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Brief Report

Behavioral avoidance of contagion in childhood

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A B S T R A C T

Although there is a large literature on children's reasoning about contagion, there has been no empirical research on children's avoidance of contagious individuals. This study is the first to investigate whether children avoid sick individuals. Participants (4- to 7-year-old children) were invited to play with two confederates—one of whom was "sick." Afterward, their knowledge of contagion was assessed. Overall, children avoided proximity to and contact with the sick confederate and her toys, but only 6- and 7-year-olds performed above chance. The best predictor of avoidance behavior was not age but rather children's ability to make predictions about illness outcomes. This provides the first evidence of behavioral avoidance of contagious illness in childhood and suggests that causal knowledge underlies avoidance behavior.

Introduction

Children's understanding of contagion (i.e., the transmission of illness caused by microbes through proximity or physical contact) has been a fruitful area in studying causal learning in early childhood because it has implications for how children acquire biological knowledge and reason about non-obvious properties and mechanisms (Au, Sidle, & Rollins, 1993; Kalish, 1996; Keil, Levin, Gutheil, & Richman, 1999). Although the term "germ," for example, is generally introduced to children early in life, it describes a causal mechanism for illness that they cannot see or touch. Thus, researchers have taken an interest in how children develop concepts of illness and how illness is transmitted from one person to another.

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Children's reasoning about illness begins to develop during the preschool years and continues throughout middle childhood (Keil et al., 1999; Myant & Williams, 2005). Some studies report an early-emerging understanding of how contagious illness is transmitted, suggesting that by 4 years of age children have a physical understanding of illness transmission and differentiate between contagious and non-contagious interactions (Kalish, 1996). For example, 4-year-olds can provide physical explanations for what made someone sick, indicating that they have some knowledge of the relevant causes of illness and recognize that contact plays a special role in transmission (Legare, Wellman, & Gelman, 2009).

Conversely, studies examining a wider age range suggest that a full understanding of illness transmission develops in a piecemeal fashion and is organized into a coherent framework only once children have acquired an understanding of the complex biological processes that underlie illness transmission (Kalish, 1999). In other words, although young children may have some knowledge of risk behaviors and contaminants such as germs, they do not acquire a deeper understanding of the causes of illness until much later in development. For example, preschool children can pick out relevant *causes* of illnesses, but they cannot use that knowledge to make *predictions* about whether someone will become sick after engaging in a risk behavior (Legare et al., 2009).

Although there is a large body of research examining children's conceptual understanding of illness transmission, there are only a handful of studies on how children *behave* toward a contaminated object (e.g., DeJesus, Shutts, & Kinzler, 2015; Rozin & Fallon, 1987) and there is no research to date on how children's behavior is affected by a sick or contagious person. The lack of data on this topic is problematic because children are especially risky carriers of infection, not only by catching diseases themselves but also by enabling greater transmission of infection to others (Bryant & McDonald, 2009; de Lencastre & Tomasz, 2002; Lambe et al., 2012). Contact with or exposure to sick people is what causes contagious illnesses to spread. Thus, behavior when confronted with a sick individual is most relevant to how children actually get sick and whether they are likely to spread illness to others.

Given that it is adaptive to engage in disease-avoidant behaviors, several theories predict that behaviors leading to the avoidance of harmful pathogens should appear early in development and persist into adulthood (Boyer & Bergstrom, 2011; Rottman, 2014; Schaller & Park, 2011). The behavioral immune system theory, for example, proposes that humans have a system of psychological mechanisms that protect against infectious disease (Neuberg, Kenrick, & Schaller, 2011; Schaller & Park, 2011). Evidence suggests that adults engage in behaviors that limit contact with pathogens and that these behaviors even overgeneralize to people who show signs of non-contagious illnesses and disfigurements (Park, Van Leeuwen, & Chochorelou, 2013; Ryan, Oaten, Stevenson, & Case, 2012). However, due to the lack of data on children's behavior, the developmental trajectory of these behaviors and the developmental mechanisms underlying them remain unexplored.

