability of more than one type of explanation. The three types of reasoning vary in the extent to which biological and bewitchment explanations co-exist explicitly. Explanations were coded by vignette (each participant responded to a total of 8 vignettes). Percentages of explanation types represent the number of participants who used each kind of reasoning at least once, divided by the total number of participants. The first kind of reasoning, *juxtaposition*, is characterized by using both biological risk taking and witchcraft to explain individual cases of illness, but not in a well-integrated manner (see Table 5). In cases of juxtaposition, participants mentioned both biological and bewitchment explanations, either explicitly (30% of participants) or without explicitly tying them together (27% of participants).

Table 5
Study 3: Sample co-existence explanations

Juxtaposition	Proximal Versus Distal	Real Versus Fictitious
“Might be unprotected sex and bewitchmen”	“Witchcraft can fool you into sleeping with an HIV infected person”	“Witchcraft can cause a disease that acts like AIDS”
“Adultery and witchcraft”	“A witch can make a condom weak, and break”	“Witchcraft or a spell in disguise as AIDS”
“Having so many enemies causes bewitchment, and maybe unfaithful partners cause AIDS too”	“Jealousy and spells, people sent someone with AIDS to sleep with him”	“The spell was supposed to look like AIDS”
“Muthi, which is mixed with evil spirits and having unprotected sex”	“Witchcraft can make you have sex with someone who has AIDS”	“To medical doctors it seems like AIDS, but it is not”
“Muthi and bewitchment, and unfaithfulness”	“The people that hated her paid the witches to put the virus in her path”	“AIDS is only caused by unprotected sex. Witchcraft practices cause you to have incurable sickness that people might think is AIDS”
“He was bewitched and sleeping with infected people”	“They targeted her and what I know from witchcraft is that anything is possible if it is meant to kill you. Witches can use anything to kill you; evil magic and AIDS viruses”	“He was bewitched by his aunt, it wasn’t AIDS”

In the second kind of reasoning, *proximal/distal*, witchcraft provides an answer to the “why” question of illness (the distal cause), whereas biology provides an answer to the “how” question of illness (the proximal cause). For example, according to a 33-year-old man, “a witch can make a condom weak, and break” (see Table 5). Thirty-eight percent of participants used proximal/distal reasoning at least once.

Finally, we found evidence for a third kind of reasoning, where participants propose a distinction between *real versus fictitious* illnesses. Adults using this kind of reasoning indicated that witchcraft practices can cause you to have an incurable sickness erroneously disguised as AIDS (see Table 5). In other words, biologically caused illness and witchcraft-caused illness may look alike on the surface, but in actuality are two distinct illnesses. Twenty-six percent of participants used real versus fictitious AIDS co-existence reasoning at least once. Notably, the real versus fictitious explanations indicated that, although an illness might appear biological, witchcraft is actually responsible. Participants’ explanations did not indicate the reverse; that although an illness might look like witchcraft, it has a purely biological explanation.

Both juxtaposition and proximal/distal reasoning demonstrate different ways that biological and bewitchment explanations co-exist and are recruited to explain and interpret illness. However, in the case of real versus fictitious illness reasoning, it is possible that explanations allocated to this category can be reasonably regarded as explanations that deny the need

to recruit both biological and bewitchment explanations. If this is the case, this kind of reasoning can be understood as an additional way of accommodating diverse explanatory systems.

As an inclusive index of co-existence reasoning, collapsing across all three kinds of reasoning types, 69% of participants gave a co-existence explanation at least once, and 35% of participants endorsed at least two different kinds of co-existence reasoning. These participants acknowledge the potential availability of each type of explanation for a given illness even if they do not necessarily recruit both explicitly. By excluding the real versus fictitious reasoning type and thereby creating a less inclusive measure that combines juxtaposition with proximal/distal reasoning, 59% of participants gave a co-existence explanation at least once. These participants explicitly recruited both biological and bewitchment explanations concurrently for the same illness.

