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Beliefs about unobservable scientific and religious entities are transmitted via subtle linguistic cues in parental testimony

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Abstract

We explored the role of parental testimony in children's developing beliefs about the ontological status of typically unobservable phenomena. US parents and their 5- to 7-year-old children (N = 25 dyads) separately rated their confidence in the existence of scientific and religious unobservable entities (e.g., germs, angels), and were invited to engage in an unmoderated dyadic conversation about the entities. Both parents and children were more confident in the existence of the scientific entities compared to the religious entities. Parental religiosity predicted the strength of their belief in the religious entities, and these beliefs were positively associated with their children's judgements in the domain of religion. We coded parental testimony produced during the unmoderated conversation for a number of subtle linguistic cues that convey their confidence and prevailing beliefs in an entity's existence. The results revealed consistent cross-domain differences: parents expressed more *uncertainty*, were more likely to mention *variation in people's beliefs* and *make explicit claims about the ontological status* of the religious, as compared to the scientific entities. However, with increasing religiosity, parents produced fewer cues to uncertainty, mentioned belief variation less often, and were more likely to make claims of endorsement when talking about the religious unobservables. Importantly, the pattern of linguistic cues in parental testimony was significantly associated with children's ontological judgements. The present findings have implications for understanding the socio-cultural mechanisms by which confidence in the existence of invisible agents and processes develops in childhood.

Keywords: Concepts, parent-child interaction, social cognition

Beliefs about unobservable scientific and religious entities are transmitted via subtle linguistic cues in parental testimony

Although we are not able to directly experience or encounter many everyday causal phenomena, beliefs in the existence of these phenomena can have a powerful influence on our behavior. For example, in the months succeeding the declaration of the global COVID-19 pandemic by the World Health Organization (WHO, 2020), psychologists have sought to understand the perceptions and motivations that lead to commitments to public health practices that can halt the spread of the invisible, yet highly infectious, virus (see Van Bavel et al., 2020, for a review). Similarly, belief in the causal efficacy of both scientific and supernatural remedies, such as vaccines and prayer, influences the behaviors that adults and children engage in to protect themselves (Legare, Evans, Rosengren, & Harris, 2012; Rutjens & Preston, 2020). An open question is just how beliefs about typically unobservable entities develop in individuals across the lifespan.

In the current study, we focus on the mechanisms through which confidence in the existence of unobservables emerges in childhood. Two hypotheses seem plausible. On the one hand, constructivist theories of cognitive development indicate that belief formation is heavily influenced by children's own experience with the world (Gopnik & Meltzoff, 1997; Gopnik & Wellman, 2012; Piaget, 1957). On this hypothesis, because unobservable entities are by definition not visible, children should ignore or even doubt their existence. On the other hand, a second body of research proposes that young children learn about unobservable agents and processes through the prevalent adult testimony in their community (Harris & Corriveau, 2014; Harris & Koenig, 2006). On this hypothesis, subtle variation in discussions about different unobservables influences the development of children's conceptualization of these entities.

To date, research on the core proposition of the second hypothesis has focused on the strength of beliefs in the unobservable across different cultures, as well as the quality of children's epistemic justifications. One striking finding is the similarity in the types of explanations that both adults and children provide when justifying the existence of endorsed phenomena – namely scientific entities such as germs, as well as religious figures such as God, and special beings such as Santa Claus (Harris, Pasquini, Duke, Asscher, & Pons, 2006; Shtulman, 2013). For example, US adults and children frequently refer to the causal powers of unobservable scientific and supernatural agents. Despite these cross-domain similarities in patterns of justification, children profess more confidence in the existence of scientific as compared to supernatural unobservables (among other endorsed entities), in most of the cultural contexts studied thus far (Clegg, Cui, Harris, & Corriveau, 2019; Cui et al., 2019; Davoodi et al., 2018; Davoodi et al., 2020; Harris & Corriveau, 2020; Harris et al., 2006; Guerrero, Enesco, & Harris, 2010). One possible explanation for the differential level of confidence is that there is important linguistic variation in the testimony surrounding each type of entity. The present research explores this possibility by investigating the pattern of linguistic cues – that convey confidence and prevailing belief in an entity's existence - in adult testimony when discussing endorsed unobservable entities in the domains of science and religion with young children. Critically, we investigated the *relation* between variation in such linguistic markers and children's belief in the existence of the entities.

