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Development and Coherence of Beliefs About Disease Causality and Prevention

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Abstract

Guided by a naïve theories perspective on the development of thinking about disease, this study of 188 children aged 6 to 18 examined knowledge of HIV/AIDS causality and prevention using parallel measures derived from open-ended and structured interviews. Knowledge of both risk factors and prevention rules, as well as conceptual understanding of AIDS causality, increased with age. Younger children displayed more advanced knowledge in response to structured questions than in response to open-ended questions. Contrary to hypothesis, knowledge of causality was not more advanced than knowledge of prevention in elementary school. Moreover, correlations between the two types of knowledge were often nonsignificant except when the same method was used to assess both. Thus, methodology matters in assessing children's knowledge of disease, children's intuitive thinking is not consistently coherent, and it may be safest to educate children explicitly about sound prevention rules rather than assume they will infer the rules themselves from information about a disease's causes.

Does knowing what causes a disease translate into knowing how to protect oneself from it? Sometimes connections between disease risk factors or causes and prevention strategies are not at all straightforward. For example, flu is caused by a virus internalized when we come in contact with people who have the flu, but getting a flu shot is a good way of preventing it, and “Eat healthy food” is an illness prevention rule that is relevant to a wide range of health conditions but may not match up well with risk factors for a particular disease. In other cases, causal factors and prevention rules are closely connected logically. Thus, if smoking contributes to lung cancer, “don't smoke” is a sound lung cancer prevention rule. To what extent do the ideas held by children of different ages about causal contributors to a disease correspond to their ideas about preventing it? Must one teach children prevention rules explicitly or can one expect that children will infer appropriate prevention rules once they come to regard certain behaviors as risk factors for the disease? Does it help if children understand how those risk factors increase the odds of disease?

HIV/AIDS (human immunodeficiency virus/acquired immunodeficiency syndrome) is a focus of the U.S. government's Healthy People 2020 and National Health Education Standards and of health promotion and health education efforts around the world (Heymann,

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Kidman, & Sherr, 2012; Inman, van Bakergem, Larosa, & Garr, 2011). It was selected as the focus of this study (a) because it continues to represent a major health problem in the United States, where the incidence of HIV infection among adolescents has been edging upward (Centers for Disease Control and Prevention, 2010; Gordon et al., 2012), and (b) because it is a disease for which both causality (risk factors or modes of transmission, disease agent) and prevention are well-understood and should be in close correspondence (e.g., if unprotected sex can increase the risk of HIV/AIDS, avoiding unprotected sex can help prevent it).

The present study explores, among children ranging in age from 6 to 18, age differences in beliefs about HIV/AIDS causality and prevention and the relationship between the two using both structured and open-ended questioning methodologies. Compared to beliefs about causality, beliefs about prevention have been neglected in the literature on children's concepts of disease, despite the importance of educating children and adolescents about how to protect their health—and despite evidence that HIV/AIDS education can have positive effects on adolescents' sexual and drug use behavior, especially if it is begun in preadolescence, before the onset of sexual activity (Ma, Fisher, & Kuller, 2014; Poobalan et al., 2009).

The literature on children's knowledge and understanding of illness and disease has focused most closely on children's thinking about what causes illness in general and specific diseases like HIV/AIDS in particular. Moreover, much of it has been guided by Piagetian theory and has focused on conceptual understanding, or the structural complexity of children's causal thinking apart from its accuracy, rather than on children's knowledge, or the factual correctness or incorrectness of their thinking (see Bibace & Walsh, 1980, and Perrin & Gerrity, 1981, on the important distinction between knowledge and understanding). The present study corrects for this imbalance in the literature by focusing primarily on children's knowledge while also attending to understanding.

The study is guided by a naïve or intuitive theories perspective on cognitive development. This perspective holds that, from an early age, children have or construct theories that organize their knowledge of phenomena (Wellman & Gelman, 1998). Naïve theories of biology (or of psychology or physics) define a domain of knowledge, specify the causal explanatory principles that apply in the domain, and are characterized by coherence, or interrelatedness among ideas (see Wellman & Gelman, 1998). Researchers guided by this perspective pay more attention to the content of children's thinking than to its causal complexity, although, like Piagetian researchers, they have been especially interested in thinking about causality (e.g., Au & Romo, 1996; Inagaki & Hatano, 2006; Sigelman, Estrada, Derenowski, & Woods, 1996). Although research guided by both the Piagetian and the naïve theories perspectives, along with a good deal of atheoretical research on children's thinking about HIV/AIDS, flourished in the 1990s, interest has waned since, with the exception of a few studies in countries with significant HIV problems (e.g., Carnevale et al., 2011; Legare & Gelman, 2009; Plattner, 2013; Zhao et al., 2011). Surprisingly, neither the earlier nor the more recent literature has investigated the extent to which ideas about causality are aligned with and perhaps inform thinking about prevention.

In examining the consistency of children's thinking about HIV/AIDS causality and prevention, the concept of coherence as a defining feature of naïve theories becomes especially relevant. According to the naïve theories perspective, even young children's knowledge, "...is organized into coherent, causal-explanatory systems" (Wellman & Gelman, 1998, p. 528). If children's thinking about HIV/AIDS has this kind of theoretical coherence, their ideas about causal mechanisms should inform their thinking about prevention and there should be correspondence between their beliefs about disease causality and their beliefs about prevention. Such coherence would be evidenced by similar levels of mention or endorsement of corresponding beliefs about risk factors and prevention rules (e.g., "Having sex can increase the risk of AIDS" and "Don't have sex if you want to keep from getting AIDS"), as well as by correlations between the two sets of beliefs.

What do we know, then, about the coherence of children's thinking about HIV/AIDS causality and prevention, and how does coherence change with age? Studies that have examined understanding and/or knowledge of both disease causality and prevention have only rarely examined the relationships between them. As a result, it is not clear whether children who know the risk factors for a disease like HIV/AIDS and understand its causality endorse prevention rules consistent with their causal knowledge and understanding.