6.5. Discussion

Our data provide insight into how biological and bewitchment explanations co-exist and in which kinds of contexts they are used. All participants in this study gave biological explanations for both the AIDS and the illness conditions, and 93% of participants gave at least one bewitchment explanation across the vignettes. We demonstrate that in addition to using biological explanations for some cases of illness and bewitchment explanations for other cases of illness, witchcraft explanations are often used alongside biological explanations to explain the same cases of illness. For example, nearly one half of the participants gave both biological and bewitchment explanations (within priming type) to explain when both, neither, and only bewitchment explanations were primed. However, when only biological risk taking was primed, co-existence scores were lowest, indicating that bewitchment explanations are not used in all circumstances of fatal disease. Bewitchment explanations are nuanced, flexible, and contextually specific in ways that biological explanations are less bound by.

We also have strong evidence that witchcraft is not a default explanatory framework; it is not used only when biological explanations are lacking or unavailable. When both biological and bewitchment explanations were primed, both biological and witchcraft explanations were given at high levels. In addition, bewitchment explanations were just as high when both kinds of explanations were primed as when only bewitchment was primed. This would not be predicted if witchcraft explanations were just a default when biological explanations are lacking.

By analyzing explanations across conditions, we found evidence for several ways that individuals reconcile and reason about seemingly incompatible belief systems. Biological and bewitchment explanations co-exist to explain illness in three distinct ways in this cultural context: juxtaposition reasoning, proximal/distal reasoning, and real versus fictitious reasoning. Each reasoning type is a different solution to the problem of how to combine biological and bewitchment belief systems. That there is no single manner of coexistence suggests that participants may to some extent be creating these solutions spontaneously during the course of the experiment. Juxtaposition reasoning is additive and accommodates multiple belief systems most directly, although not especially coherently (i.e., it is not clear what role

each domain plays). Proximal/distal reasoning appears to be the most coherent co-existence reasoning because it takes into account which aspects of the causal chain should be attributed to each explanation type. This kind of reasoning addresses the “how” versus “why” distinction in causal explanations. Most typically, the proximate cause is identified as unprotected sex, whereas the distal cause is believed to be witchcraft. For example, witches are believed to be capable of distorting your sense of good judgment or putting an AIDS-infected person in your path. The real versus fictitious explanation provides the greatest separation between biology and witchcraft. Although in such cases, adults acknowledge the role of each—they see them as entirely non-interactive. Adults using real versus fictitious reasoning maintain the explanatory framework of witchcraft in the face of disconfirming information by accommodating their explanations to fit new criteria. The notion of “fictitious AIDS” is arguably a reaction to the information people receive from AIDS education programs indicating explicitly that witchcraft does not cause AIDS, while nonetheless maintaining witchcraft as an explanatory system for illness and misfortune generally (Niehaus, 2001).

Rather than viewing AIDS as a special case of bewitchment, our data demonstrate that AIDS has been integrated into a broader framework for explaining illness and misfortune more generally in this cultural context. In fact, although contextual priming affected the rate of biological and bewitchment explanations, as well as the extent to which they co-existed, our data suggest that, overall, AIDS is no more likely to be attributed to witchcraft than are other fatal diseases.

The lack of differences between age groups in the likelihood of providing bewitchment explanations is noteworthy. Younger adults had more education on average than older adults; however, they gave bewitchment explanations to the same extent as older adults with less education. This suggests that lack of information about biological causes of disease may not be driving the age differences in bewitchment explanations found in Studies 1 and 2, between young adolescents and adults. Further evidence that increased endorsement of bewitchment explanations among adults cannot be attributed solely to lack of health-related information is that participants of all age groups have exposure to the widespread multimedia public health campaign concerning AIDS and HIV prevention. We hypothesize that greater experience interpreting serious illness in this cultural context may supplement biological explanations for illness with non-biological explanations, not replace them. Decreased exposure to health education information coupled with increased experience with witchcraft-related belief systems would explain the U-shaped curve in the developmental data, with witchcraft explanations decreasing among older children and adolescents and increasing again among adults.

Sesotho adolescents and adults make use of nuanced explanatory frameworks for interpreting and explaining serious illnesses. Our data demonstrate that biological explanations based on sexually risky behavior (sleeping with many partners) appear to be the default explanatory framework in cases when attention is drawn to this or no other obvious explanations. However, when attention is drawn to socially risky behavior (such as too much good fortune attracting jealousy and lack of generosity), Sesotho adolescents and adults give bewitchment explanations significantly more often than biological explanations. This provides evidence that when illnesses have to be explained (or resolved), the cultural context of the illness determines the interpretation and explanation given.

