The Role of Germs and Viruses in Children's Theories of AIDS (or, AIDS Are Not Band-Aids)

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The development of knowledge of germs and viruses in relation to AIDS and flu was examined in a predominantly Mexican American sample of children aged 8-9, 10-11, and 12-13. Children progressed with age from identifying the disease agent for these diseases as a nondescript germ or something other than a germ to implicating a disease-specific germ or virus. Parallel age trends in mastery of the two diseases were observed; gender and ethnic differences were minimal. Solid command of germ and virus concepts in relation to AIDS was associated with more causally sophisticated understanding of the disease but not with more accurate knowledge of modes of HIV transmission. Grasp of flu germ/virus concepts did not contribute to greater understanding or knowledge of AIDS. Overall, children seem predisposed to construct a germ theory of an unfamiliar disease such as AIDS but need help in differentiating between one germ and another.

Seven-year-old Wesley did not know what to make of AIDS at first: "When my mom and dad said that AIDS can kill you, I said, 'No, they can't,' I said, but they said, 'Yeah, they can,' so I said, 'No they can't. They're Band-Aids. How can Band-Aids kill you?' And they explained to me on AIDS." Asked what he would most want to tell a student who had never heard of AIDS about it, he replied, "I'd tell them that AIDS are not Band-Aids."

Understanding AIDS poses a challenge for children because the human immunodeficiency virus (HIV) is different from the microorganisms that transmit more familiar infectious diseases. Increasingly, developmental psychologists appreciate that children do not merely accumulate isolated facts about the world. Instead, from an early age, they construct organized theories in such domains as physics, biology, and psychology.[1-3] An

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accurate theory of AIDS must feature an AIDS-specific germ or virus, making it important to find out what children of different ages know about the disease-causing role of germs and viruses and how well they distinguish between the "germ" that causes AIDS and other germs.

Research on children's understandings of disease has tended to examine either their knowledge of germs and contagion or the complexity of their causal explanations of disease processes. The earliest work on awareness of germs, conducted by Nagy,[4,5] suggested that most children as young as 5 to 7 years of age were familiar with the concept of germs but did not understand that different germs cause different diseases. Many young children portrayed germs in drawings as animals, especially insects. Understanding of germs then increases predictably with age.[6,7,8] It is not until adolescence that children also become acquainted with the term *virus*, which they use to describe either a germlike disease agent or an illness.[8]

Recent studies using simplified questioning techniques suggest that young children have more sophisticated intuitions about infectious disease than previously implied. Preschool children seem aware that germs and even viruses (once the concept is defined for them) are animate rather than inanimate and that they are contagious but not sentient.[2] They grasp the distinction between contagious ailments such as colds and noncontagious ailments such as toothaches.[9] Moreover, they prefer contagion explanations of illness to immanent justice explanations viewing illness as a punishment for misbehavior.[9,10,11]

By contrast, Piagetian studies that assess developmental changes in understanding of disease—that is, the complexity of children's explanations of the causal processes involved—suggest that preschool and early elementary school children are largely unable to explain illness in terms of germs.[12-15] Young children typically offer explanations based on magical processes or mere association. They cite behaviors that put one at risk (e.g., going out in cold weather without a coat) but do not refer to the internalization of a disease-causing agent to explain *how* risky behavior leads to illness. Between ages 7 and 10, children begin to put some internalized, disease-causing agent (e.g., a germ) at the center of their theories of disease. Only as they enter adolescence do they differentiate more clearly among different germs and diseases and consider multiple, interactive factors in their explanations of illness.