Conceptual Understanding of Causality and Prevention

Most research on children's thinking about illness causality and prevention has been based on the work of Perrin and Gerrity (1981) and an open-ended interview schedule their team developed (Schonfeld, Johnson, Perrin, O'Hare, & Cicchetti, 1993). These researchers, guided by Piagetian theory, devised a six-level scale assessing complexity of conceptual understanding of illness--independent of factual correctness—and used it to assess children's responses to questions about illness causation, prevention, and treatment (e.g., How do children get sick? How can children keep from getting sick? How can they get better?). The scale values range from lack of explanation and magical thinking to concrete awareness that a disease-causing agent like a germ is internalized to a complex view of interacting causes involving both external and internal factors. As Perrin and Gerrity (1981) and others have found, understanding of illness increases with age over childhood and correlates with Piagetian measures of cognitive development. Although Perrin and Gerrity did not report specific means or correlate causality, prevention, and treatment scores, they indicated that understanding of prevention lagged behind understanding of causation and treatment in their study.

Other studies based on this Piagetian approach have tended to support the conclusion that understanding of prevention lags behind understanding of causality. In a study of Icelandic children ages 6 to 15, Hansdottir and Malcarne (1998) found that both prevention and treatment of illness were less well understood than causality and symptomatology. It was noted that young children often gave "specific and rigid" rules for preventing illness, many centered on dressing warmly and avoiding bad weather. Similarly, Drahota and Malcarne (2008) reported that children's understanding of prevention appeared to lag behind their understanding of causality, although statistical tests were not reported. Neither study reported correlations between understanding scores for the different dimensions of illness.

Why might prevention be harder to grasp than causality? One possibility is that the many general health rules children are taught spring to mind when they are asked how to prevent a disease—rules that concern healthy eating, exercise, hygiene, and avoidance of bad weather, rules that may not be very useful in preventing a particular disease like AIDS or at least do not call for avoiding specific risk factors for AIDS (see, for example, Bird & Podmore, 1990; Hansdottir & Malcarne, 1998). Another possibility, suggested by Legare and Gelman (2009), is that prevention rules do not involve a change from one state to another and therefore do not provoke as many why questions as information about how people change from a healthy to a diseased state (causality) or return from a diseased state to a healthy state (treatment or cure). Still another possibility is that prevention rules are linguistically challenging because they often involve negative constructions (“Don’t...”).

Studies of the cognitive complexity of illness understandings, although they establish relationships between understandings of illness and both age and cognitive development and suggest that understanding of prevention lags behind understanding of causality, leave many questions unanswered. Most notably, they usually do not tell us whether children have accurate knowledge of causality and prevention, whether knowledge and understanding of causality and prevention are correlated, or whether any such correlations change with age. The literature on children's thinking about HIV/AIDS specifically has somewhat more to say on these issues.

Studies of HIV/AIDS

In a study of understanding of HIV/AIDS, colds, and cancer using Perrin and Gerrity's approach, Schonfeld et al. (1993) found that understanding scores for the concepts of causality, prevention, and treatment all increased with age from kindergarten to sixth grade and were correlated, but only moderately (.38-.49); specific correlations were not reported. Legare and Gelman (2009), studying South African children ranging in age from 5 to 15 and focusing on AIDS and flu, examined both knowledge of causality (by content coding explanations given in response to open-ended questions) and understanding of causality, prevention, and treatment (using Perrin and Gerrity's approach). They concluded that many children had accurate factual knowledge of risk factors for the two diseases but could not explain underlying causal mechanisms. The conceptual complexity of answers about treatment was greater than that of answers about either causality or prevention; moreover, neither treatment nor prevention scores increased with age, whereas causality scores did. Analysis of knowledge scores revealed many casual contagion myths about AIDS among younger children and fewer among older children and adolescents, consistent with other studies showing increases with age in knowledge of AIDS causality and prevention (Carnevale et al., 2011; Peltzer & Promtussananon, 2003; Sigelman, Estrada, et al., 1996).

Age Differences in Coherence of Thinking

Even when disease causality and prevention scores have been correlated, age differences in correlations have usually not been examined. Although evidence regarding diseases and other biological phenomena is lacking, from a naïve theories perspective, coherence is to be expected even at young ages because causal principles are said to organize thinking

(Wellman & Gelman, 1998). Yet children's thinking might also be expected to become more coherent with age as children gain more information and increasingly organize and integrate it (Chi, Hutchinson, & Robin, 1989; Wellman & Gelman, 1998). It has been argued and found, for example, that teaching children and adolescents about the underlying causal mechanism responsible for HIV and other STDs helps them better distinguish between safe and unsafe behaviors (Au & Romo, 1996; Zamora, Romo, & Au, 2006). Yet in at least one study of illness concepts (Kalish, 1996), preschool children were found to connect the concept of being ill to other illness-related features such as taking medicine and having a fever more closely than adults did, possibly because the children had a simpler, less differentiated concepts of illness. Moreover, both children and adults seem to find it quite possible to hold multiple, and sometimes contradictory, ideas about disease at once, as when they subscribe to both germ theories and supernatural theories of HIV/AIDS (Legare, Evans, Rosengren, & Harris, 2012) or to both cold weather and germ theories of colds (Raman & Winer, 2002; Sigelman, 2012). It is now evident that learning scientific theories may suppress but does not necessarily supplant incompatible naïve or lay theories (Shtulman & Valcarcel, 2012).

Using a coding system that attempted to consider both the complexity and accuracy of children's thinking, Paterson, Moss-Morris, and Butler (1999) found modest coherence in the thinking of children age 7 to 14 about six dimensions of colds and asthma, including causality and prevention. They did not report correlations between specific dimensions of illness or examine age differences in coherence, however. Meanwhile, Rosenthal, Waters, and Glaun (1995), in a study of AIDS knowledge and understanding among children aged 10 to 18, reported that causality and prevention knowledge scores based on true-false questions were not significantly correlated until age 18, and that causality and prevention understanding scores based on open-ended questions were significantly correlated at age 12 and 18 but not 10 and 15. In sum, these studies do not provide a firm basis for hypothesizing how much coherence in thinking about HIV/AIDS causality and prevention we can expect or how it might be related to age, but they make clear that the issue warrants attention.