7. General discussion

The primary objective of the present studies was to investigate the extent to which witchcraft coexists with biology as explanatory systems, in a cultural context where both traditional healing frameworks (including non-biological witchcraft explanations) and Western biomedical frameworks are available. A standard assumption is that biological knowledge will supplant witchcraft explanations, such that witchcraft will be endorsed only in the absence of accurate biological explanations (Mitchell, 1965). In contrast, we found that witchcraft beliefs persisted even when participants had ample knowledge of the biological processes involved in illness transmission. In this cultural context, biological explanations for illness were endorsed at high levels. Nonetheless, witchcraft continued to be an important explanatory framework for interpreting illness, and co-existed alongside biological explanations. These two belief systems—natural and supernatural—were not viewed by participants as inconsistent with one another and, in fact, provided distinct, complementary causal information.

Further support for this conclusion is found in comparisons of Studies 1 and 2. Although participants in Study 1 displayed greater biological knowledge on several measures, they were no less likely to endorse bewitchment than participants in Study 2. Similarly, to the extent that correct responses to the questions regarding the unobservable or “hidden nature” of illness serve as a measure of biological knowledge, this also illustrates that biological knowledge and bewitchment beliefs are not closely linked. Overall, participants understood the hidden nature of AIDS better than the hidden nature of the flu, perhaps due to the distinctive nature of AIDS, with its long incubation period. More important, however, participants were just as likely to use bewitchment explanations for AIDS as for the flu. Once again, bewitchment does not reflect a lack of biological knowledge. Furthermore, those participants who performed best on the hidden nature task (adults) also were most likely to endorse bewitchment explanations.

We found evidence for three distinct ways that adults accommodated seemingly incompatible belief systems: juxtaposing two types of explanations without integrating them, distinguishing proximal versus distal causes, and distinguishing real versus fictitious illness. These three types of co-existence vary in their degree of coherence. Proximal versus distal reasoning and real versus fictitious reasoning both involve some attempt to reconcile the two explanatory systems into one overarching framework. In contrast, juxtaposition simply involves endorsing both explanatory systems for a single event. Certainly, adults are able to use all three kinds of reasoning. It would be interesting in future research to determine if there are developmental changes in the extent to which each of these types of reasoning is endorsed.

The present studies regarding the co-existence of diverse explanatory frameworks also speak to theoretical debates over the nature of coherence and fragmentation of concepts (DiSessa, Gillespie, & Esterly, 2004). Although our data provide evidence for variation in explanatory coherence, with some participants appealing to both bewitchment and biology without attempting to reconcile them, it is also clear that explicit attempts at coherence are not uncommon. Even with seemingly incompatible (and thus potentially fragmentary) explanatory systems (scientific and religious, respectively) applied to the same domain, some participants actively constructed coherent explanations. For example, proximal/distal explanations are an explicit attempt to reconcile disparate sources of information into a coherent explanatory concept.

Our evidence of explicit attempts to reconcile competing explanatory frameworks for illness is consistent with research on reasoning about competing explanatory frameworks for biological origins (Evans, 2001; Evans, in press). Supporters of intelligent design and theistic evolution accommodate both creationist and (micro)evolutionary beliefs by using co-existence reasoning analogous to the proximal versus distal reasoning found in this study. For example, biological evolutionary processes are often endorsed as proximate causes, whereas God is endorsed as a distal cause. Our findings in the realm of illness coupled with data from co-existence reasoning about biological origins provide important support for the claim that viewing diverse explanatory frameworks as mutually exclusive, non-overlapping belief systems does not capture the flexibility and, more important, heterogeneity of human reasoning.

The second objective of this research was to determine whether AIDS is uniquely understood to be a special case or consequence of bewitchment or whether AIDS has been integrated into the existing explanatory framework for mysterious, fatal illnesses. This question is important as it helps us to understand whether bewitchment beliefs are invoked only in special circumstances. Overall, our data suggest that AIDS is not seen as a special case; instead, witchcraft explanations were given equally often for AIDS and unspecified, fatal illness. Although data from Study 1 suggest that witchcraft explanations may be more common for AIDS than the flu, we did not find evidence that this was the case in Study 2 with the rural sample.

