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How Children Develop Healthy Behavioral Choices to Promote Illness Prevention

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Abstract

Children's understanding of contagion has been a fruitful area for studying children's learning. However, despite a large literature on children's conceptual understanding of illness, there is very little research on the impact of children's knowledge about illness transmission on adaptive behavior. This is important because how children behave when faced with a sick individual or a contaminated object is what is most relevant to whether children get sick and pass along that illness to other people. Here, we will bring together various theories of how children learn to behave adaptively when faced with the possibility of getting sick (a) to better illuminate the different ways by which children might acquire health-related behaviors and (b) to help develop recommendations for designing interventions aimed at teaching children about contagion and illness prevention in a way that produces the most adaptive health behaviors.

Keywords

contagion, illness transmission, causal learning, disgust, health behavior

Researchers have long been interested in studying children's developing understanding of contagion (i.e., the transmission of illness caused by microbes through proximity or physical contact), given that it has implications for how children acquire biological knowledge and for how they reason about nonobvious properties and mechanisms (Kalish, 1996; Keil, 2006). For example, although the term "germ" is generally introduced to children early in life, it describes a causal mechanism for illness that they cannot see or touch. Further, contagion is a prime example of a counterintuitive concept, as it violates predominant theories influencing the perception of causality—unobservable entities, temporal noncontingency, and stochastic outcomes. Indeed, when individuals are directly contaminated by a pathogen, only a portion of them become physically sick (e.g., Cohen et al., 1998), making contagion a difficult concept to grasp even for adults. One study reported that 84% of college-educated adults endorsed the idea that cold and rainy weather is a risk factor for catching a cold, suggesting that difficulty understanding the biology that underlies illness transmission is persistent over the life span (Sigelman et al., 1993). And although there have been some intuitions about the existence of germs since the Roman Empire, humans did not develop germ theory until the late 19th century, suggesting that it took hundreds of years of human scientific thought to fully understand illness transmission.

Despite the complexity of how illness is transmitted, research suggests that children begin to reason about contagion in the preschool years. For example, by the age of 3 and 4, children can provide physical explanations for what makes someone sick, indicating that they have some knowledge about the association between illness and contact (Legare et al., 2009). Further, 4- and 5-year-old children can differentiate between situations where one is likely or unlikely to become sick; they also know that "germs" cause illness and that germs are living, or biological entities (Kalish, 1996). Children of this age also prefer biological explanations for illness to social ones (Springer & Ruckel, 1992), thus demonstrating that they have some basic intuitions about how illness is transmitted. However, children of the same age have difficulty making predictions about whether

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Table 1. Strengths and Weakness of each Pathway

Pathway	Strength	Weakness
Rule-based learning	• Easy to learn • Has been used effectively in classrooms to promote safety	• Might be too specific • Might lead to undergeneralization
Disgust	• Could be easy to acquire • Effectively promotes avoidance of contamination and contagion	• Dependent on the presence of visible symptoms • Might promote overgeneralization and stigmatization
Causal knowledge	• Has been used effectively with children over 7 years old to promote health behaviors • Might promote appropriate generalization	• Difficult for young children to learn • Not clear what level of causal information is needed

a fictional character would get sick after engaging in risky behavior (e.g., eating contaminated food; Legare et al., 2009). Thus, although children have some understanding of illness in the preschool years, a full understanding of illness transmission develops slowly between the ages of 4 and 9, likely facilitated by formal schooling (Keil et al., 1999; Myant & Williams, 2005).

Importantly, although we know quite a bit about children's developing conceptual understanding of illness, there is very little research on the way children behave when faced with the possibility of getting sick. This gap in the literature is important to fill for several reasons. For one, despite evidence that young children have some knowledge about illness transmission, we have little understanding of when children can apply that knowledge adaptively to guide action. Furthermore, how children behave when faced with a sick individual or a contaminated object is what is most relevant to whether children actually get sick. Indeed, children are especially risky carriers of infection not only because they catch diseases themselves but also because they enable greater transmission of infection to other people (e.g., de Lencastre & Tomasz, 2002). This makes children's behavior in response to a potentially contagious entity directly relevant to public health. In the context of the recent COVID-19 pandemic, it is more important than ever to understand how young children learn about illness transmission in ways that would allow them to act as agents in their own illness prevention.

Several theorists have proposed different ways for how children might acquire adaptive health behaviors regarding illness transmission. However, these theories tend to come from different areas of psychology, education, and cognitive science, most of which rarely overlap. Here, we will discuss various theories of how children learn to behave adaptively when faced with the possibility of getting sick. By bringing together these different views, we first hope to better illuminate the various pathways by which children might acquire health-related behaviors and the advantages and disadvantages of each. Second, by bringing these pathways together, we hope to navigate the implications of learning from each one and develop recommendations for designing interventions aimed at teaching children about contagion and illness prevention in a way that produces the most adaptive health behaviors.