Children often have access to multiple sources of information in their environment, but parents are likely to be an influential, familiar and even preferred source (Harris, Koenig, Corriveau, & Jaswal, 2018; McLoughlin et al., in press), especially in early childhood (Corriveau et al., 2009). Recent studies conducted in Mainland China highlight the importance of the home

environment for children's developing beliefs about unobservable phenomena. Cui et al. (2019) showed that parents and their children (both 5- to 6-year-olds, and 9- to 11-year-olds) who adopted the majority secular view of this culture were skeptical about the existence of religious concepts. By contrast, Christian parents and their children (a minority group in China) were confident that religious entities exist. Moreover, there was a positive association between the ontological religious judgements of the parents and their children. Interestingly, this relation continued to hold among the older children even though they had more extensive exposure to the secular state curriculum. Indeed, Davoodi et al. (2020) found that children belonging to the minority religious group in China frequently appealed to specific testimonial sources in their immediate social circle when justifying their religious beliefs.

In a pioneering study of parental input, Canfield and Ganea (2014) identified subtle variations in the language that US parents used to discuss endorsed special beings (e.g., Santa Claus, Tooth Fairy, God) compared to entities in the domains of science and history with their 3- to 5-year-olds. Parents were more likely to communicate doubt (e.g., use modulations such as "I think" and "I believe"), acknowledge a lack of consensus in belief more generally (e.g., "Some people think that God…"), and refer to the imaginary nature of the entity when talking about the endorsed beings as compared to the scientific entities. These findings suggest that certain linguistic cues are used more frequently to convey information about the ontological status of unobservable religious entities as compared to scientific unobservables. However, Canfield and Ganea (2014) did not explore the relation between parent and child beliefs, and, importantly, whether the observed variation in adult testimony for the different type of entities was related to children's judgements (most likely in part because the families in this study were only asked to discuss one of four potential topics in each domain).

We aimed to build upon previous research in the following ways. First, we replicated studies conducted in mainland China (e.g., Cui et al., 2019) and Iran (e.g., Davoodi et al., 2018) by investigating the possible relations between the ontological judgements of parents and their children in a society that is characterized by a *broader diversity* of religious practices and values, notably the United States. We chose to situate the current research questions in this context because, given the pluralistic standing of religiosity in many regions of the United States (Norris & Inglehart, 2011), as well as the formal separation between church and state institutions, the development of children's belief systems might primarily depend on the testimony they have access to at home.

Second, we drew from Canfield and Ganea's (2014) methods to examine whether there are systematic differences in subtle linguistic cues to existence when parents discuss multiple topics across the domains of science and religion. For example, we coded: (1) the number of cues to doubt or uncertainty that parents expressed when talking about each entity; (2) general references to variation in societal consensus regarding the existence of the entity; and (3) references to the reality status of the entities. For the third coding category of interest, we focused on parents' use of *explicit* reality status statements (e.g., "I believe in God"; "Germs are real"; "Angels do not exist") because prior research has suggested that they can be powerful source for young children's beliefs about novel entities (Dore, Woolley, & Hixon, 2018; Woolley, Ma, & Lopez-Mobilia, 2011).

We extend previous work to explore if the expected variation in parental testimony across the two domains is influenced by their epistemic views (in this case, parental level of religiosity). Our final aim was to provide a direct test of the testimony hypothesis and investigate the potential relation between the coded linguistic cues in parental talk and children's own

ontological judgements.

In the present study, we asked US parents and their young children to separately rate their confidence in the existence of various scientific and religious entities. In another phase of the study, each parent engaged in an unmoderated conversation with their child about the unobservable entities. Parents and children were asked to rate and discuss a diverse set of scientific and religious entities. The focus of the current report is on their ratings and discussion of a subset of these entities: three religious (i.e., God, Heaven, Angels) and three scientific (i.e., Germs, Oxygen, Electricity). We chose these items based on those used in previous research that investigated relations among parent-child scientific and religious beliefs (Cui et al., 2019; Davoodi et al., 2018) and survey data that indicated a strong consensus about the existence and non-existence of these entities within individuals in the United States (Clegg et al., 2019). We recruited parents and their 5- to 7-year-old children because previous studies have suggested that by this age, children are generally familiar with this subset of phenomena (Davoodi et al., 2020; Harris et al., 2006). Moreover, children in this age range might be particularly reliant on, and receptive to, parental testimony regarding natural and supernatural unobservables.

We had several predictions: Based on previous work with US participants (e.g., Clegg et al., 2019; Harris et al., 2006), we expected that both parents and children would be more confident about the existence of the scientific as compared to the religious entities. Relatedly, on the basis of research revealing the association between parent-child religious beliefs in societies with modest religious diversity (e.g., Cui et al., 2019), we anticipated that parental beliefs would significantly predict the strength of their children's confidence in the domain of religion. By contrast, this relation might not emerge in our analyses in the domain of science because we anticipated little to no variation in parent and children's ontological judgements (i.e., almost

everyone will be very confident that the scientific entities exist; see Clegg et al., 2019; Cui et al, 2019; Davoodi et al., 2020).