Questioning Approach

Analysis of previous research also points to the need for more attention to methodology and its implications for the levels of knowledge or understanding displayed. Most research on children's concepts of illness in general and HIV/AIDS in particular has involved asking open-ended questions. However, open-ended questions can underestimate the knowledge and understanding of young children because they demand cognitive and linguistic abilities that young children may lack (e.g., Ganea, Lillard, & Turkheimer, 2004; Miller & Bartsch, 1997). As a result, age differences in understanding of disease may reflect age differences in verbal and cognitive abilities. Moreover, whereas measures of understanding of disease are often derived from open-ended questions, measures of knowledge are often based on answers to structured true-false or multiple-choice questions (e.g., Rosenthal et al., 1995). Structured questions are not without problems of their own; for example, they can plant ideas and cause children to make more factual errors than open-ended questions do (Horowitz, 2009). The present study therefore systematically compares open-ended and structured questioning strategies. Theoretical coherence in children's thinking about HIV/

AIDS would be implied if causal knowledge and prevention knowledge are correlated even when different methods are used to assess them. Guided by the concept of multitrait-multimethod analysis (Campbell & Fiske, 1959), the study asks whether the variance associated with the trait being assessed (risk factor knowledge vs. prevention knowledge) is greater than the variance associated with the method of assessment (structured vs. open-ended questioning).

Hypotheses and Research Questions

Based on the above analysis, the present study tested the following hypotheses:

1. Knowledge of AIDS risk factors, knowledge of AIDS prevention, and understanding of AIDS causality will all increase with age (e.g., Legare & Gelman, 2009; Pelzer & Promtussananon, 2003; Rosenthal et al., 1995).
2. Knowledge of risk factors will be more advanced than knowledge of prevention rules (Drahota & Malcarne, 2008; Hansdottir & Malcarne, 1998; Perrin & Gerrity, 1981).
3. Younger children will display more knowledge in response to structured questions than in response to open-ended questions (Ganea et al., 2004; Miller & Bartsch, 1997).
4. Both knowledge and understanding of disease causality will predict knowledge of prevention rules, even with age controlled. As Schonfeld et al. (1993), Legare & Gelman (2009), and others have suggested, many children learn facts about what causes AIDS without much understanding of the causal mechanisms involved. Because such children may be in a poor position to translate their knowledge of causality into strategies for prevention, we examine how both risk factor knowledge and understanding of causality are related to knowledge of prevention.

Finally, because little is known about the coherence of naïve theories of biology (Wellman & Gelman, 1998), we examine in an exploratory way correlations at different age levels between knowledge of causality and knowledge of prevention to determine whether they do or do not change with age in a manner that might suggest increasing theoretical coherence.

Method

Participants

The sample for this new analysis of previously collected data consisted of 188 children and adolescents in a Southwestern city. They ranged in age from 6 to 18, and none reported when asked that they had a parent or other immediate family member with HIV. With university IRB approval, written parent consent, and child assent, participants were recruited from 10 after-school care and recreational facilities. Parent consent forms were given to parents or sent home with children at the centers; the return rate was 33%, so it should be borne in mind that this was a volunteer sample that was not necessarily representative of the larger community.

For purposes of analysis, the 188 participating children were divided into five grade groups: first-second, third-fourth, fifth-sixth, seventh-to-ninth, and tenth-to-twelfth. Demographic characteristics of the five groups are displayed in Table 1. Generally the sample had an even mix of boys and girls (50-50 overall); was predominantly Euro-American (66.0% overall) but had significant Hispanic (16.4%) and African-American (11.6%) representation; and had parents whose years of education ranged from 10 to 18 and averaged two to three years beyond high school. ANOVAs and contingency table analyses depending on the variable revealed no significant differences between the five grade groups on any of these demographics besides age; moreover, multiple regression analyses testing for effects of age, gender, child ethnicity (white vs. minority), and parent years of education on the four main AIDS knowledge measures to be examined below revealed no significant effects of any of these demographic factors except age. Thus we can be confident that the grade differences to be reported are not distorted by demographic differences between grade groups.

Interview Questions and Resulting Measures

Interviewed in a quiet place in their after-school care facilities, participants were always given an open-ended interview covering a range of topics concerning AIDS first so that their thinking would not be affected by our asking specific structured questions. They then completed a structured interview on the same topics, elementary school children usually a day or two after their open-ended interviews so as not to exhaust their attention, secondary school students typically on the same day or the following day depending on the length of the interview. To conduct the planned analysis, it was necessary to identify coding categories for open-ended questions and structured questions on risk factors and prevention rules that matched up well from among the larger number of coding categories used and structured questions asked. Five behaviors qualified, three true and two false risk factors for HIV/AIDS, and became the focus of the study: having sex, sharing drug needles, having contact with blood, kissing/exchanging saliva, and being breathed on/airborne transmission. Data regarding each of the five behaviors were obtained through both open-ended and structured questioning regarding both risk factors and prevention rules, as described below.

Open-ended risk factor knowledge—The open-ended interview began with questions about what AIDS is, how a person might get it, and how that would cause AIDS (with attention to the disease agent and how it would make the person get sick). Children were asked this key question about causality: “Say somebody has AIDS. How did this person probably get AIDS?” A follow-up question, “How would this give someone AIDS exactly?,” along with probes designed to prompt children to be more specific about causal ideas they mentioned, and a follow-up question about other possible ways to get it, were also asked. Responses were coded into various correct and incorrect risk factor categories (for each, 1 = mentioned, 0 = not mentioned).

Open-ended prevention knowledge—Later in the open-ended interview, after intervening questions about risk groups, symptoms or effects, and treatment, children were asked, “What should people do if they want to prevent AIDS, or keep from ever getting it? Start out with the best rule you can think of for everyone to follow if they don't want to get AIDS” (with a follow-up question on how it would keep people from getting AIDS and a

request for other good rules to follow). Prevention rules mentioned were coded into various content categories (1 = mentioned, 0 = not mentioned).