Rule-Based Learning

According to the education literature, one way that children can acquire illness-related health behaviors is through simple rule-based learning. In the context of learning healthy disease-reducing behaviors, a child might hear "wash your hands before eating your snack" or "cover your mouth when you cough." There is a large and growing literature demonstrating that children can acquire specific behaviors in this way. For example, rules for safety and order have been used successfully to modify behavior in classrooms for decades (Hester et al., 2009). Further, research suggests that children as young as 3 can even learn biological facts in this way. For example, preschool-aged children who were given information about the co-occurrence of emotions (e.g., embarrassment) and biological events (e.g., blushing) were able to overturn a belief that psychosomatic events were impossible, and they learned about a new psychosomatic outcome following training (Bonawitz et al., 2012). Indeed, much of early science education tends to focus on presenting children with domain-specific, fact-based instruction (Braaten & Windschitl, 2011; Keil, 2006; Thagard, 1989).

However, it is not clear whether such training leads to appropriate generalization and supports either knowledge or behavioral decisions in real-world practice.

Indeed, Bonawitz et al. (2012) found that children did not generalize learned biological content to beliefs about psychological-biological domain boundaries more generally. Likewise, there is also evidence that interventions designed to teach children isolated facts about risk behaviors through rote learning of behavioral "dos" and "don'ts" have no effect on children's preventative behaviors, such as handwashing (Au et al., 2008; Witta & Spencer, 2004).

Altogether, rule-based learning has a long history of effectiveness for modifying behavior in classrooms. This method for learning health-related behaviors such as handwashing might be particularly effective for very young children who are unlikely to fully understand how illness is transmitted. However, although research from the education literature suggests that teaching children rules for when to engage in protective behaviors can lead to effective learning of rule-based actions, it might also cause children to undergeneralize health behaviors, reserving them for the specific situations they learned and potentially leaving children without the knowledge to apply these behaviors to novel situations that might incur risk. More research is needed to find out for certain.

Disgust Learning

A second pathway that has received attention in the social-psychology literature involves how disgust responses to physical signs of illness or contamination could lead to illness avoidance. Indeed, several evolutionary theories of pathogen transmission suggest that humans evolved psychological mechanisms to detect perceptual cues in the environment that signal the presence of pathogens or infectious illness and to initiate cognitive and emotional responses, such as disgust, that lead to avoidance behavior (e.g., Oaten et al., 2011; Schaller & Park, 2011; Tybur & Lieberman, 2016). In other words, recognizing physical symptoms of illness transmission can evoke disgust, which thereby should cause avoidance of a contagious entity.

Consistent with this view, research has shown that adults' subjective feelings about contagious individuals is related to disgust (Kupfer, 2018). There is also evidence that adults avoid contacting items previously touched by someone who showed physical symptoms (i.e., coughing, sneezing) of a contagious illness (LoBue et al., 2022), suggesting that adults often do use physical symptoms to determine whether to avoid potentially contagious people and contaminated objects. There are fewer studies on children's health-related behaviors as the result of disgust, but a handful of studies have shown that by middle childhood, children do avoid potentially contaminated foods, such as a contaminated glass of juice or a bowl of applesauce that has previously been sneezed in (e.g., DeJesus et al., 2015; Rozin et al., 1985). However, these same studies suggest that younger, preschool-aged children are much less likely to avoid such contaminated foods, even foods that have been directly contaminated by a sneeze.

Importantly, one limitation of this pathway is that whereas disgust responses might elicit avoidance of contagious people and contaminated objects in situations in which there are visible physical symptoms, there are some diseases that are contagious but have physical symptoms that are not perceptually salient. Further, according to evolutionary theories of pathogen transmission, in order to avoid the costly mistake of interacting with someone who is contagious, humans' hypersensitivity to perceptual indicators of potential pathogen presence might cause them to overextend emotional responses associated with infection to individuals who exhibit atypical but noncontagious features (e.g., facial disfigurement, skin conditions, disability, obesity; Tybur et al., 2014). For example, although adults report being less comfortable with the thought of making physical contact than nonphysical contact with individuals who have contagious illnesses, they also extend this discomfort to individuals with noncontagious morphologies such as limb amputation or obesity (Park et al., 2013). Further, individuals who perceive themselves to be more vulnerable to disease have fewer friends with disabilities (Park et al., 2003) and show stronger associations between unpleasantness/disease and elderly individuals (Duncan & Schaller, 2009).