One potential mechanism underlying the development of disease-avoidant behavior may be children's causal knowledge of contagion and how illnesses are spread (Siegal, Fadda, & Overton, 2011). Children who have a more sophisticated causal understanding of illness transmission may be more likely to understand how engaging in risk behaviors, such as approaching someone who is sick, could lead to the transmission of illness (Au et al., 2008). If this is the case, avoidance behavior should develop between 4 and 7 years of age alongside children's causal knowledge of illness transmission. An alternative possibility is that avoidance behavior appears even earlier in development or that avoidance behavior is unrelated to children's knowledge about illness transmission; each of these outcomes would suggest that causal knowledge does not play a critical role in the development of these behaviors.

Given that there is currently no empirical work on when children begin to exhibit avoidance of sick individuals, the current study aimed to specify the developmental trajectory of disease-avoidant behavior in early childhood. Children from 4 to 7 years of age were invited to play with two confederates—one who was "sick" and one who was not—for a period of 5 min, and we measured children's proximity to and contact with the sick/healthy confederates and their toys. In addition, we explored whether children's causal knowledge of illness transmission is related to their avoidance behavior by giving them a vignette task that assesses their explanations for and predictions about scenarios involving illness transmission.

Method

Participants

The participants were 25 4- and 5-year-olds (13 female; M_{age} = 4;10 [years;months], range = 4;0–5;9) and 20 6- and 7-year-olds (14 female; M_{age} = 7;0; range = 6;3–7;9). An additional 10 children (5 from each age group) were excluded from analyses: 2 for refusing to complete the study, 2 for experimental error, 2 for parental interference, 2 for failing to remember which experimenter was sick, and 2 for exhibiting a response bias in the interview.

Procedure

Behavioral task

At the beginning of the study, an experimenter introduced each child to a large playroom. In the playroom, two confederates (C1 and C2) were seated on the floor, one on either side of a large box, the contents of which were not visible. The experimenter then introduced C1 (healthy) and C2 (sick) using three facts to describe each: "Thanks for coming to play with us today! We have a bunch of toys to show you. [C1] and [C2] want to play with you too! That is [C1]; she has brown hair and brown eyes and is wearing a [green/yellow] shirt. That is [C2]; she has a cold, so she has a fever, a headache, and a sore throat. Let's go in and play!" Each confederate wore a different color shirt (green or yellow), and the color and location of each confederate, along with the order of her introduction (sick or healthy first), was counterbalanced. The confederates were not aware of whether or not they were "sick" because they wore headphones playing loud music while their traits were described to the children.

After the experimenter described the two confederates, she signaled to the confederates to remove their headphones to begin the free play task. Next, the confederates removed identical toys out of the box one by one—a ball, a set of toy cars, crayons and paper, and Mr. Potato Head—and placed them on the floor. The toys were chosen because they were suitable for the wide age range in our study. The experimenter then encouraged the children to play with whatever toys they wished. After 5 min, the experimenter told the children that the play session was over and invited them to sit at a small table for the verbal knowledge task. After the play session, the confederates put their headphones back on while the children were interviewed.

Verbal knowledge task

Following the behavioral task, the children were interviewed to assess their knowledge about illness transmission. First, they were asked about the free play session. As a memory check, the children were asked whether they remembered which confederate (C1 or C2) was sick (only 2 children failed to answer this question correctly and were eliminated from data analyses). During the main portion of the interview, the children were read vignettes about a child with a cold and a child with a broken arm. For the cold vignette, they were shown a picture of a child and were told, "This is Sal. Sal has a cold, so Sal has a runny nose, a headache, and sore throat." For the broken arm vignette, they were shown a picture of a different child and were told, "This is Danny. Danny has a broken arm, so his arm is swollen and really hurts when he tries to move it." The children were then prompted to provide an open-ended explanation for how the child got a cold or broken arm: "How did Sal/Danny get a cold/broken arm?" Afterward, they were asked to make a prediction about whether they and another child would get a cold or broken arm after playing with the child in the vignette: "If Sal/Danny's friend plays with her while Sal/Danny has a cold/broken arm, will Sal/Danny's friend get a cold/broken arm too? What if you played with Sal/Danny? Would you get a cold/broken arm?"

Behavioral coding

Contact was defined as whenever a part of the child's body was in direct contact with a toy or with a confederate. The duration of contact with each confederate and her toys was coded. Each instance of contact was categorized as either "sick contact" if the child made contact with the sick confederate or her toys or "healthy contact" if the child made contact with the other confederate or her toys. If a child made contact with both confederates or made contact with both confederates' toys simultaneously, contact was coded as both "sick" and "healthy." The percentage of free play spent in contact with each confederate and her toys was then calculated.