Most of these Piagetian studies ask about sickness in general or about colds. However, understanding of AIDS appears to evolve through the same Piagetian levels of causal complexity.[16,17,18] *Knowledge* of AIDS, or command of facts about it, also expands with age (see Walsh and Bibace[18] regarding the important distinction between knowledge and understanding). Specifically, children shed misconceptions that the disease is transmitted through nonintravenous drug use or through saliva exchange, sneezing, and other forms of close contact with an infected person.[19-22]

In our own unpublished research, we interviewed 189 children aged 5 to 18 about what causes AIDS. Fifty percent of first and second graders, 76% of third and fourth graders, 81% of fifth and sixth graders, 90% of junior high school students, and 100% of senior high school students showed some awareness that a germ or virus causes AIDS, but only about 20% of elementary school students communicated that the germ or virus that causes AIDS is different from other germs and viruses. In other words, many children may assume that anyone who is sick or any object that is germ laden could potentially cause AIDS. Very few young elementary school children associated AIDS with dirt or insects, contrary to previous work.[5,6] Instead, asked to explain how someone might get AIDS, young children typically said they did not know, talked of "the AIDS" getting into a person, or referred to undefined germs. Not until junior high school were most students

able to define a germ or virus as a disease-causing entity and to identify HIV as the virus that causes AIDS.

In summary, prior research suggests that young children are familiar with the concept of germs, if not viruses, and that as children get older, they become more aware that different infectious diseases are associated with different germs and are more able to incorporate germs in their explanations of disease processes. However, much remains to be learned about this developmental sequence and its implications. In the present investigation, we developed a very direct, open-ended interviewing strategy that we hoped would clarify how children think about the causes of disease. In order to examine generalizability of knowledge and understanding across diseases, we asked about both AIDS and flu. Our purposes were (1) to trace the development of knowledge concerning the role of germs or viruses in AIDS and flu, (2) to determine whether germ and virus concepts are applied similarly to the two diseases, and (3) to determine whether awareness that a germ or virus is implicated in a disease contributes to more sophisticated conceptual understanding of the disease and more accurate knowledge of what behaviors do or do not cause it.

METHOD

Participants

Interviews were conducted with 157 children in third, fifth, and seventh grade in three Catholic elementary schools in a southwestern city. They were randomly selected from the 306 students in a larger intervention study (see Sigelman et al.[26]) to receive an open-ended interview about AIDS and flu. Mean ages were as follows: third grade, 8.77 years; fifth grade, 10.67 years; and seventh grade, 12.56 years. There were 62 boys and 95 girls. The majority were Anglo-American (35.7%) or Hispanic American (59.2%); the rest were African American (1.9%), Native American (1.3%), or Asian American (1.9%). At the time of the study, AIDS education was not provided at the grade levels studied.

Two schools located in low-income, heavily Mexican American neighborhoods provided 54% of the sample. In one school, 81% of the interviewees were Hispanic and 44% qualified for the school's free lunch program; in the other, 96% were Hispanic and 69% qualified for the free lunch program. We do not know if these Catholic parochial school students might have different levels of AIDS awareness than public school children. However, most of the sample was Mexican American, and about 85% of Mexican Americans in the Southwest are Catholic.[23] Whether they attend parochial or public school, then, Mexican American children are likely to have been exposed to the Catholic Church's conservative teachings on AIDS-related topics.

Parents provided written consent in response to explanatory letters that were printed in English and Spanish and sent home with children; children provided written consent at the time of their interviews.

Interview and Measures

Interviews lasting 10-30 minutes were conducted by trained interviewers (Anglo and Hispanic females) at children's schools. By random determination, half were asked about AIDS first, half about flu. Interviewers took notes and tape-recorded sessions. Tapes were

transcribed, and answers were coded by two independent coders (from a pool of seven trained coders) according to protocols to be described shortly.

The five standard questions of the interview, asked about each disease in turn, were as follows: (1) "First, can you tell me what AIDS/flu is?" (only two third graders failed to identify AIDS as a disease, and only two third graders and two fifth graders failed to identify flu as a disease, in response to this question and a multiple-choice follow-up question; these children were told AIDS or flu is a disease); (2) "Can you tell me a way someone could get AIDS/flu?" (with probing if vague response, e.g., "Can you say more about what you mean by 'from other people?' "); (3) "How would [the risk behavior the child just mentioned] give someone AIDS/flu exactly?" (if no disease agent such as a germ or virus was mentioned, the interviewer probed, "If someone gets sick with AIDS/flu from [risk factor], does something get in their body that makes them sick? What? Can you tell me more about what [disease agent identified] is/are exactly?"); (4) "When people get chicken pox, they get little red spots that itch. What happens to people when they get AIDS/flu?"; and (5) "How does [the disease agent named by the child] make them experience [the main symptom mentioned]? What happens inside their body?" (with probing if vague response, e.g., "How does that work?").

