AMERICAN PSYCHOLOGICAL ASSOCIATION

Developmental Psychology

ISSN: 0012-1649

2023, Vol. 59, No. 5, 940–952
https://doi.org/10.1037/dev0001534

Stay Away, Santa: Children's Beliefs About the Impact of COVID-19 on Real and Fictional Beings

Jessica Sullivan[1], Katharine Tillman[2], and Andrew Shtulman[3]
[1] Department of Psychology, Skidmore College
[2] Department of Psychology, The University of Texas at Austin
[3] Department of Psychology, Occidental College

The COVID-19 pandemic has forced children to reckon with the causal relations underlying disease transmission. What are children's theories of how COVID-19 is transmitted? And how do they understand the relation between COVID-19 susceptibility and the need for disease-mitigating behavior? We asked these questions in the context of children's beliefs about supernatural beings, like Santa and the Tooth Fairy. Because these beings cannot be observed, children's beliefs about the impact of COVID-19 on them must be based on their underlying theories of disease transmission and prevention rather than on experience. In the summer of 2020, $N = 218$ U.S. children between the ages of 3 and 10 years ($M = 81.2$ months) were asked to rate supernatural beings' susceptibility to COVID-19, and the extent to which these beings should engage in disease-mitigating behaviors, such as social distancing and mask wearing. Many children believed supernatural beings were susceptible to COVID-19. However, children rated the need for supernatural beings to engage in disease-mitigating behaviors as higher than the beings' disease susceptibility, indicating a disconnect between their conceptions of the causal relations between disease-mitigating behavior and disease prevention. Children's belief that a particular supernatural being could be impacted by COVID-19 was best predicted by the number of human-like properties they attributed to it, regardless of the child's age. Together, these findings suggest that although young children fail to appreciate specific pathways of disease transmission, they nonetheless understand disease as a bodily affliction, even for beings whose bodies have never been observed.

Public Significance Statement
The COVID-19 pandemic required children (and adults) to develop a theory of airborne disease transmission and prevention on the basis of very little data. What do children believe about COVID-19 prevention and transmission? Children in our study robustly believed that the impact of COVID-19 was greater for beings that were relatively more human-like, suggesting a lay-belief that COVID's impact depends on the possession of human-like properties. In addition, children—but not adults—sometimes said that beings should engage in disease-mitigating behaviors (e.g., mask wearing) even in cases where they believed that a particular being was not susceptible to COVID-19. These data suggest an important disconnect between children's beliefs about COVID-19 and what would be predicted by an adult-like understanding of germ theory.

Keywords: COVID-19, cognitive development, disease transmission, lay-beliefs

Supplemental materials: https://doi.org/10.1037/dev0001534.supp

Children often reason about causal relations for which they have little (or no) direct perceptual evidence (Harris et al., 2006; Kuhn, 2012; Muentener & Bonawitz, 2018; Schulz et al., 2008). These unobservable causal relations are especially prevalent in the cultural myths and narratives surrounding fictional beings. Santa Claus visits children's houses unseen and leaves gifts. When the Tooth Fairy takes children's teeth, they are asleep and cannot know how she did it. Belief in supernatural beings is itself a testament to children's willingness to infer unobservable causes. While the causal mysteries related to supernatural beings are relatively innocuous, children must also navigate higher-stakes invisible causal relations in the real world. For example, coronavirus is too small to see, and when a child wears a mask, they have no visible evidence that doing so alters which particles enter their lungs. Still, children must reason about

This article was published Online First March 23, 2023.
Jessica Sullivan https://orcid.org/0000-0002-3843-3712
Jessica Sullivan served as lead for data curation, formal analysis, investigation, methodology, project administration, resources, validation, visualization, writing–original draft and contributed equally to funding acquisition. Katharine Tillman contributed equally to validation and visualization. Jessica Sullivan, Katharine Tillman, and Andrew Shtulman contributed equally to writing–review and editing. Katharine Tillman and Andrew Shtulman contributed equally to investigation, methodology, writing–original draft, conceptualization.

Correspondence concerning this article should be addressed to Jessica Sullivan, Department of Psychology at Skidmore College, 815 North Broadway, Saratoga Springs, NY 12866, United States. Email: jsulliv1@skidmore.edu

disease transmission and prevention and must do so on the basis of little-to-no perceptual evidence. The present study investigates how children understand the causal forces underlying disease transmission by examining children's beliefs about the impact of germs on the bodies of humans and supernatural beings.

Building a causal theory of disease transmission and prevention is challenging. In order to understand the relation between pathogens and disease, we must know that germs (e.g., bacteria, viruses) enter our bodies, and when they do so, they can cause infections. In other words, germ theory requires reasoning about something that cannot be seen by the human eye. People regularly catch colds, but no one (outside of a laboratory) sees the rhinovirus that causes them. Moreover, the correlation between potential moments of infection and actual episodes of illness is imperfect and often substantially time-delayed, making it difficult to discern a clear causal explanation for illness from perceptual evidence alone. Sometimes we get sneezed on but we do not become sick. Sometimes we become extremely sick but have no memory of engaging in a high-disease-risk interaction. As a result, identifying the relationships between pathogens and illnesses is a tricky causal leap—tricky enough that Western medicine only began developing a robust understanding of the relation between germs and disease within the last 200 years, and children only reliably develop effective theories of germ-based transmission late in elementary school (Kalish, 1999). Even adults have been shown to sometimes struggle to accurately explain viruses like the common cold and COVID-19 using germ theory (Labotka & Gelman, 2022).

In order for children and adults to be able to predict and prevent illness, they need to understand how germs impact the human body. This, of course, requires a strong theory of the body. While children have robust theories of bodies, animals, and living beings from a young age, these beliefs are often non-adult-like (Carey, 1985). For example, children initially conflate motion with life-status, leading them to classify living things that do not move (like plants) as not alive, and nonliving things that do move (like cars) as alive (Hickling & Gelman, 1995; see Shtulman & Walker, 2020). Children's initial understanding of life and death (e.g., Slaughter & Lyons, 2003) is similarly limited, suggesting that children may hold beliefs about bodies that are incompatible with adult-like scientific descriptions of how the human body works.

Just as children's understanding of bodies is limited, so too is their understanding of how behaviors might help prevent disease. For example, during the first SARS pandemic, children in Hong Kong demonstrated excellent knowledge of disease transmission while in the classroom, but nevertheless engaged in high-risk behaviors (e.g., touching shared hand railings and then touching their faces) immediately after leaving the classroom (Au et al., 2008), suggesting that they fail to apply their knowledge of disease transmission to real-world contexts. In addition, 3-year-olds are willing to eat food that has been sneezed on (DeJesus et al., 2015), and older children believe that ailments caused by poison are as transmissible as those caused by germs (Solomon & Cassimatis, 1999).

A host of additional studies have confirmed that children have limited understanding of germs, disease transmission, and disease prevention (Au et al., 2008; Badani & Schonfeld, 2002; Chaudhary et al., 2010; Kalish, 1996; Kister & Patterson, 1980; Legare et al., 2009; McCann-Sanford et al., 1982; Sigelman, 2012; Sigelman & Glaser, 2019), and that improvement of their understanding arises primarily when they learn about the causal relation between pathogens and disease transmission (Au et al., 1999, 2008; Au & Romo, 1996; Witta & Spencer, 2004; Zamora et al., 2006). In fact, children's knowledge of the causal mechanisms underlying disease transmission predicts disease-avoidant behavior more strongly than age (Blacker & LoBue, 2016).