We hypothesized that parental confidence in the existence of the scientific, as compared to religious entities, would be communicated by fewer cues to uncertainty and fewer references to belief variation when discussing the scientific unobservables (Canfield & Ganea, 2014). One possible cross-domain pattern that could emerge for explicit reality status statements is that, overall, parents might be less inclined discuss the ontological status of entities whose existence they presuppose or take for granted (Harris et al., 2006). Ultimately, we expected that, as in Canfield & Ganea (2014), parents would be more likely to explicitly affirm the existence of the scientific entities relative to the religious entities. We extended the original study toexplore whether the use of such cues also varied with the religiosity of the parent.

Finally, we anticipated that if testimony is important for the transmission of beliefs in the unobservable, linguistic cues in parent testimony reflecting uncertainty, belief variation, and reality status would predict the level of their child's confidence in the existence of the individual entities.

Method

Participants

A total of 25 families participated in all phases of the current study (n = 21 mothers; 16 boys, mean age = 6 years 3 months, age range = 4 years 11 months – 7 years 6 months). The sample size was appropriate (N = 24 minimum) for 90% power in a mixed design with six observations per participant, $\alpha = .05$ and expecting a medium effect size ($f = 0.25$; see Canfield & Ganea, 2014). Families were recruited via contact with local schools, media advertisements and a university database in the Northeast region of the United States from May 2017 – July

2019. The main purpose of the recruitment methods was to gain access to families that are representative of the relatively broad spectrum in commitment to religious values and practices characteristic of this region (Pew Research Center, 2015). Each family received a children's science book and a $30 Amazon gift voucher for their participation.

Table 1 displays parents' self-reported religious denomination, educational level and self-perceived socioeconomic status (as compared to other people in their town or city[1]; see Adler, Epel, Castellazzo & Ickovics, 2000; Davoodi et al., 2018; Mistry, Brown, White, Chow, & Gillen-O'Neel, 2015). One parent did not provide a response to any of the relevant demographic questions and two additional parents did not provide a response to the question regarding their religious affiliation and education respectively. As shown, approximately 70% of parents reported identifying with a religious denomination, all parents had at least some college education, and, according to the responses to the perceived socioeconomic status question, the majority of families fell into the middle-income range (although the sample included a range of socioeconomic backgrounds, according to this measure).

[1] We used a perceived socioeconomic measure taken from a larger survey designed to explore the transmission of beliefs in the domain of science and religion across diverse cultures. We decided to include a subjective measure to control for cultural differences in average family income and/or other objective socioeconomic status indicators because we planned to run cross-cultural comparisons of the sample demographics.

Table 1. *Distribution of parents' self-reported religious affiliation, education level and perceived socioeconomic status.*

	N	**%**
Religious denomination		
Protestantism	3	13.0
Roman Catholicism	7	30.4
Judaism	3	13.0
Other	3	13.0
None	7	30.4
Education level		
Graduate or professional degree	13	56.5
Some college/College degree	10	43.5
High school or less	0	0
Perceived SES		
High income	4	16.7
Middle income	14	58.3
Low income	6	25.0

Materials & Procedure

Parent Religiosity Index

We created a continuous composite score of religiosity for each parent from their responses to three questions taken from a larger questionnaire examining parents' valuation of and attitudes towards science and religion (see also Clegg et al., 2019; McLoughlin et al., in press; Payir et al., 2020). Parents were asked to complete this questionnaire in the lab or online in their own time.

Note that the religiosity index score was calculated independent of parents' specific religious denomination (as shown in Table 1) to avoid conflating practicing religious participants

with those who only culturally identify with a religious group. The measure of parental religiosity included questions regarding their identification as a *religious* person, their frequency of private worship and their frequency of public worship. Parents who self-identified as a religious person in response to the question "*Would you say you are a religious person or not a religious person?*" received a score of 1, and received a score of 0 otherwise. Parents were given an additional individual score of 1 if they engaged in private worship once a week or more, and an additional score of 1 if they attended a public religious service at least once a month. Otherwise, they received a score of 0 for each of these two questions. Consequently, every parent was assigned a score of religiosity ranging between 0 and 3.