Two parallel scales were created to represent children's knowledge of the role of a germ or virus in causing AIDS and flu, respectively: *AIDS germ concept* and *flu germ concept*. Both scales were the sums of scores on five variables coded from the interviews and then recoded as either correct (1) or incorrect (0): (1) knowledge that a person must have the disease before being able to transmit it to another person, (2) knowledge that a germ or virus is the agent that gets into people, (3) knowledge that the agent is a tiny entity that causes disease, (4) knowledge of how risk behavior allows the disease agent into the body, and (5) use of the term *virus* to mean a disease-causing agent anywhere in the interview.

Interrater agreement for the original coding categories averaged 80% for the five AIDS items and 78% for the five flu items. Two coders coded each interview, and disagreements were resolved through discussion before final codes were assigned. The resulting germ concept variables could range from 0 to 5; alpha was .66 for the AIDS Germ scale (N = 156) and .64 for the Flu Germ scale (N = 157).

Responses to the entire AIDS and flu interviews were also coded for the complexity of the child's overall *understanding* of each disease based on the Developmental Conceptions of Illness Category System.[12,18] The six levels reflect the complexity of causal reasoning, *not* the correctness, of children's explanations of illness theories and are as follows: (1) a largely magical association between some phenomenon and the illness; (2) the association of a specific cause and a specific effect without explanation of how one leads to the other; (3) an account of how external causes such as contact lead to the internalization of a disease agent (though not necessarily a germ) and symptoms involving whole body; (4) a mechanistic sequence of specific causes leading to specific changes in internal organs/processes and then to symptoms; (5) an entire causal sequence involving the interaction of multiple causes and multiple effects, with the body playing an active role; and (6) transformations at the cellular level involving multiple interacting causes and effects. With "don't know" responses coded 0, total understanding scores could range from 0 to 6. Interrater agreement was 71% for AIDS understanding and 67% for flu understanding.

Finally, we assessed the accuracy of students' *knowledge* of HIV transmission through an AIDS survey administered during in-class testing sessions. Questions were read aloud to students according to a standard procedure, and students marked their answers on

multiple-choice answer sheets. Children were asked to judge the chances that a person could get AIDS from various activities, given the following response options displayed on a large bar graph: no chance, a very little chance, a pretty good chance, and a big chance. Scores could range from 0 to 3, with 3 reflecting accurate knowledge (i.e., endorsement of true risk factors or rejection of false ones).

The scales were as follows: (a) *knowledge of true risk factors* (seven items; e.g., having sex with many people, shooting drugs with a needle used by a person with AIDS [PWA], being born to a mother with AIDS; alpha = .61); (b) *knowledge of inhalation/ingestion myths* (five items; e.g., drinking from the same glass as a PWA, letting a PWA breathe on you; alpha = .85); (c) *knowledge of contact myths* (six items concerning direct or indirect contact, such as sitting next to a PWA or eating food prepared by a PWA; alpha = .75); (d) *knowledge of low-risk drugs* (six forms of drug use that pose little risk of AIDS, such as sniffing cocaine and smoking marijuana; alpha = .81).

RESULTS

The data in Table 1 show what children of different ages think gets into people to cause AIDS and flu. Responses regarding AIDS differed significantly by age group, $\chi^2(10, 156) = 22.51, p < .05$. "Don't know" responses decreased with age. Responses referring to bugs or inanimate objects were rare, even among the youngest children, but 12%-17% of children across age groups characterized the disease agent as the disease itself (e.g., bits of disease or "the AIDS," often used in the plural). With age, more children (54% in third, 77% in fifth, and 82% in seventh grade) identified either an unspecified germ or virus or an AIDS-specific germ or virus as the disease agent for AIDS, but even in seventh grade, only 29% communicated that the germ/virus was AIDS specific.