Proximity to the sick confederate was coded on two dimensions. First, the horizontal location of the child was coded as being either on the side of the sick confederate or on the side of the healthy confederate. Second, the child's vertical location was coded as belonging to one of two categories. The child was coded as sitting either directly in front of the confederate (close proximity) or approximately 3 feet or more away from the confederate (far back). A location code was given if the child remained in the same area for at least 2 s. The percentage of the play session that each child spent in each of these areas was calculated. Furthermore, the percentage of time spent playing in *close proximity* to the sick confederate was calculated. This yielded two key scores for each child: one based on how long the child spent on the same side of the play area as the sick confederate, which provides a broad measure for how long the child spent in proximity to the sick experimenter; and one based on how long the child played directly in front of the sick confederate, which provides information about how much time the child spent in close proximity to the sick confederate.

Verbal knowledge coding

Children's explanations were coded as follows:

Risk behaviors: Any mention of engaging in a risk behavior that typically leads to catching a cold or getting a broken arm (e.g., touching something contaminated, falling down).
Proximity: Mention of proximity to someone who was sick or person-to-person contact.
Preventative measures: Mention of failure to engage in a preventative measure that typically prevents catching a cold or getting a broken arm (e.g., not washing hands).
Biological: Explicit mention of germs.
Other: "I don't know" and all other responses.
Contagion-relevant/irrelevant: Explanations were grouped as to whether or not they fell into two broad categories: contagion-relevant and contagion-irrelevant. Explanations that were initially coded as mentioning a risk behavior, as a failure to engage in a preventative measure, as biological, or as including person-to-person contact or proximity (cold only) were categorized as contagion-relevant. Explanations that fell under "other" or "I don't know" were combined to form the contagion-irrelevant category.

Children's responses to the prediction questions about person-to-person transmission were coded as 1 for a correct response ("yes" for cold and "no" for broken arm) and as 0 for an incorrect response ("no" for cold and "yes" for broken arm). A coder blind to condition coded the responses on all measures for all children, and a second coder coded a random 25% of the responses. Coder agreement was above 90% for all measures. Preliminary analyses did not yield any effects of gender, shirt color, or target side, so these variables were not included in the main analyses.

Results

Contact

First, we examined the percentage of time children spent in contact with the sick versus healthy confederate's toys. The results of a 2 $\times$ 2 repeated-measures analysis of variance (ANOVA) with confederate type (sick vs. healthy) as a within-participants variable and age (4- and 5-year-olds vs. 6- and 7-year-olds) as a between-participants variable revealed only a main effect of confederate type, with children spending a greater percentage of time with the healthy confederate (M = .64, SD = .45) than the sick confederate (M = .36, SD = .46), $F(1,43)$ = 4.71, p = .04, η^2 = .10. To examine whether children's avoidance behaviors were significantly different from chance (50%), we ran follow-up one-sample t-tests on the percentage of time children in each age group spent in contact with each of the confederate's toys. The percentage of time 4- and 5-year-olds spent with the sick confederate's toys ($M = .43$, $SD = .47$) was not significantly different from chance, $t(24) = -0.73$, $p = .47$, nor was the percentage of time they spent with the healthy confederate's toys ($M = .57$, $SD = .47$), $t(24) = 0.79$, $p = .44$. Conversely, the 6- and 7-year-olds spent more time with the healthy confederate's toys ($M = .72$, $SD = .44$), $t(19) = 2.23$, $p = .04$, and less time with the sick confederate's toys ($M = .27$, $SD = .44$), $t(19) = -2.36$, $p = .03$, than could be expected by chance (see Fig. 1). It is important to note that *none* of the children ever made physical contact with either of the confederates themselves, so these data could not be analyzed.