However, even when children learn facts about germs and disease transmission, these facts are often not grounded in an understanding that germs are living things (e.g., Kalish, 1999), and therefore children's causal models for disease transmission differ substantially from the biological causal model possessed by many Western adults. For example, preschoolers who understand that their friend might get sick if their friend plays with someone who has a cold fail to apply this understanding to themselves: If asked if *they themselves* could get sick from playing with someone with a cold, these children responded at chance (Conrad et al., 2020).

Beginning in early 2020, adults and children around the globe experienced the worldwide COVID-19 pandemic, whose scope and scale were unprecedented within living memory. In the United States, messaging about disease prevention permeated nearly every domain: There were signs on the highway and the doors of local coffee shops reminding people to wear masks, and lines of tape on grocery store floors telling people where to stand. Children in the United States (and elsewhere) experienced radical changes in behavior in order to reduce the spread of disease, including wearing masks, social distancing, remote schooling, and school cancelation. These changes created a unique environment in which children (and adults) were asked to rapidly learn about COVID-19, and about measures to reduce its spread. Indeed, one study reported both an increase in conversations between parents and children about disease transmission in the wake of COVID-19 and an increase in knowledge about disease transmission in young children (Leotti et al., 2021), although other studies have shown that children's beliefs about the predictors of disease transmission did not differ before and after the start of the COVID-19 pandemic (DeJesus et al., 2021). What did children come to believe about the causal mechanisms underlying COVID-19 and its prevention during the first months of the pandemic, and where did those beliefs come from?

The novelty of the COVID-19 pandemic provided a natural experiment for understanding the relative roles of maturation and experience in shaping children's beliefs about disease transmission and prevention. Specifically, most developmental work on children's understanding of disease transmission and prevention has focused on diseases that are endemic, like the common cold and the flu (Au et al., 2008; Badani & Schonfeld, 2002; Chaudhary et al., 2010; Gelman & Legare, 2009; McCann-Sanford et al., 1982; Sigelman, 2012; Sigelman & Glaser, 2019). However, in these studies, chronological age is confounded with experience of the ailment being studied. In contrast, the novelty of COVID-19 dissociates chronological age from experience with the disease: The participants in our study differed wildly in chronological age, yet all had only a few months of experience with COVID-19. Thus, any differences in belief across ages are unlikely to be attributed to experience with COVID-19, and instead must be attributable to other factors, such as maturation, developmental changes in one's understanding of diseases, or the application of experience with familiar diseases to COVID-19.

For this reason, the present work focuses on children ranging from preschool to elementary school age: An age range much younger

than is often tested in studies about children's understanding of disease transmission (Chaudhary et al., 2010; Sigelman & Glaser, 2019), and much wider than is typically tested in most developmental studies. By sampling a wide range of ages, we can begin to understand how chronological age and relative experience with a particular disease shape beliefs about disease transmission and prevention.

In the present study, we investigated children's beliefs about COVID-19 transmission and prevention by asking children to reason about the impact of COVID-19 on supernatural beings, namely ghosts, God, the Tooth Fairy, the Easter Bunny, and Santa Claus. We focused on supernatural beings for three main reasons. First, supernatural beings cannot be seen, and therefore children's beliefs about the impact of COVID-19 on them cannot be shaped by direct perceptual evidence. Second, children are not explicitly taught about the impact of disease on Santa Claus or the Easter Bunny, so their beliefs about disease transmission among such beings are unlikely to be products of direct instruction.[1] Instead, children must use their existing theories of disease transmission to make inferences about what is likely true for supernatural beings. Finally—as described below—supernatural beings differ in the extent to which they share the bodily properties of humans. This allowed us to directly measure the impact of having human-like properties on children's beliefs about how human-borne diseases are transmitted and prevented.

Despite not having access to direct evidence about supernatural beings, children and adults nevertheless have robust theories about these beings, their abilities, and the extent to which they possess human-like biological properties (e.g., Lesage & Richert, 2021; Shtulman, 2008; Sharon & Woolley, 2004). When asked whether fictional beings (e.g., fairies, ghosts) and religious beings (e.g., God, angels) could be described in terms applicable to humans and other living things (e.g., hot/cold; curious/bored; healthy/sick), previous research has shown that both adults and 5-year-old children were willing to apply some (approximately ⅓–½; Sharon & Woolley, 2004; Shtulman, 2008) of the human-like properties to these beings.

Previous research has also documented variability, across beings and across properties, in children's attributions of human properties to supernatural beings, suggesting that supernatural and fictional beings fall along an anthropomorphic spectrum. While adults attribute most human-like properties to fictional beings, they attribute few such properties to religious beings. In one study, adults were also more likely to apply psychological properties to supernatural beings (fictional and religious beings alike) than they were to apply biological properties, including getting sick (Shtulman, 2008). In contrast, 5-year-old children were as likely to apply biological properties to these beings as they were to apply other properties, raising the possibility that children may also believe that religious and fictional beings can be impacted by COVID-19. And while 5-year-olds applied as many human-like properties to religious beings as fictional beings, studies with older children find that they increasingly differentiate the two types of beings with age, anthropomorphizing fictional beings more than religious beings, similar to adults (Richert & Granqvist, 2013; Saide & Richert, 2020; Shtulman et al., 2019).

In the present study, we make use of the fact that there is a spectrum of human-like properties attributed to supernatural beings in order to directly test children's beliefs about the relationship between disease transmission and the possession of human-like attributes. Specifically, we asked three main questions. First, we asked whether children believe that supernatural beings are susceptible to COVID-19 and if they believe that supernatural beings can transmit COVID-19 to others. Second, we asked whether children understand the causal relations between disease risk and disease-mitigating behaviors by testing whether children's beliefs about whether supernatural beings should engage in public health (PH) measures to mitigate the spread of COVID-19 align with their beliefs about those beings' susceptibility to COVID-19. Third, we asked whether children's beliefs about the impact of COVID-19 on supernatural and fictional beings could be explained by the extent to which children anthropomorphize those beings, allowing us to measure how the possession of human-like properties shapes beliefs about the bodily impact of COVID-19.

Method

Transparency and Openness

All procedures, methods, and analyses were preregistered, and we conformed to this plan unless otherwise noted. The preregistration can be accessed at: https://osf.io/rha4z/?view_only=e371ed5a9a15458ab4e5a23b81c432f6.

The project was approved by the IRB at Skidmore College with approval number #2006-906.

Participants

Participants aged 3–10 years old and their parents were recruited via laboratory correspondences, word of mouth, and social media. In recruiting participants via social media, we aimed to recruit from a wide array of sources, including parenting groups with particular study-relevant interests (e.g., religious parenting groups, groups interested in child development) and parenting groups that are targeted toward particular demographics (e.g., parenting groups for single parents, parenting groups for parents with more than three children, parenting groups for academics). All data were collected between June and August of 2020. Data collection was virtual, via a Qualtrics survey. Attrition was high, likely because of the unique circumstances of data collection, and because participants were not directly compensated for participating (and instead were entered into a raffle to win one of two gift cards). While 323 participants consented and provided their child's age, 36 did not respond to our training questions, and 38 failed our training questions. As preregistered, these participants were excluded. An additional 31 participants failed to respond to at least 80% of our critical COVID-related questions and were also excluded (as preregistered). Our final sample thus contained 218 parent–child dyads. Children's ages ranged from 3 to 10 years ($M = 81.2$ months). We did not collect additional demographic data about the children or parents. Participants who provided an e-mail address were entered into a drawing for a gift card, and their e-mail address was later scrubbed from the dataset.

We also collected post hoc adult control data, in response to comments from reviewers. Adult participants ($N = 196$) were recruited via Cloud Research Panels (Chandler et al., 2019) in June 2022. Full experimental materials for adults are available on OSF (Sullivan et al., 2022).