Similar percentages of children in each age group knew that a germ or virus of some kind is involved in the transmission of *flu*, but fewer communicated that this germ or virus is uniquely associated with flu. As with AIDS, knowledge increased with age, $\chi^2(10, 156) = 41.36, p < .001$. Most third graders either could not answer (18%), suggested that cold air causes flu (18%), or identified the flu itself as the disease agent (18%).

Table 2 shows the percentage of students who had mastered the five knowledge elements included in the AIDS and flu germ concept variables, as well as the mean scores obtained by children in each grade on the composite 0-to-5 scales.

The percentage of children who conveyed in their answer that someone must have HIV/AIDS to transmit it increased from 47% to 86% between the third and seventh grades. The percentage who indicated that someone must have flu in order to transmit it was lower but also increased with age (from 36% to 65%). For both diseases, only about 20% of third graders but half of fifth graders and two-thirds of seventh graders could accurately describe how risky behavior results in internalization of a disease-causing agent. As noted earlier, the proportions of students who identified a germ or virus as the agent causing AIDS and flu also increased substantially with age. Similarly, the percentages of children correctly defining the agent as a tiny thing that causes disease (rather than as an animal, poison, bit of disease, and so on) increased with age in much the same manner for both diseases, from about 25% to about 60%.

About 10% of third graders and 40% of both older groups used the term *virus* to refer to the agent causing AIDS. Although even less common, use of the term virus to refer to the agent causing flu also increased with age. In sum, all five elements of germ/virus knowledge increased with age for both diseases.

Table 1. Identifications of Disease Agents for AIDS and Flu in Each Grade (in percentages)

Response	Grade		
	3 (n = 56)	5 (n = 52)	7 (n = 49)
What is AIDS agent?			
Don't know/vague	18.2	1.9	2.0
Cold air/dirt/bugs	7.3	1.9	0.0
Blood/sexual fluid	5.5	1.9	4.1
Disease/AIDS	14.5	17.3	12.2
Unspecified germs/virus	41.8	55.8	53.1
AIDS virus/HIV	12.7	21.2	28.6
What is flu agent?			
Don't know/vague	17.9	5.8	0.0
Cold air/dirt/bugs	17.9	5.8	8.2
Blood/sexual fluid	0.0	0.0	0.0
Disease/flu	17.9	5.8	0.0
Unspecified germs/virus	46.4	80.8	79.6
Flu virus	0.0	1.9	12.2

Each composite germ concept scale was analyzed with a 3 (Age) × 2 (Gender) × 2 (Ethnicity: Anglo vs. minority) ANOVA in order to determine whether these age trends were similar for both sexes and across ethnic groups. Command of germ and virus concepts in relation to AIDS increased between third and fifth grade and then leveled off (see Table 2 means and Fs for the main effect of age). The interaction between grade, sex, and ethnicity was also significant, $F(2, 144) = 7.48$, $p < .001$. However, further analysis revealed only subtle differences among subgroups. Among Mexican American and other minority students, mastery was greater in fifth grade and seventh grade than in third grade. Among Anglo boys, mastery was greatest in fifth grade, whereas among Anglo girls, it was greater in seventh grade than in either younger group. No consistent gender or ethnic differences in knowledge of germ/virus concepts were observed.

Mastery of germ and virus concepts in relation to flu increased from third to fifth grade and again from fifth to seventh grade. This developmental trend was similar for children of different genders and ethnic groups, as indicated by the absence of interaction effects. Finally, the two germ concepts were significantly but only moderately correlated ($r = .38$, $p < .001$, $N = 156$).

Germ Concept Mastery in Relation to Understanding and Knowledge

Does having a solid concept of germs/viruses in relation to AIDS or a more familiar disease, flu, help children conceptualize the causality of AIDS in more sophisticated ways and better absorb information about what causes it? To find out, we performed multiple regression analyses to predict the causal complexity of children's overall explanations of AIDS and their knowledge of AIDS risk factors (the four knowledge scales described earlier) on the basis of three predictors: age, AIDS germ concept score, and flu germ concept score. This allowed us to determine whether a child's grasp of germ/virus concepts, independent of his or her age, predicts understanding and knowledge.