Thus, although disgust responses to potential signs of contamination and contagion might elicit avoidance behaviors that could help keep us from getting sick, individuals who avoid contagion via disgust might overgeneralize avoidance responses for contagious individuals to individuals who are not contagious, potentially stigmatizing individuals who have visible physical disabilities (Neuberg et al., 2011; Oaten et al., 2011; Schaller & Neuberg, 2012). Further, research on health behaviors related to disgust is relevant only to avoidance; it is not clear how disgust might foster other, more proactive health behaviors, such as handwashing. And although there is currently no research suggesting that children necessarily overgeneralize disgust responses for contagious individuals to noncontagious contexts, there is some evidence that preschool-aged children might undergeneralize disgust responses if the target is someone familiar, such as a friend or family member, or is a native versus nonnative speaker (Li et al., 2021; Raman & Gelman, 2008). Thus, additional research is required to test the long-term effectiveness of this pathway for promoting health behaviors as well.

Causal Knowledge

One final pathway for learning about contagion that is proposed in the developmental and cognitive science literatures involves developing a causal mechanistic understanding of how illnesses can spread. Recently, researchers have advocated for using explanation-based instruction with causal mechanisms to teach complex counterintuitive concepts such as contagion to young children (Kelemen, 2019). Myant and Williams (2008), for example, were able to significantly improve contagion understanding in 7- to 11-year-olds by providing them with explanations about causal mechanisms of illness transmission in both a storybook and scientific book format.

Importantly, there is also evidence that causal mechanism knowledge of how illnesses spread might underlie the development of disease-avoidant behavior. For example, Au et al. (2008) designed an intervention for use with children aged 8 and older called "Think Biology," which teaches children about the biological properties of germs. Children who received this intervention showed an increase in their causal knowledge of how illness is transmitted along with an increase in handwashing behavior before handling food, even though they were never taught about that behavior specifically in the intervention. They even outperformed children who received a control knowledge-based intervention that taught children a list of risk behaviors to avoid and preventative measures to engage in. Despite being specifically told about handwashing, children in this control condition did not show an increase in handwashing behavior. Thus, it appears that knowledge interventions that improve children's causal knowledge can support adaptive health behaviors.

It is still unclear, however, whether such causal knowledge interventions can be used with children younger than age 7 or 8. Daubert et al. (2020) found that teaching preschoolers causal mechanisms for psychosomatic events increased their ability to identify psychological events as causes of illness, but this research did not explore broader learning about germs or contagion, and it did not measure children's healthy avoidance behavior. Other work has uncovered suggestive associations between causal knowledge and germ-avoidant behavior. Specifically, some newer evidence suggests that preschool-age children who have some specific causal knowledge about illness transmission avoid contact with contaminated objects. For example, one study showed that after children were prompted to interact with two experimenters—one who had a cold and one who did not—and the toys the experimenters touched, the best predictor of children's avoidance responses was not age but their ability to predict whether contact with a sick individual would make someone sick (Blacker & LoBue, 2016). In another study, 3- to 5-year-old children were read one of four storybooks about a little girl who became sick. Children who were read a storybook with causal explanations about illness transmission showed significant improvement in their knowledge about illness transmission after the reading. Further, children who successfully learned the causal mechanism information were most likely to reject a toy that was previously handled by a contagious confederate (Conrad et al., 2020).

Thus, according to this third pathway, children who have a 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. Further, an understanding of illness transmission that relies on causal knowledge and not on the presence or absence of physical symptoms may lead children to generalize their knowledge appropriately, engaging in health behaviors in the presence of pathogens but not in the presence of individuals who do not have a contagious disease. However, no research to date has examined generalization of children's health behaviors after a causal knowledge intervention in children younger than age 8. Further, it is unclear whether learning a simple causal mechanism for illness transmission is effective in promoting appropriate generalization of health behaviors (e.g., that contact with a sick person causes illness or whether children need a whole causal model including the conditions that permit germ replication or death). Thus, as with rule-based learning and disgust, further research is needed to determine how best to use the causal knowledge pathway to promote long-term health outcomes.

Future Directions and Implications for Public Health

Despite a large and growing literature on children's understanding of illness transmission, we still have limited knowledge of how children learn illness-related health behaviors. This is an important gap because research on how children learn to use adaptive health behaviors in real-world situations has implications for public health, potentially providing avenues for limiting disease spread in schools. The research presented here brings together theories from various literatures on how children might learn illness-related behaviors. From these literatures, we see evidence that individuals can learn preventative behaviors via all three proposed pathways. However, by reviewing these pathways together, we can also see the importance of understanding the advantages and disadvantages of each and how they might or might not support appropriate generalization.