Proximity

Next, we examined proximity to the sick versus healthy confederate in terms of children's horizontal proximity (sick side vs. healthy side) to each of the confederates. The results of a 2 × 2 repeated-measures ANOVA with horizontal location (sick side vs. healthy side) as a within-participants variable and age (4- and 5-year-olds vs. 6- and 7-year-olds) as a between-participants variable revealed a marginally significant main effect of location, with children spending more time on the side of the healthy experimenter ($M = 60.95$, $SD = 45.07$) than the sick experimenter ($M = 35.85$, $SD = 44.94$), $F(1,41) = 3.721$, $p = .06$, $\eta^2 = .08$. Chance comparisons revealed that the amount of time 4- and 5-year-olds spent on the same side as the sick experimenter was not significantly different from chance, $t(23) = -0.972$, $p = .17$, but 6- and 7-year-olds spent significantly less time on the same side as the sick experimenter than would be expected by chance, $t(18) = -2.01$, $p = .03$ (see Table 1).

We then examined the amount of time children spent in close proximity to the sick experimenter. A 2 × 2 repeated-measures ANOVA with age group as a between-participants variable and location (close proximity to sick experimenter vs. healthy experimenter) revealed a main effect of location, with children spending less time in close proximity to the sick experimenter ($M = 27.72$, $SD = 42.39$) than the healthy experimenter ($M = 60.98$, $SD = 45.07$), $F(1,41) = 7.45$, $p = .009$. Chance comparisons revealed that the amount of time 4- and 5-year-olds spent in close proximity to the sick experimenter was only marginally different from chance, $t(23) = -1.59$, $p = .06$, but that 6- and 7-year-olds spent significantly less time in close proximity to the sick experimenter than would be expected by chance, $t(18) = -3.78$, $p < .001$ (see Fig. 2).

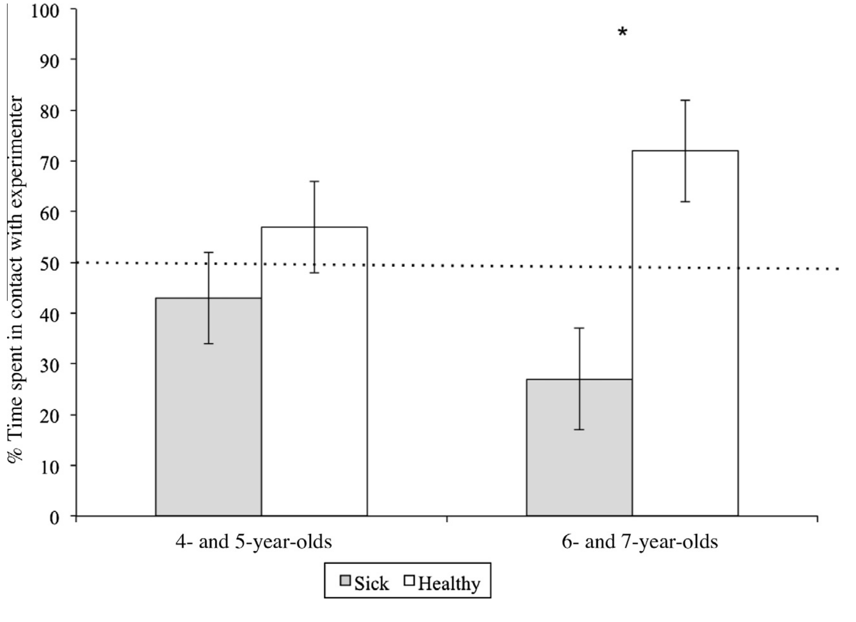

Fig. 1. Contact with each confederate's toys during the behavioral task. $^{*}p < .05$.

Table 1
Means for contact with and proximity to each experimenter by age group.

	4- and 5-year-olds	6- and 7-year-olds
Contact–sick toys	41.16	27.00
Contact–healthy toys	57.33	71.46
Close proximity–sick experimenter	35.14	18.34
Proximity–sick side	40.99	29.35
Proximity–healthy side	54.78	68.83

Note. Values in table are percentages.