[1] While Dr. Fauci and the CDC declared Santa Claus immune to COVID-19, our data were collected prior to this declaration.

Materials and Procedure

All stimuli are available on our OSF site (https://osf.io/rha4z/). To develop these materials, we conducted a pilot study with eight child participants prior to launch; these participants are not included in the manuscript, as they were tested prior to preregistration and with slightly different materials.

Prior to consenting, participants were presented with an introductory page informing them of the format of the survey. Parents were instructed to record the child's answers and to read the questions to their child if the child required such assistance.

Parents consented and children assented. The child then completed two training questions: "Do you think the sun will rise tomorrow?" and "Do you think that all of the dogs in the world will turn into butterflies tomorrow?" Participants responded on a 5-point scale (*definitely not*, *probably not*, *maybe*, *probably*, *definitely*), and parents were instructed to give their children feedback on these questions if needed. As noted above, failure to demonstrate mastery of the scale and comprehension of the task—by responding that the sun will rise and that dogs will not turn into butterflies—was grounds for exclusion.

Public Health Measures

Parents next indicated their household's engagement with five COVID-related PH measures: mask wearing, social distancing, staying home from school, staying home from work, and wiping down groceries. We summed responses on this measure to calculate the household's PH score (range 0–5). We did not collect this measure for the adult control dataset collected in 2022.

COVID-19 Measures

Using a 5-point scale (*definitely not*, *probably not*, *maybe*, *probably*, *definitely*), participants indicated their certainty that each of our targets (human, rock, Santa, Tooth Fairy, Easter Bunny, ghost, and God) could (a) give COVID-19 and (b) get COVID-19, and if the target should (c) wear a mask, and (d) socially distance. Parent–child dyads were also given a sixth response option which was "no answer/refuses to answer," in the event that the child did not respond. The order of these questions and targets was fully randomized.

Anthropomorphism Scale

Following Shtulman (2008), participants answered questions about whether each being could talk, think, breathe, eat, jump, and move. This scale assessed whether children viewed supernatural beings as similar to human beings in their psychological properties (talks, thinks), biological properties (breathes, eats), and physical properties (jumps, moves). While children generally attribute psychological properties to supernatural beings, they vary in their attribution of biological and physical properties (Shtulman et al., 2019). The latter are thus a more sensitive measure of anthropomorphism than the former, even though the properties measured are not necessarily specific to humans. The order of questions and of the targets was fully randomized. Participants responded using the same 5-point Likert scale described above, and parent–child dyads had a sixth option for "no answer/refuses to answer."

Belief and Liking

We also measured participants' belief in and liking of each being on a 5-point scale.

Free Response

We gave parents a comment section at the end of each survey page in which they could provide their own open-ended observations, in response to the prompt "Please add any comments, anecdotes, or other notable pieces of information that the child provided. Please do not include any identifying information about your child, such as his/her name, when responding." The purpose of this section was to capture any problems with the survey that we might not have observed firsthand, and to have a space for parents to report relevant anecdotes, should they desire to do so. These free response prompts were also available for our adult controls, with slightly modified wording (see OSF for materials).

Results

For all response scales, we centered response options around the midpoint labeled "Maybe," which was scored as 0. Our online supplemental materials include a preregistered analyses of data for only 5-year-olds, full reporting of preregistered age analyses, and extended reporting of several of the analyses described in the main text. The data below represent the responses of our child participants; adult control data are reported in an expanded format in the online supplemental materials, and are discussed in the main text only when explicitly noted; all data are available on OSF. See Table 1 for detailed reporting of ages and sample sizes for each measure.

Preliminary Descriptive Results

Public Health Scores

On average, child–parent dyads reported that their households engaged in 3.7 out of 5 PH behaviors, with a mode of 4. In our sample, 82.5% of respondents indicated that the child was currently out of daycare/school/camp due to COVID-19, 80% indicated that at least one adult in the house was currently staying home due to COVID-19, 86% reported wearing masks when leaving the house, 94% reported that their child was aware of the need to socially distance, and 27% reported wiping groceries down before putting them away. These data suggest that the children in our study were overwhelmingly likely to have seen and participated in the COVID-mitigation measures (mask wearing and social distancing) that were tested in our study.

Levels of Belief in Targets

On average, children reported believing in every target we tested, with the exception of ghosts, who were rated as non-real ($M = -0.95$, significantly below the midpoint "Maybe" response; $p < .0001$). That is, average belief ratings for every other target were statistically higher than the midpoint of our scale (i.e., above "Maybe"; all $ps < .0001$).

Post hoc analyses (see the online supplemental materials for visualizations) predicting children's level of belief from their age in months revealed that mean belief ratings never fell below the midpoint of our scale for rocks, humans, and God (i.e., their scores were above the midpoint across all ages). For the remaining supernatural targets,

Table 1
Sample Size and Age (in Months) Distribution (Mean, Min, Max) for Each Target

	Total *N*	Mean age	Min age	Max age	*N* 3 YOs	*N* 4 YOs	*N* 5 YOs	*N* 6 YOs	*N* 7 YOs	*N* 8 YOs	*N* 9 YOs	*N* 10 YOs
Person	217	81.4	36	130	14	30	34	40	35	31	13	20
Rock	206	81.9	36	130	12	28	32	38	34	30	13	19
Santa	164	76.8	36	125	12	25	32	34	27	20	8	6
Easter Bunny	149	75.6	36	125	12	23	30	33	23	17	6	5
Tooth Fairy	145	75.9	36	125	11	22	31	30	23	17	6	5
Ghost	71	78.5	36	127	9	8	14	12	9	8	5	6
God	153	80.4	36	127	12	21	31	30	19	25	9	13

Note. To be included in analyses for a particular target, a child must have contributed at least one data point for the dependent variables for that target and had to express belief in that target. In some analyses, the true sample size is occasionally smaller than reported below (i.e., if a child failed to provide a response for a particular DV). Min = minimum; max = maximum; YOs = year olds.

the age at which our participants dropped from above-midpoint ratings to the midpoint (i.e., "Maybe") was consistently after their ninth birthday, suggesting that some level of belief in our targets persists into late childhood (Santa = 9.75 years; Easter Bunny = 9.1 years; Tooth Fairy = 9 years; see Blair et al., 1980; Prentice et al., 1978).

We were primarily interested in children's judgments about the impact of COVID-19 on the beings that they believed were real, and preregistered our analysis to focus on only those targets. We did this because it is difficult to interpret a response like "Ghosts definitely can't wear masks" if the child also believes that ghosts definitely don't exist. Consistent with this concern, we had numerous parental reports in the comments section reporting that children said things like "God can't breathe because God isn't real" and "Ugh, it doesn't matter if the Tooth Fairy stays away because the Tooth Fairy isn't real. If they were real, they should stay away, though." We therefore only analyzed responses to those targets that the child reported believing were "Probably" or "Definitely" real. For each target and each dependent variable (DV), we had between 145 and 217 ratings from believers (except for ghosts, for which we had 69 ratings from believers for some DVs). Only these data were used in subsequent analyses, though all data are available on our OSF page (https://osf.io/rha4z/).

Baseline Items

We first consider the baseline data for humans and for rocks. Overall, children rated humans as being "Definitely" able to get and give COVID-19, and to "Definitely" need to wear a mask and socially distance (see Table 2). In contrast, rocks were rated as "Definitely Not" being susceptible to COVID-19, and "Definitely Not" needing to wear a mask or socially distance (see Table 2). These data suggest that children attended to our task were able to respond sensibly to our prompts, and had a basic understanding that humans are impacted by COVID-19 and rocks are not. Because we anticipated that children's judgments about rocks and humans would be quantitatively and qualitatively distinct from their judgments about supernatural beings, we preregistered using these targets primarily as visual baselines for comparisons. Thus, unless otherwise noted, our subsequent analyses include only supernatural beings.