Both the risk factor and prevention rule coding systems distinguished between correct and incorrect ideas. To conduct the present analysis, interrater reliability was established for the five parallel risk factor and prevention rule coding categories mentioned previously (sex, drug needle sharing, and so on) by having two pairs of coders assign 0 or 1 codes to a random sample of 30 interviews. Agreement averaged 93% and 94% for the two pairs of coders, and Cohen's kappa (reflecting agreement corrected for chance) was .84 for one pair and .85 for the other.

Structured risk factor knowledge—In the structured interviews, students were asked if a person could get AIDS by engaging in each of a number of potential risk behaviors, some true, some false. Response options, illustrated with bar graphs, were no chance, only a very little chance, a pretty good chance, or a big chance of getting AIDS. To facilitate comparison of risk factor and prevention items, risk factor items were dichotomized (0 = no or little chance, 1 = pretty good or big chance).

Structured prevention knowledge—Structured questions about prevention rules, asked after intervening questions about the effects of AIDS and its treatment, stated a prevention rule and asked if it was (1) or was not (0) a good rule to follow to help someone not get AIDS. To emphasize the focus on AIDS, the interviewer said, “Some of these might be good rules to follow because they do other good things for you, but I want you to tell me which ones would really help somebody not get AIDS.”

Composite risk factor and prevention knowledge scores—To compare risk factor knowledge and prevention knowledge as measured by structured and open-ended questioning methods, we focused on the five risk behaviors that could be matched up well with prevention rules in order to create four parallel measures: open-ended risk factor knowledge, open-ended prevention knowledge, structured risk factor knowledge, and structured prevention knowledge.

Specifically, the open-ended interviews yielded parallel risk factor/prevention rule coding categories for having sex as a risk factor/avoiding sex (being abstinent or engaging only in mutual monogamy with a safe partner) as a prevention rule, drug needle sharing/avoidance of drug needle use, and having contact with blood/avoiding contact with blood. Kissing, which was asked about specifically in the structured interview, was included in open-ended risk factor and prevention coding categories for mention of any form of saliva or mouth contact, and being breathed on was part of coding categories capturing any mention of airborne transmission as either a risk factor or a prevention strategy.

Similarly, the structured interview yielded parallel structured risk factor and prevention scores: (1) sharing a drug needle with a person who has AIDS/don't be a drug user, (2) having sex with lots of different people/don't have sex, (3) helping a bleeding person and getting blood in a sore on their hand/don't help someone who is bleeding and let their blood get on you, (4) kissing a person with AIDS on the lips/don't kiss someone who has AIDS on

the lips, and (5) being breathed on by a person with AIDS/don't let someone who has AIDS breathe on your face.

The result was four scores focused on the five behaviors: sex, drug needle sharing, blood contact, kissing/mingling saliva, and breathing/airborne transmission. After reverse scoring the incorrect responses pertaining to kissing and breathing, each of four total knowledge scores was derived by summing and averaging 0 and 1 scores across the five behaviors. On these composite measures, a score of 1 therefore represented correct responses across the five behaviors (endorsement or mention of the three true risk behaviors or prevention rules and rejection or lack of mention of the two false risk behaviors or prevention rules). A score of 0 represented incorrect responses across the five behaviors.

Conceptual understanding of AIDS causality—Conceptual understanding, sophisticated reasoning about the processes leading from engaging in a risk behavior to becoming infected and ultimately ill, was coded based on answers to the key question in the open-ended interview about how someone would get AIDS, as well as relevant responses elsewhere in the interview. The coding system was an adaptation for HIV/AIDS of Bibace and Walsh's (1980) system for coding conceptual understanding of illness regardless of accuracy developed by Walsh and Bibace (1991). Much like Perrin and Gerrity's (1981) scale, it yields the following possible scores: (0) no response or don't know, (1) a largely magical association between some phenomenon and illness, (2) the association of a specific cause and a specific effect without causal explanation, (3) an account of how an external cause leads to internalization of a disease agent and symptoms involving the whole body, (4) a mechanistic sequence of specific causes leading to specific changes in internal organs/processes and symptoms, (5) an entire causal sequence involving the interaction of multiple causes and multiple effects, with the body playing an active role, and (6) a full physiological explanation involving interactive causes and effects. As in other studies, this coding yielded a score that could range from 0 to 6, with 6 representing maximum causal sophistication (although not necessarily correct factual knowledge). Responses were scored by teams of two trained coders, who reached consensus before assigning a final code. It should be borne in mind that interrater agreement, averaging 68%, was marginal.

Results

Considered in turn are age differences in responses to open-ended and structured questions, correlations between scores on the risk factor and prevention knowledge scales in each age group, and multiple regression analyses using age, risk factor knowledge, and conceptual understanding to predict prevention knowledge.

Open-Ended Questions

Table 2 shows the proportions of children in each grade group who, in response to the open-ended questions, mentioned each behavior as a risk factor for AIDS and as a behavior to avoid to prevent AIDS. The table also reports *F* statistics for oneway analyses of variance by grade group and indicates which means differed from which based on Tukey's HSD follow-up tests for differences in means (Note that these analyses were conducted primarily to aid in identifying patterns of grade group differences and that, because multiple significance

tests were conducted, some of these differences may be significant merely by chance. See Lunney, 1970, regarding the use of analysis of variance with dichotomous variables.).

The open-ended questions revealed large and significant increases with age in mention of all three true AIDS risk factors, from proportions typically under 20% among first and second graders and third and fourth graders to 90% or more in grades 10 to 12. (It should be noted that 38% of the youngest group made other, vague references to drugs as a risk factor, suggesting that they had a sense that drugs were a danger, but were not able to specify drug needle sharing.)