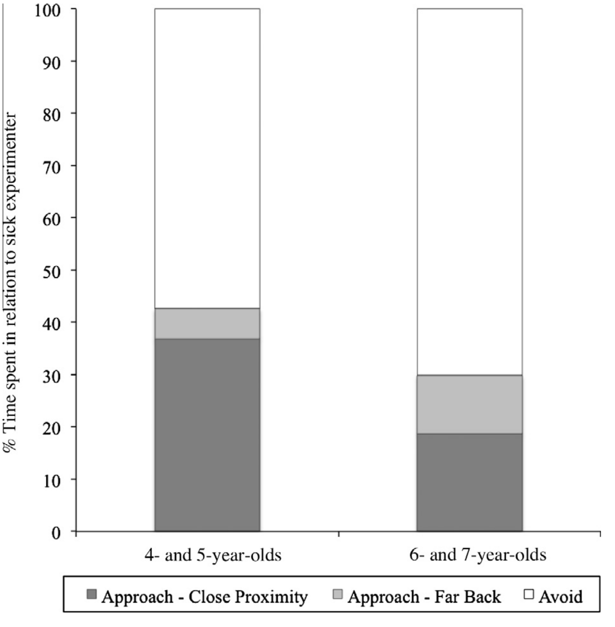

Fig. 2. Proximity to each confederate during the behavioral task.

Verbal knowledge

Two chi-square tests of independence were performed to examine the relation between age and verbal knowledge of colds: one between age and responses on the cold prediction question and one between age and explanation type for colds (contagion-relevant vs. contagion-irrelevant). The relation between age and performance on the cold prediction question was significant, $\chi^2(1,45) = 7.49$, $p = .006$. Younger children were less likely to correctly answer the cold prediction question than older children. There was no significant relation between age and explanation type, $\chi^2(1,45) = 2.21$, $p = .14$ (see Table 2).

Two additional chi-square tests of independence were performed to examine the relation between age and verbal knowledge of broken arms: one between age and responses to the broken arm prediction question and one between age and explanation type for broken arms (contagion-relevant vs. contagion-irrelevant). The relation between age and performance was not significant, $\chi^2(1,44) = 1.35$, $p = .25$, such that younger children were just as likely to correctly answer the broken arm prediction question as older children. There was a significant relation between age and explanation type for broken arms, $\chi^2(1,44) = 6.73$, $p = .009$, such that older children were more likely to provide correct explanations for a broken arm than younger children.

Table 2
Means for prediction and explanation questions in the knowledge task.

	4- and 5-year-olds	
	Cold	Broken arm
Prediction question–pass	52	60
Risk behavior explanation	0	52
Biological explanation	4	0
Person-to-person transmission explanation	16	0
Preventative behavior explanation	0	0
Other/don't know	76	44
	6- and 7-year-olds	
	Cold	Broken arm
Prediction question–pass	90	75
Risk behavior explanation	5	90
Biological explanation	10	0
Person-to-person transmission explanation	15	5
Preventative behavior explanation	5	0
Other/don't know	65	5

Note. Values in table are percentages.

Table 3
Summary of simple regression analyses predicting behavioral avoidance.

Predictor	Contact			Proximity		
	β	t	Significance	β	t	Significance
Age	.07	0.46	.65	−.05	−0.29	.77
Cold prediction	−.31*	−2.22	.03	−.31*	−2.05	.05
Cold explanation	−.135	−0.897	.375	−.05	−0.320	.75
Broken arm prediction	−.08	−0.59	.56	.09	0.61	.98
Broken arm explanation	−.03	−0.22	.83	−.004	−0.03	.98

* $p < .05$.

Verbal knowledge and avoidance

Finally, we ran a regression to examine whether knowledge (as indexed by responses to the cold prediction and cold explanation questions, respectively) and age significantly predicted avoidance behavior (as indexed by contact with the sick confederate's toys) in the free play task. In addition, we included children's responses on the broken arm prediction question and broken arm explanation type (contagion-relevant vs. contagion-irrelevant), hypothesizing that broken arm knowledge should not be related to avoidance behavior. Responses to the cold prediction question significantly predicted the percentage of time children spent touching the sick confederate's toys, $\beta = -.311$, $t(44) = -2.22$, $p = .03$. By contrast, age, cold explanation type, and responses to the broken arm question did not significantly predict the percentage of time children spent in contact with the sick confederate's toys (see Table 3).

We ran an additional regression to examine the relation between these same predictor variables and the percentage of time children spent in close proximity to the sick confederate and again found that children's responses on the cold prediction question in the knowledge task were the sole predictor of their avoidance of close proximity to the sick experimenter, $\beta = -.31$, $t(44) = -2.05$, $p = .05$.