Effects of Age

We next asked whether children's ratings of the impact of COVID-19 on each target were related to the child's age. To do this, we predicted ratings for each measure (whether the target could give COVID-19, get COVID-19, should wear a mask, and should socially distance) from the child's age in months. Full statistical reporting is available in Table S1 in the online supplemental materials. We found that older children endorsed humans' susceptibility to COVID-19 more strongly than did younger children (give: $B = 0.006$, $SE = 0.002$, $p = .0014$; get: $B = 0.004$, $SE = 0.002$, $p = .014$). However, while this effect was significant, even the youngest children agreed that humans could get (y-intercept = 1.58, or between "probably" and "definitely") and give (y-intercept = 1.31, or between "probably" and "definitely") COVID-19. In other words, age predicted the certainty of children's

Table 2
Mean Ratings of Each Target's Susceptibility to COVID-19 (Give COVID, Get COVID) and Their Need to Engage in Mitigation Strategies (Wear Mask, Socially Distance)

	Rating			
Target	Get COVID	Give COVID	Mask	Social distance
Person	Definitely (1.89, $p < .0001$)	Definitely (1.82, $p < .0001$)	Definitely (1.82, $p < .0001$)	Definitely (1.87, $p < .0001$)
Santa	Maybe[a] (0, $p = .87$)	Probably not (−0.41, $p = .0005$)	Probably (0.38, $p = .002$)	Probably (0.71, $p < .0001$)
Bunny	Probably not (−0.32, $p = .01$)	Probably not (−0.81, $p < .0001$)	Maybe[a] (0.03, $p = .88$)	Probably (0.33, $p = .02$)
Tooth Fairy	Maybe[a] (−0.23, $p = .06$)	Probably not (−0.61, $p < .0001$)	Maybe[a] (−0.20, $p = .19$)	Maybe[a] (0.12, $p = .46$)
God	Probably not (−1.10, $p < .0001$)	Probably not (−0.99, $p < .0001$)	Probably not (−0.82, $p < .0001$)	Probably not (−0.50, $p = .0003$)
Ghost	Definitely not (−1.30, $p < .0001$)	Definitely not (−1.17, $p < .0001$)	Probably not (−1.03, $p < .0001$)	Probably not (−0.67, $p = 002$)
Rock	Definitely not (−1.71, $p < .0001$)	Definitely not (−1.33, $p < .0001$)	Definitely not (−1.79, $p < .0001$)	Definitely not (−1.59, $p < .0001$)

Note. p values were generated by Wilcoxon signed-rank test comparison to 0. Labels are "Maybe" if ratings did not differ from 0; otherwise, they are the closest non-Maybe scale item. Targets are ordered from highest (top) to lowest (bottom) anthropomorphism score. Adult data are available in Table S4 in the online supplemental materials.
[a] The distribution of data was bimodal, and means should be interpreted with caution (see the online supplemental materials and description later).

responses about humans' susceptibility to COVID-19, but not the valence of those responses.

For Santa, the Tooth Fairy, and the Easter Bunny, age did not predict whether children believed the target could get or give COVID-19, or whether they believed the target should wear a mask. For God, ghosts, and rocks, these analyses revealed that older children were more certain than younger children that these targets could not get COVID-19, although, once again, this age-related difference was driven by differences in children's level of certainty, not the valence of their responses (i.e., all *y*-intercepts were <0, indicating disagreement with the possibility that these targets could get or give COVID-19; note that none of these relationships remain significant when correcting for multiple comparisons). However, they also demonstrated that older children were more likely than younger children to disagree with the possibility that supernatural targets should socially distance. For God, ghosts, and rocks, these effects were significant even when correcting for multiple comparisons (see the online supplemental materials for full reporting). For Santa, the Tooth Fairy, and God, with increasing age, children went from believing that the target should socially distance (*y*-intercept > 0) to believing that they should not (line of best-fit crossing below 0; this effect was only significant for Santa and the Tooth Fairy when not correcting for multiple comparisons); see the online supplemental materials for visualizations. Thus, these analyses provide some evidence that older children were less likely to endorse social distancing than younger children.

Perceived Impact of COVID-19 on Supernatural Beings

Supernatural Beings' Susceptibility to COVID-19

We used planned Wilcoxon signed-rank tests to ask whether ratings differed from the midpoint of our scale (0; "maybe") for each DV for each target. Means and *p* values for the Wilcoxon signed-rank tests are reported in Table 2. In addition, we conducted unplanned, post hoc Dunnett's mean comparisons to test whether each supernatural being was rated as (a) more likely to be impacted by COVID-19 than a rock is and (b) less likely to be impacted by COVID-19 than a person is. We found that children did not rate ghosts differently from rocks with respect to their likelihood of giving ($p = .33$) or getting ($p = .47$) COVID-19, and children did not rate God as different from rocks with respect to their likelihood of giving COVID-19 ($p = .16$). All other supernatural beings were rated as significantly more likely than rocks to give and get COVID-19 (all $ps < .01$). All targets were rated as significantly less likely than humans to give and get COVID-19 (all $ps < .0001$).

Importantly, while mean ratings of COVID-19 susceptibility for supernatural beings suggested that children believed supernatural targets were less likely to get COVID-19 than were humans, many children in the sample nevertheless entertained the possibility that supernatural beings could get or give COVID-19. For example, while 87% of children (and 96% of adult controls) said that a rock could "definitely not" get COVID-19 and 67% of children (and 92% of adults) said a ghost could definitely not get COVID-19, children were less likely to completely deny the possibility of the other supernatural beings getting COVID-19 (see the online supplemental materials for full statistical reporting). Only 59% of children claimed that God could "definitely not" get COVID-19, and that percentage was 33% for the Easter Bunny, 28% for the Tooth Fairy, and 30% for Santa. In contrast, the vast majority of adults denied the possibility of all nonhuman targets getting COVID-19 (God: 89%; Easter Bunny: 78%; Tooth Fairy: 78%; Santa: 71%), but almost never indicated that humans could "definitely not" get COVID-19 (1%).

In addition, a sizeable subset of children believed that supernatural beings "definitely" or "probably" *could* get COVID-19 (Santa = 47%; Easter Bunny = 34%; Tooth Fairy = 38%; God = 15%; Ghost = 10%) and definitely or probably could give COVID-19 (Santa = 32%; Easter Bunny = 21%; Tooth Fairy = 27%; God = 18%; Ghost = 14%). However, adults rarely indicated that supernatural targets could "definitely" or "probably" get or give COVID-19 (Get: Santa = 20%; Easter Bunny = 10%; Tooth Fairy = 11%; God = 3%; Ghost = 2%; Give: Santa = 21%; Easter Bunny = 12%; Tooth Fairy = 12%; God = 11%; Ghost = 2%), but nearly always did for humans (Get: 96%; Give: 94%). Notably, some of the adults (and two of the children) who reported believing that Santa, the Easter Bunny, or the Tooth Fairy were susceptible to COVID also noted in their qualitative responses that this was because they believed these beings must be humans wearing costumes. These findings suggest that some children believe that human diseases can impact supernatural beings, while others do not. In addition, while mean responses about COVID-19 susceptibility for Santa, the Easter Bunny, and the Tooth Fairy tended to be near 0 (i.e., "Maybe," see Table 2), the distributions of responses were bimodal (see the online supplemental materials for distributions). Indeed, children responded that a supernatural target could "Maybe" get/give COVID-19 only 7%–13% of the time, depending on the target.