Mentions of prevention rules highlighting the avoidance of sex, drug needle sharing, and blood contact increased in parallel fashion across the grade levels. Although many of the high school students did not offer a blanket "Don't have sex" rule, most provided responses suggesting awareness of safe sex concepts. Mention of sex and blood-related risk factors exceeded mention of sex and blood-related prevention rules.

Misconceptions about kissing or saliva contact as a risk factor were common; indeed, 91% of the youngest children, and high proportions of older elementary school students as well, spontaneously cited saliva-mingling behaviors such as kissing, sharing drinking glasses, and the like as risk factors for AIDS, a tendency that dropped off significantly only after sixth grade. Yet very few children recommended avoidance of kissing or other saliva-spreading activities as a way to prevent AIDS, suggesting that they were not translating their belief about the dangers of kissing into a prevention rule. Mention of airborne transmission as a risk factor, or of prevention rules related to it, was relatively rare at all grade levels, although more common among first and second graders than among older students.

The full range of open-ended responses is not reported in Table 2, but it is noteworthy that even first and second grade children could and did state a variety of prevention rules. Their rules most often took the form of general health rules such as don't go out in the cold, don't eat junk food, and get lots of exercise (38%); vague proximity rules such as avoid people with AIDS (31%); medically-focused rules such as go to the doctor (25%); and vague rules such as be careful and take good care of yourself (16%).

As Table 1 also shows, scores on the six-level conceptual understanding measure derived from open-ended responses also increased with age. First/second and third/fourth graders gave less causally complex responses than fifth/sixth and seventh-to-ninth graders, who in turn gave less sophisticated responses than high school students.

Structured Questions

Table 3 presents the parallel data from the structured interview, first proportions of children endorsing statements describing various risk behaviors, then proportions endorsing corresponding prevention rules. Age group differences in awareness of true AIDS risk factors, and especially of effective prevention rules, were not as pronounced in the structured interview responses as in the open-ended interview responses. Even most first and second graders recognized drug needle sharing and sex with lots of partners as risk factors, although awareness that AIDS could be spread through these behaviors nonetheless

increased significantly with age. The parallel prevention rules centered on avoiding drugs and sex were endorsed by large majorities in all age groups. Beliefs that helping a bleeding person is a risk factor and that avoiding helping a bleeding person is a sound prevention tactic were not as common and did not differ across grade groups, suggesting that even many adolescents either did not fully appreciate the dangers of contact with blood or did not want to appear to be an unhelpful person.

Mistaken beliefs about HIV transmission through kissing or being breathed on, as well as mistaken beliefs that avoiding kissing or being breathed on by someone with AIDS prevents HIV transmission, decreased markedly with age. Elementary school children often endorsed a “don't kiss a person with AIDS” prevention rule in the structured interview but did not spontaneously mention it in the open-ended interview despite their stated belief that kissing can cause AIDS.

Composite Correctness Scores

Figure 1 displays mean composite correctness scores by age group for measures of risk factor knowledge and prevention knowledge assessed through parallel structured and open-ended questions. Each mean is a percentage correct score formed by averaging the 0 (incorrect) and 1 (correct) scores for the five items that compose it. The data were analyzed with a $5 \times 2 \times 2$ analysis of variance, the factors being grade group (the five described), questioning method (open-ended vs. structured), and question focus (risk factors vs. prevention rules), with repeated measures on the last two factors. All effects were significant: grade group $F(4, 174) = 81.58, p < .0001$; content, $F(1, 174) = 19.62, p < .0001$; questioning method, $F(1, 174) = 73.95, p < .0001$; grade $\times$ content, $F(4, 174) = 11.47, p < .0001$; grade $\times$ method, $F(4, 174) = 22.15, p < .0001$; content $\times$ method, $F(1, 174) = 10.58, p < .001$; and the three-way interaction, $F(4, 174) = 3.49, p < .01$.

Follow-up tests for simple effects revealed significant age-related differences for all four total knowledge scores; differences were larger for open-ended risk factor knowledge, $F(4, 174) = 100.48, p < .0001$, and open-ended prevention knowledge, $F(4, 174) = 59.09, p < .0001$, than for structured risk factor knowledge, $F(4, 174) = 22.49, p < .0001$, and structured prevention knowledge, $F(4, 174) = 6.99, p < .0001$. Follow-up tests also revealed that, on the open-ended questions, risk factor knowledge scores were significantly lower than prevention scores among first-second and third-fourth graders, roughly equal to them among fifth-sixth graders; and significantly higher than prevention scores among seventh-to-ninth and tenth-to-twelfth graders. On the structured questions, risk factor knowledge was no higher than prevention knowledge among the youngest two groups but outstripped prevention knowledge at all higher grade levels, significantly so ($ps < .0001$) among fifth-sixth graders and tenth-to-twelfth graders.

As for questioning method, scores on the structured risk factor knowledge scale were higher than scores on the open-ended risk factor knowledge scale in the first three grade groups (all $ps < .0001$), but not among secondary school students. In the three youngest grade groups, scores on the structured prevention scale also exceeded scores on the open-ended prevention scale ($ps < .0001$). Among, seventh-to-ninth graders, there was no difference, whereas

among high school students, scores on the open-ended prevention scale exceeded those on the structured scale ($p < .05$).

Overall, then, knowledge was greater when assessed through structured questions than when assessed through open-ended questions among elementary school children, whereas questioning method made little difference for secondary school students. As a result, age-related differences were larger for open-ended questions than for structured questions. Finally, risk factor knowledge exceeded prevention knowledge only among older students.

Correlational Analyses

Table 4 presents a multitrait-multimethod analysis of the correlations between the four risk and prevention scales at the five different grade levels. It addresses questions about relationships between risk factor knowledge and prevention rule knowledge as well as about the influence of questioning method on those relationships. Many of these correlations are modest in size; indeed, 18 of 30 are nonsignificant, suggesting that neither children nor adolescents were highly coherent in their thinking about causality and prevention. Overall, although we lack the statistical power to formally test the differences, correlations tend to rise to a peak in fifth-sixth and seventh-to-ninth grades and are weakest among senior high school students.