Table 2. Percentages of Children in Each Grade With Correct Answers on Items in AIDS and Flu Germ Concept Scales and Overall Scale Means

Item	Grade			Statistics
	3	5	7	
1. Knows a person must have the disease to transmit the disease				
AIDS	47.3	78.8	85.7	$\chi^2 = 21.18$**
Flu	35.7	42.3	65.3	$\chi^2 = 9.91$*
2. Describes internalization of disease agent correctly				
AIDS	18.2	55.8	63.3	$\chi^2 = 25.04$**
Flu	21.4	46.2	65.3	$\chi^2 = 20.75$**
3. Knows a germ or virus is the disease agent that gets into people				
AIDS	53.6	75.0	79.6	$\chi^2 = 9.64$*
Flu	46.4	80.8	91.8	$\chi^2 = 25.69$**
4. Defines agent as a tiny thing that causes disease				
AIDS	23.6	46.2	57.1	$\chi^2 = 12.62$*
Flu	25.0	40.4	61.2	$\chi^2 = 14.17$**
5. Uses the term virus to mean a disease agent				
AIDS	10.7	42.3	40.8	$\chi^2 = 16.20$**
Flu	0.0	23.1	24.5	$\chi^2 = 15.74$**
Total germ concept score				
AIDS	1.55^a	2.98^b	3.27^b	$F = 27.10$**
Flu	1.29^a	2.33^b	3.08^c	$F = 24.89$**

NOTE: Means for the total germ concept score with similar superscripts are not significantly different from each other. *df*s for all χ^2 results = (2, 157); *df*s for *F*-test results from the Age × Sex × Ethnicity ANOVAs were (2, 144) for AIDS and (2, 145) for flu.
*$p < .01$; **$p < .001$.

Causal understanding of both AIDS and flu increased with age. However, once age differences in knowledge of the role of germs and viruses in AIDS and flu were controlled, age no longer predicted level of conceptual understanding of AIDS causality. Knowledge of the role of germs or viruses in AIDS was the only significant predictor in the regression model (beta = .42, $p < .001$), and the three predictors jointly accounted for 26% of the variance in AIDS understanding, $F(3, 151) = 17.69$, $p < .0001$. Similarly, conceptual understanding of flu causality was predicted only by knowledge of germ/virus concepts in relation to flu rather than AIDS (beta = .34, $p < .001$); the model accounted for 21% of the variance, $F(3, 151) = 13.36$, $p < .0001$.

By contrast, the regression analyses to predict the four AIDS risk factor knowledge scores indicated that mastery of AIDS and flu germ concepts contributed nothing additional beyond the effects of age to knowledge. Knowledge of true AIDS risk factors could not be predicted from a child's age or mastery of AIDS and flu germ concepts. The three predictors jointly accounted for 22% of the variance in knowledge of contact myths, 30% of the variance in knowledge of ingestion/inhalation myths, and 30% of the variance in knowledge of low-risk drug myths (all *p*s < .001). In each case, older children had significantly fewer misconceptions than younger children (betas = .30, .45, and .41,

respectively), even with age differences in germ concept mastery controlled. An unanticipated relationship between mastery of the flu germ concept and knowledge of low-risk drugs in relation to AIDS ($p < .05$) was the only significant relationship between germ concept mastery and knowledge of AIDS risk factors.

These analyses suggest the following: (1) mastery of germ/virus concepts in relation to one disease does not contribute to more sophisticated theorizing about a different disease, (2) knowledge of germ/virus concepts in relation to a disease *is* related to being able to provide a coherent account of the causality of that disease and may be the reason for age differences in such understanding, (3) mastery of germ/virus concepts is not predictive of knowing what does or does not cause AIDS (i.e., something other than increased mastery of germ/virus concepts must account for the increase in such knowledge with age).

DISCUSSION

The research reported here revealed substantial age-related increases in knowledge of germs and viruses in relation to both AIDS and flu. Boys and girls, Anglo- and Mexican American children, showed quite similar levels of mastery and developmental trends. Developmental trends for the two diseases were also highly similar. Finally, acquiring knowledge of germs and viruses in relation to a particular disease appears to help children understand the causal processes involved in that disease but does not make them less susceptible to factual misconceptions about which behaviors cause the disease or improve their understanding of other diseases.