One critical question is whether children's beliefs about supernatural targets were internally consistent (suggesting a unifying theory—even if not an adult-like one—of disease transmission), or whether instead they were chaotic (suggesting confusion about disease transmission or noisy data). Post hoc analyses revealed that individual children tended to provide internally consistent responses to questions about Santa, the Easter Bunny, and the Tooth Fairy. We saw evidence of this consistency in two ways. First, we calculated the *SD* of children's responses for these three targets (Santa, the Easter Bunny, and the Tooth Fairy) for each child. A value of 0 would indicate that the child's responses were identical across all three targets, with larger *SD*s indicating a higher level of differentiation across the three targets. For each of our four main DVs, a sizeable subset of children had a *SD* of 0 (Get COVID-19: $n = 93/208$; Give COVID-19; $n = 107/218$; Wear Mask: $n = 97/218$; Distance = 96/215), and the mean *SD* was <0.8 for all DVs (Get: .65; Give: .61; Mask; .71; Distance: .79). We also asked whether children consistently provided responses on the same side of the scale for all three beings, and found that they did so the majority of the time (see Table S6 in the online supplemental materials). Once again, these data suggest that children held similar beliefs about the impact of COVID-19 on Santa, the Easter Bunny, and the Tooth Fairy. Thus, our sample contained one group of children who consistently doubted that supernatural targets could get and give COVID-19, and another group of children who consistently affirmed that supernatural targets could get and give COVID-19.

Supernatural Beings' Engagement With Public Health Measures

As shown in Table 2, children were relatively likely to endorse the idea that supernatural beings should engage in COVID-related PH measures. This was not simply a tendency to say that everyone

and everything should engage in PH measures: Only 3% of children (and 2% of adults) indicated that rocks "probably" or "definitely" should wear masks, suggesting that participants did not believe that inanimate objects need to engage in COVID-related PH behaviors. Unplanned post hoc Dunnett's mean comparisons revealed that children's ratings of the need to engage in disease-mitigating behaviors were higher for every supernatural being than they were for rocks, and lower for every supernatural being than they were for humans (all $ps < .0001$).

Approximately 15% of children said that ghosts should "probably" or "definitely" wear a mask, and 23% said God should "probably" or "definitely" wear a mask. For the other supernatural beings, around half of the children felt that the target should "probably" or "definitely" wear a mask: Santa = 57%; Easter Bunny = 47%; Tooth Fairy = 53%. The pattern was similar for endorsement of social distancing ("probably" or "definitely" should distance: Santa = 67%; Easter Bunny = 58%; Tooth Fairy = 49%; God = 30%; Ghost = 29%; Rock = 6%). In other words, at least half of the children in our study believed that many of the supernatural targets should engage in disease-mitigating behaviors.

Comparisons Across Measures

As preregistered, we next compared ratings on our four primary DVs to one another. We did this once for each target, using Tukey's honestly significant difference (HSD; analysis that allows us to conduct multiple pairwise comparisons while correcting for multiple comparisons). This analysis allowed us to determine whether, for example, the perceived likelihood of giving COVID-19 differed from the likelihood of getting COVID-19. We found that children rated the likelihood of a human giving COVID as comparable to the likelihood of a human getting COVID, and as comparable to the need to wear masks and to socially distance (see Table 3, Figure 1). This is consistent with the idea that children understood the basic mechanism of COVID-19 transmission: Humans can both get and give COVID-19, and therefore need to both socially distance and wear masks.

In addition, across all targets, and for both children and adults, there was no difference in the perceived importance of social distancing versus wearing a mask (see Table 3 for child data and Table S5 in the online supplemental materials for adult data). Consistent with this, post hoc correlations revealed significant positive relationships between ratings of the need to wear a mask and the need to socially distance for each target (all $ps < .0001$). Similarly, for nearly every target, there was no difference between the perceived likelihood that a particular target would get versus give COVID-19 (the only exceptions were that the Easter Bunny was perceived as more likely to get COVID than to give it by children; $p = .03$; and God was perceived as more likely to give COVID than to get it by adults, $p = .002$). Post hoc correlations found a significant predictive relationship between the perceived likelihood of giving COVID and getting COVID for each fictional being (all $ps < .0001$). These data suggest that children and adults tended to believe that targets who were less likely to get COVID-19 were also less likely to transmit COVID-19.

While the difference in perceived likelihood to get versus give COVID-19 was not statistically significant for most of our targets (Table 3), we noticed that mean ratings of likelihood to give COVID-19 were generally lower than mean ratings of the likelihood of getting COVID-19 for children. Post hoc paired-samples t test found that our primary target supernatural beings (Santa, Easter Bunny, and Tooth Fairy) were rated significantly less likely to give COVID-19 than to get COVID-19 by children, $t(173) = -4.7$, $p < .0001$, but no more or less likely to get COVID-19 than to give it by adults, $t(195) = 1.96$, $p = .051$.

Relationship Between Disease Risk and Disease Mitigation

Finally, we asked about the relationship between perceived susceptibility to COVID-19 (i.e., risk of giving and getting COVID) and perceived need to engage in disease mitigation measures (i.e., social distancing and mask wearing). This question allows us to understand beliefs about the causal mechanisms that relate disease transmission to disease prevention. We report Tukey's HSD mean comparison for each target for each DV in Table 3 (last four columns) for children and in Table S5 in the online supplemental materials for adults. Significant p values indicate a significant difference between a being's perceived susceptibility to COVID-19 and their perceived need to engage in a PH behavior. As discussed below, children showed no difference in susceptibility and mitigation measures for humans, but did show significant differences for supernatural beings (Table 3). In contrast, adults showed the opposite pattern: No significant differences between susceptibility and mitigation measures for supernatural targets, but a significant difference for human targets (Table S5 in the online supplemental materials; the need for humans to engage in mitigating behaviors was rated lower than humans' susceptibility to COVID-19).

We conducted post hoc paired analyses comparing children's endorsement of PH measures (the average of distancing and mask

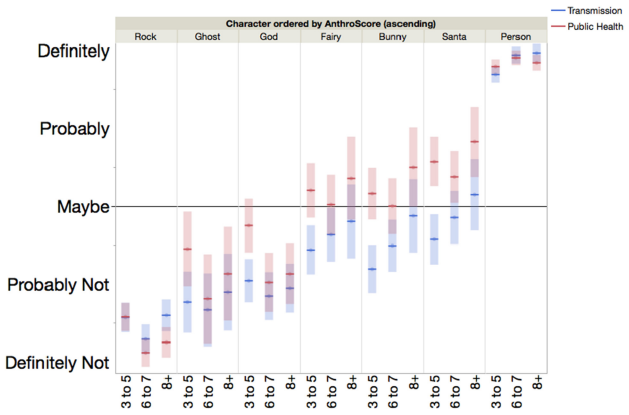
Table 3
Tukey's Honestly Significant Difference Comparisons of Dependent Variables for Each Target

	Comparison					
Target	Giving vs. getting	Distancing vs. masks	Getting vs. masks	Giving vs. masks	Getting vs. distancing	Giving vs. distancing
Person	n.s., $p = .71$	n.s., $p = .84$	n.s., $p = .66$	n.s., $p = .99$	n.s., $p = .99$	n.s., $p = .88$
Santa	n.s., $p = .08$	n.s., $p = .23$	n.s., $p = .11$	$p < .0001$	$p = .0002$	$p < .0001$
Bunny	$p = .03$	n.s., $p = .32$	n.s., $p = .21$	$p < .0001$	$p = .002$	$p < .0001$
Tooth Fairy	n.s., $p = .16$	n.s., $p = .97$	n.s., $p = .10$	$p < .0001$	n.s., $p = .25$	$p = .0005$
God	n.s., $p = .91$	n.s., $p = .22$	n.s., $p = .32$	n.s., $p = .73$	$p = .002$	$p = .02$
Ghost	n.s., $p = .42$	n.s., $p = .95$	n.s., $p = .65$	n.s., $p = .93$	$p = .04$	n.s., $p = .14$

Note. Targets are ordered by anthropomorphism score (highest = top to lowest = bottom). We only preregistered the comparisons of getting versus giving and distancing versus masks; all other comparisons are post hoc. For all significant analyses, the second item (e.g., "Getting" in the column "Giving vs. getting") had the higher mean score. Adult data can be found in Table S5 in the online supplemental materials.