Table 4 also reveals that correlations between different methods of assessing the same concept were significant for open-ended and structured risk factor scales in all three elementary school grade groups but not for secondary school students. They were significant for the two alternative prevention scales only in high school. Meanwhile, risk factor and prevention scores were correlated in all grade groups but the oldest when open-ended questions were the basis for creating both scales and at grades three-four, five-six, and seven-to-nine when structured questions were used to assess both risk factor and prevention knowledge. By contrast, risk factor/prevention correlations were not significant when the open-ended risk factor scale was correlated with the structured prevention scale, or (except among seventh-ninth graders) when the structured risk factor scale was correlated with the open-ended prevention scale. Thus questioning method had a considerable bearing on patterns of correlation: Risk factor/prevention correlations were higher when the same method was used to assess both concepts than when different methods were used.

Predictors of Prevention Knowledge

Given our special interest in prevention beliefs, we asked this question: To what extent do age, risk factor knowledge, and conceptual understanding of AIDS causality predict prevention knowledge? A forced-entry multiple regression analysis was conducted to predict score on the structured prevention knowledge scale as a function of age, conceptual understanding, structured risk factor knowledge, and open-ended risk factor knowledge. R^2 was 22%, $F(4, 173) = 12.19$, $p < .0001$. The only significant individual predictor was the structured risk factor knowledge measure, $B = .27$, $SE = .09$, $\beta = .27$, $t = 3.09$, $p < .01$. Open-ended risk factor knowledge was nearly significant ($p < .08$).

The regression analysis using the same variables to predict prevention knowledge as assessed by open-ended questioning accounted for a larger percentage of the variance, 66%, $F(4, 178) = 88.25, p < .0001$. Here the significant individual predictors were age, $B = .01, SE = .01, beta = .21, t = 2.64, p < .01$, and the open-ended measure of risk factor knowledge, $B = .38, SE = .05, beta = .55, t = 7.00, p < .0001$. Conceptual understanding was nearly significant as well, $p < .06$. Given significant correlations among all of the predictors, the results of these regression analyses must be interpreted cautiously. However, they suggest that the best predictor of prevention knowledge, even with age and conceptual understanding of AIDS causality controlled, is a similarly-constructed measure of risk factor knowledge.

Discussion

Grounded in a naïve theories perspective on the development of biological knowledge, this study examined age differences in knowledge about what causes HIV/AIDS, knowledge about how to prevent it, and relationships between these two important sets of beliefs. It also examined the implications of alternative questioning strategies for conclusions about the development of disease knowledge. The findings supported the hypotheses that knowledge of both risk factors and prevention rules, as well as conceptual understanding of what causes AIDS, would increase with age from age 6 to 18; that younger children would display more knowledge in response to structured questions than in response to open-ended questions; and that knowledge of AIDS causality would predict knowledge of prevention even with age controlled (although conceptual understanding fell short of significance as an independent predictor). The findings failed to support the hypothesis that knowledge of causality would be more advanced than knowledge of prevention, although there was some support for this among secondary school students, and it provided mixed and inconclusive evidence regarding the issue of coherence in thinking about disease and age differences in correlations between knowledge of causality and knowledge of prevention.

Knowledge of both causality and prevention, as well as conceptual understanding of AIDS, clearly increased with age, as in previous studies. The present data demonstrate that this is the case whether knowledge is assessed through open-ended or structured questions. Contrary to expectation and previous research (Drahota & Malcarne, 2008; Hansdottir & Malcarne, 1998; Perrin & Gerrity, 1981), risk factor knowledge did not appear to develop ahead of prevention knowledge in elementary school. Although risk factor scores were often higher than prevention scores at the secondary school level, this may have been attributable to a reluctance on the part of adolescents to endorse a blanket “Don't have sex” rule given their greater awareness of safe sex practices or a “Don't do drugs” rule given their greater awareness of different forms of drug use. It should also be noted that other research showing causality ahead of prevention assessed conceptual understanding, whereas the present study assessed knowledge. Moreover, our measures credited children with knowledge not only when they embraced a correct idea but also when they rejected an incorrect one, and items assessing causality and prevention were not always precisely parallel.

The hypothesis that open-ended questions, compared to structured questions, underestimate the knowledge of elementary school children was supported (c.f., Horowitz, 2009). Findings such as those in Figure 1, as well as comparison of Table 2 and Table 3, indicate that

methodology matters. Most likely, younger children have more difficulty recalling and verbalizing their ideas in response to open-ended questions than they have recognizing correct and rejecting false ideas in response to structured questions.

In addition, methodology mattered in the sense that relationships between knowledge of causality and knowledge of prevention, which speak to the issue of coherence in children's thinking about disease, were stronger when the same questioning approach was used to assess both than when different methods were used. The many nonsignificant correlations in Table 4 reinforce other indications that, even among adolescents and adults, naïve thinking about disease is not very coherent and can accommodate multiple and sometimes contradictory beliefs (Legare et al., 2012; Raman & Winer, 2002; Rosenthal et al., 1995). It seems plausible that we encounter various pieces of information about a disease like HIV/AIDS piecemeal and never notice inconsistencies among them or do the mental work required to integrate them.

Yet the issue of coherence warrants further investigation. There are some grounds for expecting children's thinking about HIV/AIDS to become more coherent once they grasp its underlying causal mechanism and integrate information around it (c.f., Au & Romo, 1996). Moreover, although we lacked adequate statistical power to test for differences between correlations, trends in Table 4 (rows 3 and 6) hint that coherence of thinking about causality and prevention may increase from first and second grade to fifth and sixth grade. The low correlations among high school students may reflect a ceiling effect owing to the fact that most students have by then acquired solid knowledge of both causality and prevention. They may also reflect reluctance among teens to endorse prevention rules calling for “no sex” or “no drugs” (see above). Still, these signs of increasing coherence over the elementary school years were evident only when students responded to either structured or open-ended questions about both risk factors and prevention rules. Evidence of coherence and increased coherence with age would be more compelling if correlations were significant even when different questioning methods were used. Thus, the present findings are inconclusive. However, the present study has contributed to the literature by raising the important—but largely neglected—issue of coherence in children's thinking about disease. It is left to others to continue its study using larger samples and a variety of indicators of theoretical coherence.