Third graders appear to be quite familiar with the concept of germs and quite ready to associate them with AIDS. Contrary to some reports,[5,6] they only rarely identify "bugs" (or other little animals) as disease agents; when they do, they may only be groping for a way to describe germs. Some children *do* talk of the disease itself (e.g., "the sickness," "the AIDS") rather than disease-causing germs as the cause of AIDS, however. Their failure to differentiate between the disease and the microorganism that causes it warrants further investigation, for it may limit their grasp of other important information (e.g., the fact that people can have the HIV virus in their body for years without being sick).

Many elementary school children also do not appreciate that the virus that causes AIDS is distinct from the germs and viruses that cause other infectious diseases. As a result, some children may think that people with colds can transmit AIDS and vice versa. Even in seventh grade, fewer than half of students speak of viruses as disease-causing organisms. More research is needed to clarify when and what children learn about viruses and how they come to differentiate between HIV and other viruses.

With age controlled, mastery of germ concepts predicted the causal complexity of children's explanations of AIDS (understanding) but not their knowledge of which behaviors do and do not put one at risk for AIDS. This finding reinforces the theme that conceptual understanding and knowledge of disease are distinct.[7,18,24] Drawing on work suggesting that children's knowledge takes the form of intuitive theories,[1,2] we maintain that children construct theories of AIDS and flu that feature germs as the organizing explanatory concept. Once they become sufficiently knowledgeable about germs, they can appreciate *how* engaging in risky behaviors causes disease, and their explanations of disease therefore become more causally complex and coherent.

Yet children who have constructed a germ theory of AIDS may or may not know enough about the "AIDS germ" to know that it cannot survive long outside the body and

therefore cannot be passed from person to person through the air. They also may or may not understand methods of drug use well enough to know which can transmit HIV from person to person. Judging from our findings, knowledge of the role of germs or viruses in AIDS does not make children any more prone to think that one can get it by being sneezed on or sharing food with a PWA. Neither does it guarantee accurate knowledge of HIV transmission, however. Knowledge of germs may need to be supplemented by other knowledge (e.g., about the media in which HIV can survive) to produce accurate knowledge of what behaviors do and do not transmit HIV.

Our findings for Catholic parochial school students in the Southwest may not generalize to other populations of children. Moreover, like other studies involving open-ended interviewing of children, this one may have underestimated what children know and understand.[3] Research using structured questioning techniques may help to illuminate what children of different ages mean when they say "germs" cause AIDS or speak of "the AIDS" getting in someone's body. Finally, experimental designs might be used to determine whether teaching children more about germs can improve their knowledge and understanding of various diseases.

Implications for Practice

Without basic knowledge of germs and viruses as disease-causing agents, children are likely to have little idea how people get AIDS or other infectious diseases. They may resort to magical thinking by default.[25] However, as Carey[1] argues, one may be able to stimulate children to revise their theories by increasing their knowledge base. One need not wait, as Piagetians have argued, until children have achieved a sufficient level of cognitive maturity. Elementary school children can, with appropriate education, learn the basic facts of AIDS and achieve a greater conceptual understanding of those facts.[26] As we have seen here, children have a number of sound intuitions about illness that can serve as the foundation for educating them. They are likely to be better able to organize and remember the basic facts of AIDS if they are offered a coherent theory of HIV transmission with a germ or virus at its center than if they are presented with the same facts but are not given a meaningful conceptual framework in which to place them. Judging from our findings, they must first understand that germs are disease-causing organisms, that some diseases are caused by germs and others are not, that different germs cause different diseases, and that different germs are transmitted in different ways. Then they will be in a position to learn about a particular "germ" called HIV and how it passes from one person to another, enters the bloodstream, and destroys the body's defenses. By assessing their students' current thinking about disease and identifying gaps in their knowledge and understanding, health educators will be better able to lead students toward more complete and accurate theories of AIDS and other diseases.

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