Figure 1

Children's Ratings of How Likely It Is That Each Target Is Susceptible to COVID-19 (Give and Get COVID-19; Blue) and Whether Each Target Should Engage in Public Health Measures Related to COVID-19 (Social Distancing and Mask Wearing; Red)



Note. Targets are arranged by anthropomorphism score (low to high); participants are binned by age group. Only data from "believers" in each supernatural being are presented. See the online article for the color version of this figure.

wearing) to targets' risk of giving and getting COVID-19. Post hoc paired-samples *t* tests revealed that children rated the need to engage in disease mitigation measures as higher than the risk of giving/getting COVID. This was the case for each supernatural character (all $ps < .001$), but not for humans, $t(216) = -0.28$, $p = .78$. As shown in Figure 1, even when children thought a target was unlikely to be involved in COVID-19 transmission (lower ratings shown in blue), they often endorsed the use of PH measures (higher ratings shown in red). These findings may suggest that children's sensitivity to PH norms may be distinct from their beliefs about disease transmission, and/or that other factors (e.g., that prominent figures should set a good example) shape their judgments about engaging in disease-mitigating behavior.

Explaining Differences Between Targets

We next asked whether some targets were rated as more or less likely to be impacted by COVID-19 than other targets. To do this, we compared ratings for the four main DVs across the five critical targets, again using Tukey's HSD, which controls for multiple comparisons. We found that for children, God and ghosts were rated as significantly less likely to get COVID-19 than Santa, the Easter Bunny, or the Tooth Fairy (all $ps < .0001$). We also found that God was rated as less likely to give COVID-19 than Santa ($p = .001$), and that ghosts were rated as less likely to give COVID-19 than God ($p = .004$), the Tooth Fairy ($p < .0001$), the Easter Bunny ($p < .0001$), and Santa ($p < .0001$). God and ghosts were also rated as less likely to need to wear a mask or to socially distance than any of the other supernatural targets (all $ps < .001$), the Tooth Fairy was rated as less likely to need to socially distance than Santa ($p = .015$), and the Easter Bunny was rated as less likely to need to wear a mask than Santa ($p = .015$). These data suggest that children considered God and ghosts to be substantially less affected by COVID-19 than the other supernatural targets, and that, in some cases, Santa was rated as more impacted by COVID-19 than the other supernatural targets. The overall finding that Santa was most impacted by COVID-19 and that ghosts and God were least impacted was replicated in our adult sample, although adults' relative ratings for our other targets differed somewhat from children's, and adults endorsed qualitatively lower levels of disease susceptibility for supernatural targets than did children (see the online supplemental materials for adult analyses).

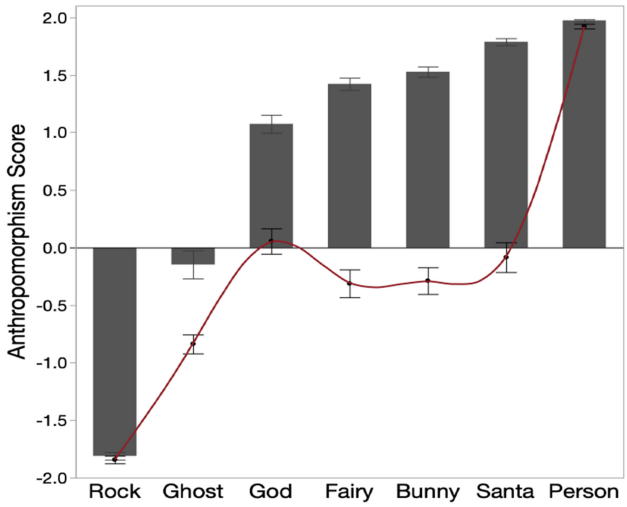
Anthropomorphism Score and COVID Susceptibility

As planned, we next assessed whether these differences between targets were related to their Anthropomorphism Score. A global anthropomorphism score (Cronbach's $\alpha = .91$) for each target was calculated by taking the average of children's ratings for six queried abilities: Whether the target could breathe, eat, talk, think, jump, and/or move; for item-specific ratings, see the online supplemental materials). As shown in Figure 2, most of our targets had relatively high anthropomorphism scores (above the "maybe" midpoint). As also shown in Figure 2, adults provided identical anthropomorphism scores for people and rocks as did children, but provided scores for the Easter Bunny, Santa, and the Tooth Fairy that were below the midpoint of the scale (while children provided scores above the midpoint of the scale; Figure 2).

Last, we used model testing to determine the strongest predictors of children's beliefs about COVID-19's impact on supernatural beings. As planned, we did not include humans or rocks in these analyses, as we did not want the models to be overwhelmed by our "control" items. Thus, we considered data only for ghosts, God, the Easter Bunny, the Tooth Fairy, and Santa. We constructed four separate models, one for each of our four COVID-19-dependent measures. As predictors, we included the child's age (in months), their family's PH score 0–4, the child's belief in the target (binomial: "probably real" vs. "definitely real," since our study only analyzed

Figure 2

*Anthropomorphism Scores (*y*-Axis) for Each Target*



Note. Bars indicate scores for children and lines indicate scores for adults. Error bars indicate standard error of the mean. A score of 0 indicates that the participant's mean rating was that the target "maybe" displayed the queried abilities. See the online article for the color version of this figure.

data from believers), the child's liking of the target (5-point scale), and the target-specific anthropomorphism score. We included participant and target as random effects. Parameter estimates and 95% CIs are shown in Figure 3; full model outputs, including intercept estimates, are available in the online supplemental materials.

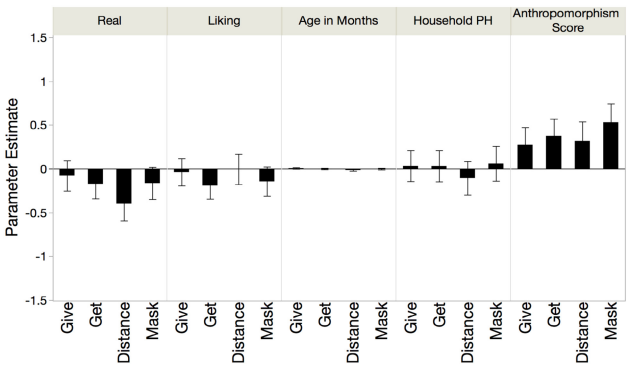
Overall, we found that the anthropomorphism score predicted each of our four DVs (Figure 3). We also found that there was a negative relationship between belief in the targets and belief in their susceptibility to COVID-19. Children who thought that a target was "Definitely" real were less likely to think that the target could be impacted by COVID-19 than those who thought that the target was "Probably" real. We discuss this unexpected finding in the Discussion. More importantly, anthropomorphism score was a consistently strong predictor of children's belief that a target was susceptible to COVID-19 (all $ps < .01$). Even without direct evidence about the impact of disease on unseen beings, more human-like targets were inferred to be more impacted by COVID-19.