Discussion

In the current study, we sought to conduct the very first investigation of children's behavior when confronted with a sick individual and various contaminated objects and the relation between behavior and children's knowledge of illness transmission. In both age groups, children showed evidence of avoiding both contact with and close proximity to the sick confederate. Although we did not find a significant interaction between age group and contact or proximity with the sick confederate, the children in the younger age group did not perform differently from chance in the avoidance task, but older children spent significantly less time with the sick confederate than could be expected by chance.

Furthermore, as a group, the 4- and 5-year-olds did not exhibit avoidance behavior at levels above chance, but when age was analyzed as a continuous linear variable, age was not predictive of children's avoidance. Instead, the best predictor of children's avoidance behavior was their ability to make predictions about cold transmission. In contrast, knowledge about injuries was not related to children's behavior during free play. In other words, it was children's specific knowledge of contagious illness that was related to their behavior, not their knowledge of injuries. These findings are consistent with the hypothesis that children's causal knowledge of contagion underlies their avoidance behavior and provides evidence that children's developing causal representations of illness transmission are a potential mechanism underlying their behavior.

Although we found a relation between children's predictions about cold transmission and their behavior, we did not find a relation between cold explanations and avoidance behavior. This might be because children's causal knowledge must be sophisticated enough for them to use it to make predictions about the future. Prior research suggests that the ability to reason backward about causes and hone in on relevant explanations for outcomes develops before the ability to reason forward from a cause to predict its effects (Legare et al., 2009). This highlights an important difference between explaining an outcome in terms of known potential causes and predicting an outcome based on whether or not a particular cause is present in that deciding whether or not to approach a sick person or a contaminated object involves making a *prediction* about whether or not doing so will lead to contracting an illness.

One possible alternative explanation for children's performance in the avoidance task is that the children were simply avoiding negative valence; essentialist views propose that children might intuitively know that being sick is negative or undesirable without having specific knowledge about illness transmission (e.g., Gelman, 2004; Nemeroff & Rozin, 1994). However, if this were the case, it is unlikely that we would have found a relationship between children's knowledge of illness and their avoidance behavior. If children were simply responding to negative valence, the children in the younger age group should have avoided it at above chance levels given that even infants avoid objects previously associated with a negative valence (e.g., Mumme & Fernald, 2003). Another alternative possibility is that children who are more verbal also happen to exhibit more avoidance behavior. However, if children who are more verbal just happened to perform better on the avoidance task, we would expect to see a relation between children's answers to the questions about *injuries* and their avoidance behavior in addition to their answers on the cold questions. However, we did not see this pattern of results; the relationship between knowledge and avoidance held only for the questions about contagious illness.

It is important to note that the results from this study are correlational. Future work must investigate this relation further to determine whether it is causal. However, the results we present here constitute the very first investigation of the developmental trajectory of children's avoidance of sick individuals and provide the first evidence of a relation between their knowledge and avoidance behavior. These findings can be used to motivate future research to determine whether the nature of this relationship is causal and how to bring about adaptive behavioral change in young children by increasing their causal knowledge of contagion.

Future research should also examine the role of both verbal and *physical* signs of illness on children's behavior. Here we provided only verbal information about the confederate's illness to control for the possibility that children would avoid physically sick individuals because they are simply unpleasant to be around. By using an experimental design in which children were simply told about the condition of the sick experimenter, we were able to measure responding to the sick versus healthy confederate purely based on information about each confederate's condition without the presence of other potentially confounding factors. However, it is possible that physical symptoms lead to different patterns of avoidance behavior across development. We are currently exploring this possibility.

In conclusion, the current study has important implications for designing effective interventions in early childhood that aim to promote healthy behavior. Even the youngest children in our sample avoided the sick confederate if they had causal knowledge about illness transmission. Thus, it is possible that providing children with causal information about illness transmission would promote healthy avoidance behavior even during the preschool years. There is evidence that causal knowledge interventions increase engagement in preventative behaviors (e.g., hand washing) in children 8 years and older, but many programs currently implemented in preschools (e.g., Colgate-Palmolive, 2010) focus on teaching children risk behaviors without providing them with causal information about how those behaviors lead to contracting an illness, which has shown to be ineffective (see Au et al., 2008, for a review; see also Baronowski, Cullen, Nicklas, Thompson, & Baranowski, 2003; Witta & Spencer, 2004). We are currently investigating age-appropriate ways to increase preschoolers' causal knowledge of contagion in a way that also increases adaptive behavior.

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