The present study's limitations should be borne in mind. Although it came closer than previous studies to developing parallel measures of knowledge of disease causality and prevention, it did not achieve perfect parallelism of question wordings and coding categories. For example, although three of the five prevention rules asked about matched up precisely with a corresponding structured risk factor item, the prevention rule about sex was broadly worded (“Don't have sex”), did not have precisely parallel counterparts, and probably underestimated adolescents' knowledge because it did not allow room for safe sex practices such as reliable condom use or monogamous sex with a low-risk partner. Similarly, the “Don't do drugs” rule was broadly stated and may have had appeal to elementary school children for that reason but may have raised eyebrows among older students. Meanwhile, both younger and older children may have had difficulty endorsing a prevention rule that calls for not helping people who are bleeding; a more nuanced rule calling for protecting

oneself when in the presence of blood might have been clearer. In future studies, it will be important to develop clearer and more strictly parallel methods for measuring both conceptual understanding and knowledge of causality, prevention, and perhaps other major aspects of disease. Moreover, it should be understood that linkages between causation and prevention are more direct and well-established for HIV/AIDS than they are for diseases that result from many interacting causal contributors. As a result, studying relationships between beliefs about causation and prevention will need to proceed disease by disease.

In addition, open-ended interviews were always administered before structured surveys to avoid biasing children's responses, and risk factor questions always appeared before prevention questions in the surveys, although with intervening items on different topics. Varying order of administration might be informative. In addition, the measure of conceptual understanding had modest interrater reliability and might have performed better as a predictor of prevention knowledge had it been more reliable. Finally, the sample was a relatively small volunteer sample not necessarily representative of its community, and findings may not generalize to other populations or contexts, and the data were cross-sectional rather than longitudinal, leaving open questions of the directionality of relationships between knowledge of causality and prevention.

Nonetheless, the study has several important implications for studying children's thinking about disease. Rather than suggesting that only structured questions be used, the findings point to the value of using multiple methods to study children's beliefs about disease and other health topics. The advantage of open-ended questioning is that it can reveal themes in children's thinking that might be missed otherwise (here, for example, the emphasis in young children's responses on general health promotion rules rather than HIV/AIDS-specific ones). The advantage of structured questioning is that it can reveal intuitions that might go unexpressed in open-ended interviews, although it can also introduce bias or error by planting ideas that children might not otherwise have. Methodological choices are especially important in studying younger children's thinking about disease. One promising strategy is to combine structured and open-ended questioning, moving from general questions to more specific questions about ideas already offered by the child (Horowitz, 2009). Other researchers have found that asking children to draw pictures and tell stories about them or to respond to questions about pictures is helpful in eliciting their intuitions about biological phenomena (Driessnack & Gallo, 2013; Kelemen, Emmons, Schillaci, & Ganeo, 2014), including AIDS (Plattner, 2013). Method variance must be taken seriously, but our knowledge of the development of disease concepts will be on more solid ground when findings based on different methods converge.

The present findings also have implications for health promotion and health education efforts. Decades into the HIV/AIDS epidemic, partly owing to adult sensitivities about what children should be taught, HIV/AIDS education for elementary school children remains not very specific and far from universal (Kann, Telljohann, Hunt, Hunt, & Haller, 2013). This is the case despite evidence that elementary school children can grasp the basics of HIV/AIDS causality and prevention (Au & Romo, 1996; Schonfeld et al., 1995; Sigelman, Derenowski, et al., 1996) and despite evidence that HIV/AIDS education is likely to be most effective in

preventing HIV infection when it starts before youth become sexually active (Poobalan et al., 2009).

The present findings also reveal that children have misconceptions about AIDS that need to be addressed (see also Schonfeld et al., 1993; Legare & Gelman, 2009), not only to increase their knowledge of how to protect themselves but also to reduce the fears and stigmatizing tendencies that stem from misconceptions about how people get the disease (Plattner, 2013; Zhao et al., 2011). A kissing myth was most prominent in the present findings, probably because, to a child, hearing that sex causes AIDS translates into believing that kissing causes AIDS, as well as because kissing is a well-known way of spreading common diseases such as colds and flus. The findings also suggest that children need to be made aware of the dangers of contact with blood.

Although our correlational findings cannot establish whether ideas about causality inform ideas about prevention or vice versa, they suggest that parents and health educators may want to teach children prevention rules for specific diseases explicitly rather than expecting children to extract such rules on their own from either their knowledge of that disease's causality or their grab bag of generally good health promotion rules. Adults might also foster more coherent thinking about disease by pointing out the implications for prevention of information about the causes of a disease and explaining why good prevention rules are likely to work by explaining how they help people avoid the disease agent for the disease and the causal processes through which risky behavior leads to disease.

However, conveying accurate information and eliminating mistaken beliefs are only a starting point in HIV/AIDS prevention. Thus far, we have situated the present study primarily in the literature on children's concepts of illness. However, it should also be viewed in the context of health promotion and disease prevention research (Poobalan et al., 2009). In that literature, the consensus is that knowledge of HIV/AIDS is necessary but not sufficient to achieve the more challenging goal of changing behavior—that information must be supplemented by motivation to reduce risk and behavioral skills relevant to doing so (Fisher & Fisher, 1992; Poobalan et al., 2009). A host of health behavior theories (e.g., the health belief model, the theory of planned behavior) have been devised to predict risky or safe health behavior. In most, knowledge is not an element; rather the focus is on psychological constructs such as attitudes toward the health behavior of interest (e.g., condom use), beliefs about social norms, self-efficacy, intentions, and the like (e.g., Airhihenbuwa & Obregon, 2000; Noar & Zimmerman, 2005). Even these models, with their focus on individuals and their beliefs and attitudes, have been criticized because they do not sufficiently attend to the meanings of health behaviors in the context of relationships and cultural beliefs and practices (Airhihenbuwa, Ford, & Iwelunmor, 2014; Airhihenbuwa & Obregon, 2000). In sum, preventing HIV/AIDS requires far more than educating children about the disease, but educating children about the disease is nonetheless the right starting point.