Discussion

The COVID-19 pandemic caused a rapid shift in global discourse surrounding disease transmission and prevention. In the span of a few months, children (and adults) in the United States received a massive influx of information about the causal relations between disease risk and disease mitigation measures for a previously undocumented disease. The pandemic—and ensuing debates about the utility of specific disease mitigation measures—highlighted tensions between scientific beliefs about disease spread and laypeople's intuitive beliefs. More generally, the pandemic made visible the many nonscientific sources of information that shape our beliefs about disease transmission. Thus, the COVID-19 pandemic context served as an ideal context for examining children's beliefs about disease transmission and disease prevention. In the present study, we asked about children's beliefs about disease susceptibility and their beliefs about PH measures aimed at mitigating disease spread. Critically, we asked not just about their beliefs about the impact of COVID-19 on humans, but also about their beliefs about the impact of COVID-19 on supernatural beings.

Figure 3

Parameter Estimates for Five Predictors When Used in Separate Models Predicting Children's Responses to Four COVID-19 Questions



Note. The five predictors were whether the target was real, how much the child liked the target, the child's age, the household's public health score, and the target's anthropomorphism score. The four COVID-19 questions were, can supernatural beings (a) get COVID-19, (b) give COVID-19, and should they (c) socially distance and (d) wear a mask? Error bars indicate 95% CI.

Our child data were collected remotely in the Summer of 2020, at the height of pandemic restrictions in the United States. Given our remote data collection technique, we first describe important checks on data quality. Importantly, we found that children's baseline beliefs about humans and rocks were reasonable: Children thought that humans definitely could get and give COVID-19, and definitely should engage in disease-mitigating behaviors. They also thought that rocks definitely could not give or get COVID-19 and therefore need not engage in disease-mitigating behaviors. These baseline data demonstrate that children were willing and able to respond to questions about COVID-19 in the affirmative and the negative. These data also show that our sample, as whole, had at least a basic understanding that humans are more impacted by COVID-19 than are rocks. Moreover, in line with previous studies showing developmental improvements in children's understanding of human susceptibility to disease in the wake of the COVID-19 pandemic (Leotti et al., 2021), we demonstrate that children's belief that humans are susceptible to COVID-19—while high at all ages—increased with age. Again, these data suggest that we were able to collect a high-quality sample of participants between 3 and 10 years of age. Finally, as discussed further below, data from parent–child dyads were fundamentally different from data collected from adult controls in 2022.

Our first research question was whether children believe that supernatural beings are susceptible to COVID-19 and can transmit COVID-19 to others, as compared to baseline targets like humans and rocks. Most children said that God and ghosts could not get or give COVID-19, and did not need to engage in disease-mitigating measures like mask wearing and social distancing. However, children's beliefs about the Easter Bunny, Santa, and the Tooth Fairy were more varied. A large subset of children believed that these targets probably or definitely could get COVID-19 (Easter Bunny: 34%, Tooth Fairy: 38%, Santa: 47%), while another large subset believed that these targets probably or definitely could *not* get COVID-19 (Easter Bunny: 54%; Tooth Fairy: 49%; Santa: 34%). These data demonstrate diversity in children's beliefs about supernatural beings' susceptibility to COVID-19. These differences were not best explained by the child's age, indicating that these effects are unlikely to be due to general maturation. Moreover, because these analyses only included children who reported believing in the target, the diversity in their beliefs about beings' susceptibility to COVID-19 cannot be attributed to some children's disbelief in some targets. Instead, these data suggest a deep underlying divide among our child participants in terms of whether they believed that supernatural beings could get or give COVID-19. Consistent with this, post hoc analyses revealed that children tended to provide similar responses about the impact of COVID-19 on the Easter Bunny, Tooth Fairy, and Santa—while there was substantial between-subject variability, within-subject variability for these targets was low. These data suggest a bimodal distribution of children's beliefs: Some children appeared to believe that supernatural beings are impacted by COVID-19, while other children doubted this possibility. Because such differences were not explained by measures within our dataset (e.g., the child's age, the child's household's engagement with disease mitigation measures), the sources of this divide remain an open question.

Next, we asked whether children's beliefs about supernatural beings needing to engage in PH measures, like wearing a mask, were consistent with their beliefs about those beings' susceptibility to COVID-19. While there was substantial variability in children's beliefs about the susceptibility of many of our supernatural beings to COVID-19, there was far less variability in children's beliefs about whether supernatural beings should wear masks and practice social distancing. Children consistently rated the targets' need to socially distance and wear masks significantly higher than the targets' susceptibility to COVID-19. If children's support of disease mitigation measures were determined only by the beings' relative susceptibility to COVID-19, then children should not have endorsed engagement with disease-mitigating measures in cases where they didn't believe the being could contract COVID-19. However, this is not what we found. Even among children who believed that targets could "definitely" not get COVID, a sizeable subset still believed that that same target should wear a mask (Santa: 34%; Tooth Fairy: 36%; Easter Bunny: 35%) and socially distance (Santa: 57%; Tooth Fairy: 43%; Easter Bunny: 41%). These findings echo previous work showing that children's adherence to disease-mitigating measures, like hand washing, may be motivated by explicit rules ("wash your hands!") rather than children's causal understanding of germs and germ transmission (e.g., Au et al., 2008).

An alternative interpretation of this finding is that children may take an especially risk-averse stance toward COVID-19, erring on the side of engaging in preventative measures even when the risk of COVID is perceived to be low. Or, they may endorse disease-mitigating behaviors because they believe that they might reduce the risk of disease in general (i.e., even though Santa cannot get COVID-19, he should still wear a mask to prevent other diseases). If children do engage in this sort of reasoning, their behavior is non-adult-like: Adult controls in our study showed the opposite pattern of results, indicating higher levels of perceived susceptibility to COVID-19 than endorsement of engaging in disease-mitigating behaviors. Another reason to doubt that children's behavior was driven by risk-aversion is that children are not known to exert caution in disease-relevant situations. They do not express adult-like levels of disgust for contaminants (e.g., dead animals, dirty hands; Stevenson et al., 2010), and they are willing to eat food that a person has a sneezed on (DeJesus et al., 2015), and drink juice that a grasshopper has fallen into (Rozin et al., 1985). Thus, we believe that it is unlikely that children's beliefs about COVID-mitigating behaviors are motivated by general cautiousness. Children's ratings of the importance of COVID-mitigating behaviors also varied between, for example, ghosts versus Santa, suggesting that these ratings reflect more than a blanket acceptance of PH measures. Rather, these ratings appear to be related to their belief in the beings' susceptibility to COVID-19, but calibrated in such a way that COVID-mitigating behaviors are consistently emphasized over susceptibility to COVID-19 itself, possibly because children are unsure of how these behaviors actually mitigate the disease.

What information *do* children use to determine disease risk for supernatural beings? As planned at the outset, we asked whether the extent to which these beings have human-like properties (i.e., their anthropomorphism score) predicted children's beliefs about the impact of COVID-19. Indeed, for all four of our dependent measures—even when controlling for the child's age and their household's own engagement with disease-mitigating practices—we found that the strongest predictor of perceived COVID-19 susceptibility was the target's anthropomorphism score. These data suggest that supernatural beings who are perceived as being more human-like are also perceived as being more likely to be impacted by COVID-19. These data suggest that children believe that COVID-19 impacts beings that share human-like traits more than beings that do not. Interestingly, we found the same pattern for adults: While adults' anthropomorphism scores differed from those provided by children (e.g., adults rated the Tooth Fairy as much less human-like than children did [Figure 2] and Table S7 in the online supplemental materials for full reporting), their beliefs in supernatural beings' susceptibility to COVID-19 were strongly predicted by their anthropomorphism score. These data suggest some amount of developmental continuity in theories of COVID-19 transmission: The possession of human-like attributes predicts perceived COVID-19 risk across the lifespan.