First, learning specific behaviors through simple rule-based learning has been shown to be effective in

classrooms for decades. However, previous research has shown that learning isolated facts is not necessarily effective in producing preventative health behaviors, possibly because the facts do not easily generalize across various contexts (Au et al., 2008; Witta & Spencer, 2004). Thus, rule-based learning for health behaviors might be most effective if the rules are as general as possible. Further, research in classrooms has shown the best results if the rules are modeled by adults, if compliance is followed by praise, and/or if noncompliance has consistent consequences (Hester et al., 2009).

Disgust has also been shown to be a powerful mechanism for the avoidance of contaminated objects and contagious individuals. According to evolutionary theories, disgust responses are activated by physical signs of illness or contamination. These responses are emotional in nature and may thus be easy to learn. However, not all contagious illnesses carry physical symptoms. Further, research has shown that individuals who avoid contagion via disgust might overgeneralize avoidance responses for contagious individuals to individuals who are not contagious, potentially stigmatizing those with visible physical disabilities. Given that children's disgust responses do not emerge until relatively late in development, it is possible that adults can model disgust responses in appropriate situations early in development to encourage the most appropriate health outcomes. Further, it might be possible to combine disgust responses with rule-based learning or causal knowledge to encourage proper generalization.

Finally, our third pathway—promoting causal knowledge about illness transmission—might be the most promising avenue for the design of future interventions. Such interventions need not be formal; indeed, many of the studies presented here used informal learning paradigms, such as picture book readings or parent–child interactions. Our own research has shown, for example, that the onset of the COVID-19 pandemic has led to an increase in parent–child conversations about illness transmission at home. Importantly, when we examined a sample of 4- to 7-year-old children in the United States, we found greater declarative knowledge and causal reasoning in children tested after the onset of the COVID-19 pandemic compared with children tested just before, suggesting that such informal learning experiences might help shape children's reasoning about illness transmission. Unfortunately, however, we did not find an advantage for adaptive health behaviors in the postpandemic sample. This could be because, according to the parents tested, the content of most parent–child conversations about illness transmission still focuses on risks and preventative behaviors rather than causal mechanisms (Leotti et al., 2021). Thus, parents and teachers may need guidance on how to engage with children about illness transmission productively so that it leads to successful application and appropriate generalization.

Although this work points to several promising avenues for future research, no research has systematically compared the effectiveness of different content training on children's understanding of illness transmission and their health behaviors. More specifically, we do not currently have a clear understanding of how interventions that focus on different types of content lead to appropriate generalization, whether certain content is maintained for longer periods, and whether it supports broader scientific theory-building in related domains. Further, there may be other pathways for learning health-related behaviors besides the three discussed here, or combined information from multiple pathways may be most effective. Additional research is necessary to fully understand which approach can produce the most long-lasting health behaviors.

Finally, we understand very little about the developmental trajectory of acquiring illness-related behaviors. As discussed above, various theories suggest that disease avoidance specifically—at least via disgust—might have evolutionary origins (e.g., Oaten et al., 2011; Schaller & Park, 2011; Tybur & Lieberman, 2016) and thus develop early in life. However, the relatively late emergence of disgust responses in children more generally suggests instead that disgust is likely socialized and would therefore unfold differently on the basis of culture, experience, and knowledge acquisition. Thus, one possibility is that children's health behaviors follows the same developmental trajectory as children's knowledge of illness transmission or that health behaviors follow from the acquisition of specific illness-related knowledge, when children can internalize and then apply their knowledge appropriately. Alternatively, it is possible that only knowledge-based pathways—such as rule-based learning and causal knowledge—follow this trajectory and that other mechanisms—such as disgust—follow a completely different developmental timeline. Likewise, different pathways might promote different health behaviors. For example, although disgust might be a strong elicitor of behavioral avoidance, other behaviors—such as handwashing—might require causal knowledge or rule-based learning. Finally, it is possible that different pathways are differentially effective for children at different points in development; for example, rule-based learning may be most effective in the youngest age groups, whereas developing a more in-depth causal model for illness transmission is most effective in older children for long-term retention.

To understand these potential contributions requires future research programs that assess different intervention techniques at different points in development and the consequent learning that follows. Given the potential benefit to public health and developmental science,

understanding the pathways that support children's health behaviors is nothing to sneeze at.

Recommended Reading

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LoBue, V., Kim, E., Marrone, L., Blacker, K.-A., & Van de Walle, G. (2022). (See References). Demonstrates adults' avoidance of adults who show physical symptoms of contagious illness.

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