Our third objective was to examine developmental differences in the co-existence of witchcraft and biological explanations. Research on conceptual development indicates that children use intuitive, foundational theories to organize information, interpret observations, and reason about novel situations (Wellman & Gelman, 1998). "Folk-biology" has been proposed as one such foundational theory (Inagaki & Hatano, 2002), and even young children have complex and often elaborate beliefs about biological processes (Inagaki & Hatano, 2002; Keil, 1992; Wellman et al., 1997). If children have access to biological explanations at young ages, how then do they accommodate seemingly inconsistent non-biological explanations for illness?

One possibility was that young children would give more biological explanations than older children and adults, due to an increase with age in exposure to and experience with non-biological, social explanations for illness (Harris & Gimenez, 2005; Raman & Gelman, 2004). Another possibility was that increased educational instruction about AIDS in school would lead to an increase in biological explanations and a decrease in bewitchment explanations. In contrast to both these possibilities, we found a U-shaped developmental pattern in which witchcraft explanations decreased with age throughout childhood and adolescence, but then increased again among adults. This result is consistent with an increase in non-biological explanations with age due to increasing cultural input, while allowing for the impact of information from health education programs (Raman & Winer, 2002). For example, in Study 3, young adults with more formal education gave bewitchment explanations to the same extent as older adults with less formal education. Therefore, explicit information children receive in school that witchcraft is *not* a cause of AIDS does not seem to have a lasting impact on the explanatory frameworks used by adults.

In future research, it will be important to further investigate developmental differences by continuing to explore the co-existence of these belief systems across a wide age range, using

both causal explanation endorsement and contextual priming techniques. In particular, it will be important to examine more thoroughly the relative paucity of bewitchment explanations among adolescents. For example, do adolescents who have been exposed to AIDS education programs differ from those who have not? Is the impact of such programs observed only in the context of particular primes (e.g., only biological primes) or are they stable across all priming types?

An important educational implication of these data is that providing scientific information does not necessarily eradicate or supplant non-scientific or erroneous beliefs (Carey, 2000). Thus, educational programs must work to eradicate erroneous beliefs at the same time that they work to establish correct beliefs. These data also have methodological implications for assessing illness understanding, especially across diverse cultural communities. For example, although the causal explanation vignettes used in Studies 1 and 2 provide important information about the co-existence of biological and bewitchment explanation across development, the contextual information of the priming vignettes used in Study 3 provide more detailed information about how these belief systems co-exist.

Despite evidence supporting the need for culturally meaningful, informed prevention programs, there is surprisingly little research examining children's beliefs about illness in a cultural context where children have direct experience with and are directly affected by deadly disease. Because school-age children may be considered a particularly vulnerable population at risk for future development of HIV infection, school-based AIDS education beginning in primary school may serve as the best means to limit the incidence of new infections (Peltzer & Promtussananon, 2003). Prevention needs to involve educational programs founded on children's causal understandings, not just factual knowledge (Au, Romo, & Dewitt, 1999). Our research is consistent with the current emphasis in educational intervention research on prevention of the disease and provides a timely source of data concerning children's beliefs about AIDS.

Acknowledgments

This research was supported by fellowships to Cristine H. Legare from the Center for Afroamerican and African Studies at the University of Michigan, the SAIO Moody Foundation, and the University of Michigan Culture and Cognition Program. The research was also supported by NICHD Grant HD36043 to Susan A. Gelman. We are grateful to the teachers, staff, and children of Tlokweg School for participating in this research. We also thank Paul Theron, Ntsoaki Sekete, Thokozile Motsate, and Gugu Nkosi for their able assistance with data collection, transcription, and coding. We also thank Henry Wellman for helpful comments on previous drafts of this article.

References

- Ashforth, A. (2001). An epidemic of witchcraft? The implications of AIDS for the post-apartheid state. In H. Moore & T. Sanders (Eds.), *Magical interpretations, material realities* (pp. 184–225). London: Routledge.