While not predicted at the outset, we also found that when children expressed greater levels of belief in a particular entity, they also tended to believe that that entity was less likely to be impacted by COVID-19. Critically, our analyses only included children who said that they thought a particular target was "probably real" or "definitely real." In other words, this finding shows that among believers—and even when taking into account the child's age and the target's anthropomorphism score—children who express greater certainty in an entity's existence also endorse greater immunity to COVID-19. This pattern is consistent with an overall bias toward wishful thinking, such that children who believe more strongly in beings like Santa Claus or the Tooth Fairy are also more convinced that these beings cannot get COVID-19. Conversely, this pattern may reflect the emergence of a general skepticism among children who are uncertain of supernatural beings; these children are skeptical not only of the beings' existence but also of the beings' ability to avoid COVID-19. Importantly, children's belief in the target explained variability in ratings of the target's COVID susceptibility even when taking into account the target's anthropomorphism score, ruling out the possibility that this pattern was driven by children who believe that Santa is just a human in a suit. Future research should study both the roles of wishful thinking and skepticism in shaping children's beliefs about behaviors surrounding disease prevention.

Across all analyses, we also considered whether children's age and their own households' engagement with PH measures predicted their beliefs. Surprisingly, we found few consistent participant-level effects. A child's age, for example, did not predict their belief in our targets, nor was it an overall predictor of beliefs about the impact of COVID-19 on our supernatural targets. In simple correlations, age only predicted children's belief in humans' susceptibility to COVID, and their belief that supernatural targets should socially distance; but, when accounting for our other measures, we found that anthropomorphism score and belief in the being (and not age) were the best predictors of perceptions of disease impact. These relatively restricted age effects may make sense: Among children aged 3–10 years, age brings no additional "experience" of the impact of disease on supernatural beings. And, given the novelty of COVID-19 at the time of data collection, children in our experiment all had about the same duration of experience with the virus: 6 months. In this way, unlike previous work on children's beliefs about the cold/flu (where the child's amount of experience with the virus was correlated with their chronological age), it was possible for us to disentangle the impact of chronological age from the impact of experience. Thus, children in our study either based their

judgments on their underlying theories of disease transmission, or on the COVID-specific information they had acquired during the preceding 6 months.

Overall, we found that while children recognize that bodies are a prerequisite for illness—judging, for instance, that Santa is more likely to get COVID-19 than a ghost—they fail to adequately connect this understanding to behaviors that mitigate disease transmission. Mask wearing and social distancing are prescribed with more certainty than children's perception of whether a being can even get COVID-19. This discrepancy between endorsement of PH measures and perception of COVID susceptibility implies either that children were confused about how the COVID-mitigating behaviors actually mitigate the spread of COVID-19 or that they view these behaviors as healthful in and of themselves. Or, perhaps children received messaging that explicitly decoupled COVID-19 risk from disease-mitigating behavior: Some children's parents may have reassured them that they were unlikely to get COVID-19, but that they nevertheless should engage in disease-mitigating behavior. Alternatively, children may base their beliefs about transmission on the behaviors they observe. Previous research on children's understanding of cold/flu transmission has found that children's predictions of cold/flu transmission are based on behavior stereotypically associated with disease rather than actual exposure to germs (Au et al., 2008; Solomon & Cassimatis, 1999). Here, we replicate and extend those findings by showing that children focus on behavior even when those behaviors are novel, like mask wearing and social distancing, and they apply this focus even to beings whose behavior has never been observed.

Our study had several important limitations that may reduce generalizability. First, parents administered the study to their children online, and an experimenter was not present during that process. While this is an increasingly common practice in developmental science (Rhodes et al., 2020), it allows for more parental interference or parental error than might occur in a laboratory. For example, parents may have used cues (e.g., tone of voice, body language) that a trained experimenter might not in inferring children's level of certainty; whether this adds signal or noise to the data is a question that remains for future researchers. Despite these concerns, we have several reasons to think that the data are high quality. First, we offered participants the possibility to include free response answers (i.e., transcribing what their children said). These responses, while optional, uniformly reflected plausible child utterances (see the online supplemental materials for all free responses). Second, participants responded to our control targets (rocks and humans) as intended, suggesting that children were attentive during the task, and that parents were able to accurately record responses. Third, children's responses were, in general, non-adult-like, suggesting that parents accurately communicated their children's responses; for example, the anthropomorphism scores that children provided for the supernatural targets differed substantially from those provided by adult controls. Finally, we did not recruit from sites like Mechanical Turk, where participants may be primarily focused on completing tasks quickly for direct compensation. Instead, we recruited from communities of parents—many of whom lacked childcare at the time of testing—and we offered compensation by lottery, meaning that participants completed the study without expecting direct compensation.

While our recruitment strategy likely improved the quality of our data, there are several limitations posed by the composition of our sample. First, we recruited participants online, using existing laboratory databases, Facebook groups, Reddit, and other social media. We focused our recruitment on parenting groups, aiming to include a diverse array of special parenting interests (e.g., groups focused on child development, groups focused on thinking about religion and child raising, groups focused on parents of multiple children, groups focused on single-parent families). However, our online recruitment strategy almost certainly underrepresented some groups. For example, while we did not collect any demographic data, we did ask parents to report the extent to which they engaged in PH measures intended to mitigate the spread of COVID-19. Parents overwhelmingly reported engaging in multiple PH measures, with only nine participants reporting engaging in 0 or 1 COVID-mitigating measures. Thus, we almost certainly undersampled anti-maskers and other COVID-19 skeptics, whose children may have answered the questions in the survey quite differently.

A second potential limitation of our data is that our data capture a time-specific snapshot of U.S. children's beliefs about COVID-19. Indeed, messaging surrounding COVID-19 and individual children's experiences with COVID-19 has changed since the time of child data collection (late Summer of 2020). On the one hand, our study was designed to test children's belief about the impact of communicable diseases on supernatural beings—given that children's beliefs about these impacts cannot be driven by perceptual experience, it is likely that many of the findings within this study would generalize to new contexts (e.g., different historical moments, different disease contexts). On the other hand, we expect that some of the specific details (i.e., degree of endorsement of mask wearing) would change depending on the dominant PH practices in the child's environment. Ongoing research in our laboratories is aimed at understanding the relative roles of historical context and context-general disease reasoning in shaping children's beliefs.

In conclusion, we examined children's beliefs about the influence of COVID-19 on supernatural beings, during the first summer of the global COVID-19 pandemic. We found that many children believed that beings like Santa and the Tooth Fairy can get and give COVID-19. The strongest predictor of children's belief that a supernatural entity could be impacted by COVID-19 was the being's anthropomorphism score (i.e., how human-like they perceived the being to be), indicating that children have an intuitive causal understanding of the role played by bodies in germ transmission. However, children were more likely to judge that supernatural beings should engage in PH practices than they were to judge that these beings could get or give COVID-19, suggesting that children have incomplete causal understanding of the purpose of PH behaviors aimed at mitigating disease transmission.

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Received April 27, 2022
Revision received January 6, 2023
Accepted January 19, 2023 ■