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Figure 1.

Open-ended (OE) and structured (ST) AIDS risk factor and prevention knowledge scores by grade level, where a score of 1.0 represents correct knowledge on all five items that compose each scale.

Table 1

Demographic Characteristics of the Grade Groups

Characteristic	Grade Group						Total
	1st-2nd	3rd-4th	5th-6th	7th-9th	10th-12th		
N	32	37	30	38	51	188	
Age	7.09	8.57	10.50	12.97	16.06	11.55	
Gender							
% female	62.5	43.2	33.3	57.9	59.9	50.5	
% male	37.5	56.8	66.7	42.1	47.1	49.5	
Ethnicity							
% Euro-American	50.0	75.7	64.5	68.4	68.6	66.1	
% Hispanic	25.0	8.1	19.4	13.2	17.6	16.4	
% African-American	12.5	10.8	9.7	13.2	11.8	11.6	
% Other	12.5	5.4	6.4	5.2	2.0	5.8	
Parent education	14.06	15.35	14.19	15.13	14.98	14.78	

Table 2
Proportions of Children by Grade Group Mentioning Risk Factors and Prevention Rules in Response to Open-Ended Questions and Conceptual Understanding Scores

Item	Grade Group					F
	1st-2nd	3rd-4th	5th-6th	7th-9th	10th-12th	
Risk factors						
Sex	.19 ^a	.30 ^a	.68 ^b	.97 ^c	1.00 ^c	48.40***
Drug needle sharing	.03 ^a	.16 ^{ab}	.39 ^b	.84 ^c	.90 ^c	48.09***
Blood contact	.16 ^a	.19 ^a	.52 ^b	.79 ^c	.96 ^c	36.01***
Saliva/kissing	.91 ^a	.73 ^a	.81 ^a	.34 ^b	.16 ^b	25.10***
Airborne transmission	.22 ^a	.11 ^{ab}	.16 ^{ab}	.00 ^b	.00 ^b	4.87**
Prevention rules						
Don't have sex	.03 ^a	.11 ^a	.10 ^a	.46 ^b	.56 ^b	14.59***
Don't share drug needles	.03 ^a	.14 ^a	.26 ^a	.65 ^b	.84 ^b	33.45***
Avoid blood contact	.03 ^a	.16 ^{ab}	.32 ^{bc}	.46 ^{cd}	.68 ^d	14.46***
Avoid saliva/kissing	.09 ^{ab}	.16 ^{ab}	.23 ^a	.03 ^b	.02 ^b	3.46***
Avoid airborne	.13 ^a	.00 ^b	.00 ^b	.00 ^b	.00 ^b	5.39***
Conceptual understanding	2.84 ^a	3.11 ^a	3.81 ^b	4.24 ^b	5.26 ^c	36.30***

Note: Each proportion represents the percentage of children in a grade grouping who mentioned a behavior in response to the open-ended risk factor or prevention question. Degrees of freedom for anovas are 4 and 183 for risk factor items and causal complexity scores, 4 and 182 for prevention items. In each row, means that do not share a superscript in common are significantly different at $p < .05$ based on a Tukey HSD test.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3
Proportions of Children by Grade Group Endorsing Risk Factors and Prevention Rules in Response to Structured Questions

Item	Grade Group					F
	1 st -2 nd	3 rd -4 th	5 th -6 th	7 th -9 th	10 th -12 th	
Risk factors						
Sex with lots of people	.77	.76	.90	.94	.96	3.47**
Sharing drug needles	.81 ^a	.76 ^{ab}	.97 ^{bc}	.97 ^{bc}	1.00 ^c	6.18***
Helping bleeding person	.43	.51	.55	.44	.55	ns
Kissing PWA	.71 ^a	.51 ^{ab}	.42 ^{bc}	.17 ^{cd}	.06 ^d	15.56***
Breathed on by PWA	.45 ^a	.27 ^{ab}	.29 ^{ab}	.06 ^{bc}	.02 ^c	8.97***
Prevention rules						
Don't have sex	.62	.67	.81	.78	.69	ns
Don't be a drug user	.80	.78	.90	1.00	.84	ns
Don't help bleeding people	.68 ^a	.34 ^b	.42 ^{ab}	.49 ^{ab}	.45 ^{ab}	ns
Don't kiss a PWA	.67 ^a	.54 ^{ab}	.71 ^a	.33 ^b	.25 ^b	6.94***
Don't let a PWA breathe on you	.67 ^a	.38 ^b	.35 ^b	.17 ^{bc}	.04 ^c	12.91***

Note: PWA means person with AIDS. Means are proportions of children endorsing a risk factor (saying there is a pretty good or big chance it could cause AIDS) or endorsing a prevention rule. Degrees of freedom for each ANOVA range from 4 and 180 to 4 and 181 for the risk factor items and from 4 and 175 to 4 and 180 for the prevention items. Means that do not share a superscript in common are significantly different at $p < .05$ based on a Tukey's HSD test.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4
Correlations between Pairs of Composite Correctness Scores for Each Grade Group

Item	Grade Group					
	1st-2nd	3rd-4th	5th-6th	7th-9th	10th-12th	
Risk OE/Risk ST	.43*	.47**	.52**	.30	-.19	
Prevent-OE/Prevent-ST	.04	-.13	.24	.27	.29*	
Risk OE/Prevent-OE	.52**	.68***	.71***	.42**	.10	
Risk OE/Prevent-ST	.18	.16	.32	.26	.03	
Risk ST/Prevent-OE	.23	.15	.25	.38**	-.11	
Risk ST/Prevent-ST	.19	.39*	.47**	.47**	.23	

Note. OE = codings of answers to open-ended questions, ST = answers to structured questions.

*
p < .05.
**
p < .01.

p < .001.