- Ashforth, A. (2005). *Witchcraft, violence, and democracy in South Africa*. Chicago, IL: University of Chicago Press.
- Astuti, R., & Harris, P. (in press). Understanding mortality and the life of ancestors in rural Madagascar. *Cognitive Science*.
- Astuti, R., Solomon, G., & Carey, S. (2004). Constraints on conceptual development. *Monographs of the Society for Research in Child Development*, 69, vii–135.
- Au, T., Romo, L., & Dewitt, J. (1999). Considering children's folkbiology in health education. In M. Siegal & C. Peterson (Eds.), *Children's understanding of biology and health* (pp. 209–234). Cambridge, England: Cambridge University Press.
- Barrett, J., & Keil, F. (1996). Conceptualizing and nonnatural entity: Anthropomorphism in God concepts. *Cognitive Psychology*, 31, 219–247.
- Boyer, P., & Walker, S. (2000). Intuitive ontology and cultural input in the acquisition of religious concepts. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 130–156). Cambridge, England: Cambridge University Press.
- Brandt, A., & Rozin, P. (Eds.). (1997). *Morality and health*. New York: Routledge.
- Callanan, M., & Oakes, L. (1992). Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development*, 7, 213–233.
- Carey, S. (2000). Science education as conceptual change. *Journal of Applied Developmental Psychology*, 21, 13–19.
- Department of Health. (2005). *National HIV and syphilis antenatal sero-prevalence survey in South Africa*. Retrieved February 2, 2007, from <http://www.doh.gov.za/docs/hiv-syphilis-f.html>
- DiSessa, A., Gillespie, N., & Esterly, J. (2004). Coherence versus fragmentation in the development of the concept of force. *Cognitive Science*, 28, 843–900.
- Evans, E. M. (2000). Beyond scopes: Why creationism is here to stay. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 305–333). Cambridge, England: Cambridge University Press.
- Evans, E. M. (2001). Cognitive and contextual factors in the emergence of diverse belief systems: Creation versus evolution. *Cognitive Psychology*, 42, 217–266.
- Evans, E. M. (in press). Conceptual change and evolutionary biology: A developmental analysis. In S. Vosniadou (Ed.), *Handbook of research on conceptual change*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Farmer, P. (1999). *Infections and inequalities: The modern plagues*. Berkeley: The University of California Press.
- Green, E. (1999). *Indigenous theories of contagious disease*. Walnut Creek, CA: AltaMira.
- Harris, P., & Gimenez, M. (2005). Children's acceptance of conflicting testimony: The case of death. *Journal of Cognition and Culture*, 5, 143–164.
- Harris, P., & Koenig, M. (2006). Trust in testimony: How children learn about science and religion. *Child Development*, 77, 505–524.
- Harris, P., Pasquini, E., Duke, S., Asscher, J., & Pons, F. (2006). Germs and angels: The role of testimony in young children's ontology. *Developmental Science*, 9, 76–96.
- Hickling, A., & Wellman, H. (2001). The emergence of children's causal explanations and theories: Evidence from everyday conversation. *Developmental Psychology*, 37, 668–683.
- Inagaki, K., & Hatano, G. (2002). *Young children's naïve thinking about the biological world*. New York: Psychology Press.
- Kalish, C. (1996). Causes and symptoms in preschoolers' conceptions of illness. *Child Development*, 67, 1647–1670.
- Kalish, C. (1999). What young children's understanding of contamination and contagion tells us about their concepts of illness. In M. Siegal & C. Petersen (Eds.), *Children's understanding of biology and health* (pp. 99–130). New York: Cambridge University Press.
- Keil, F. (1992). The origins of an autonomous biology. In M. R. Gunnar & M. Maratsos (Eds.), *Modularity and constraints in language and cognition: Minnesota symposia on child psychology, vol. XXV* (pp. 103–138). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

- Keil, F. (2006). Explanation and understanding. *Annual Review of Psychology*, 57, 227–254.
- Kidder, T. (2003). *Mountains beyond mountains: The quest of Dr. Paul Farmer, a man who would cure the world*. New York: Random House.
- Kister, M., & Patterson, C. (1980). Children's conceptions of the cause of illness: Understanding contagion and the use of immanent justice. *Child Development*, 51, 839–846.
- Mitchell, J. (1965). The meaning of misfortune for urban Africans. In M. Fortes & G. Dieterlen (Eds.), *African systems of thought* (pp. 192–203). London: Oxford University Press.
- Nemeroff, C., & Rozin, P. (2000). The makings of the magical mind: The nature and function of sympathetic magical thinking. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 1–34). Cambridge, England: Cambridge University Press.
- Niehaus, I. (2001). Witchcraft in the new South Africa: From colonial superstition to postcolonial reality. In H. Moore & T. Sanders (Eds.), *Magical interpretations, material realities* (pp. 184–225). London: Routledge.
- Peltzer, K., & Promtussananon, S. (2003). Black South African children's understanding of health and illness: Colds, chicken pox, broken arms and AIDS. *Child: Care, Health and Development*, 29, 385–393.
- Raman, L., & Gelman, S. A. (2004). A cross-cultural developmental analysis of children's and adults' understanding of illness in South Asia (India) and the United States. *Journal of Cognition and Culture*, 2, 293–317.
- Raman, L., & Gelman, S. A. (2007). Children's recognition of time in the causes and cures of physical and emotional reactions to illnesses and injury. *British Journal of Psychology*, 98(3), 389–410.
- Raman, L., & Winer, G. (2002). Children's and adults' understanding of illness: Evidence in support of a co-existence model of illness. *Genetic, Social, and General Psychology Monographs*, 128, 325–355.
- Raman, L., & Winer, G. (2004). Evidence of more immanent justice responding in adults than children: A challenge to traditional developmental theories. *British Journal of Developmental Psychology*, 22, 255–274.
- Rosengren, K., & Hickling, A. (2000). Metamorphosis and magic: The development of children's thinking about possible events and plausible mechanisms. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 75–98). Cambridge, England: Cambridge University Press.
- Schlebusch, L., & Ruggieri, G. (1996). Health beliefs of a sample of Black patients attending a specialized medical facility. *South African Journal of Psychology*, 26, 35–38.
- Shweder, R. A., Much, N. C., Mahapatra, M., & Park, L. (1997). The “big three” of morality (autonomy, community, divinity) and the “big three” explanations of suffering. In A. Brand & P. Rozin (Eds.), *Morality and health* (pp. 119–169). New York: Routledge.
- Stadler, J. (2003). The young, the rich, and the beautiful: Secrecy, suspicion, and discourses of AIDS in the South African lowveld. *African Journal of AIDS Research*, 2, 127–139.
- Stats Online. (2005). The digital face of stats SA. *Statistics South Africa*. Retrieved February 2, 2007, from <http://www.statssa.gov.za>
- Thagard, P. (1998). Explaining disease: Correlations, causes, and mechanisms. *Minds and Machines*, 8, 61–78.
- Turiel, E. (2006). The development of morality. In N. Eisenberg, W. Damon, & R. Lerner (Eds.), *Handbook of child psychology: Vol. 3, Social, emotional, and personality development* (6th ed., pp. 789–857). Hoboken, NJ: Wiley.
- Wellman, H., & Gelman, S. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology*, 43, 337–375.
- Wellman, H., & Gelman, S. A. (1998). Knowledge acquisition in foundational domains. In D. Kuhn & R. Siegler (Eds.), *Cognition, perception, and language* (pp. 523–573). New York: Wiley.
- Wellman, H., Hickling, A., & Schult, C. (1997). Young children's psychological, physical, and biological explanations. In H. M. Wellman & K. Inagaki (Eds.), *The emergence of core domains of thought: Reasoning about physical, psychological and biological phenomena* (pp. 7–25). San Francisco, CA: Jossey-Bass.
- Woolley, J. (2000). The development of beliefs about direct mental-physical causality in imagination, magic, and religion. In K. Rosengren, C. Johnson, & P. Harris (Eds.), *Imagining the impossible: Magical, scientific, and religious thinking in children* (pp. 99–129). Cambridge, England: Cambridge University Press.
- Woolley, J., Boerger, E., & Markman, A. (2004). A visit from the Candy Witch: Factors influencing young children's belief in a novel fantastical being. *Developmental Science*, 7, 456–468.