A total of 12 parents received a religiosity score of 0 and thus could be taken to represent the secular families in our sample. However, in a separate section of the questionnaire, we observed that some of these parents (N = 6) indicated that they identified as "Spiritual" in response to the question "*What best describes you? "Religious and Spiritual", "Religious", "Spiritual", or "Neither Religious nor Spiritual".* We included this question in the survey because recent adult survey data revealed that approximately 20% of US adults identify as spiritual but not religious (Pew Research Center, 2017; Public Religion Research Institute, 2017).

We reasoned that because spiritual beliefs do not necessarily represent a strictly secular worldview, we should score this question and include it in the religiosity index for the parents identifying as spiritual (but originally as secular according to the other religiosity questions). Thus, these parents received a score of 1 on the index. The remaining parents who originally

received a score of 0 on the religiosity index and responded that they hold "Neither Religious nor Spiritual" beliefs to this question retained a score of 0 on the religiosity index[2].

Parents' Confidence in the Existence of the Entities

The measure for parents' belief judgements was extracted from the same parent questionnaire. Participants were invited to rate their belief in the existence of 29 scientific and religious phenomena on a 7-point scale (1 = *Definitely does not exist*, 7 = *Definitely exists*). We used their ratings of the chosen subset of unobservable entities (i.e., Germs, Oxygen, Electricity; God, Heaven, Angels) in the present measure, all of which had been met with a high consensus as to their existence and non-existence among US adults (Clegg et al., 2019).

Children's Confidence in the Existence of the Entities

For the measure of children's existence judgements, an experimenter asked the participants a series of questions in a quiet space. Children were first invited to respond to two-warm-up questions about the existence of a real entity (i.e., "*Are dogs real or not real?*") and a fantastical entity (i.e., "*Are flying dogs real or not real?*"). Children were also asked about their certainty in each existence judgement (e.g., "*Are you very sure or not very sure that dogs are real?*").

Next, children were asked about 13 different endorsed entities in a random order. The experimenter drew a random card from a shuffled deck and presented each item individually to the child. Children were first asked about their familiarity with the specific item (e.g., "*Have you heard about germs*?"). If the child was not familiar with an item, the experimenter immediately proceeded to the next item. If the child was familiar with the item, the experimenter asked about the existence of the entity (to which they could respond with "Yes" or "No") and the follow-up

[2] All of the main and interaction effects reported in the analyses hold when we do not include the scoring of this question in the religiosity index.

question regarding children's certainty in their existence judgement (to which they could respond with "Very sure" or "Not very sure").

We created four ordered response categories based on children's answers to the two questions. They were categorized as either: 1 = *very sure about non-existence*, 2 = *not very sure about non-existence*, 3 = *not very sure about existence* or 4 = *very sure about existence*. In order to analyze relations between parental measures and children's beliefs, we report children's judgements only for the six entities of interest - God, Heaven, Angels, Germs, Oxygen, Electricity.

Parent-Child Unmoderated Conversation

The parent and child participated in the interaction phase in a quiet room in the lab. The experimenter gave the family a stack of 18 cards with a different topic written on each one and invited them to shuffle the deck. Parents were asked to discuss each item, one by one, as they normally would if the topic came up in conversation at home. They were invited to spend a few minutes talking about each entity with their child, but also told that they could skip a card if they were uncomfortable discussing that specific topic (however, all parents opted to talk about the six entities with their children). After providing parents with these basic instructions and answering any potential clarification questions, the experimenter turned on the audio recorder, placed it on the table, and left the room[3].

Note that although parents were invited to talk about 18 entities in total, to allow for appropriate comparisons across the parent and child measures, we focus on the dyad's discussion of the three high-consensus religious (God, Heaven, Angels) and three high-consensus scientific (Germs, Oxygen, Electricity) entities.

[3] One family participated in this phase at home and received identical written instructions. The only difference in the protocol for home participation was that parents, rather than the experimenter, had to operate the audio recorder provided to them.

Coding of Parental Testimony

Parent-child interactions were transcribed and verified for accuracy by trained research assistants. The entirety of the conversation about each entity was transcribed, and transcription was only discontinued when the dyad began to pursue irrelevant lines of discussion (for, e.g., when the parent addressed children's behavioral issues or physiological needs during the conversation).

We acknowledge that parental talk was part of a conversation co-constructed with their child. However, we decided to code the content of parental statements only because our primary goal was to shed light on the critical role of parental testimony in the development of children's beliefs. To confirm our assumptions about the importance of parental input in such conversations, the first author reviewed and categorized the parent-child interaction style of each dyad according to a coding scheme developed by Callanan et al. (2020). All but 4 dyads were best characterized by the parent-directed style category (the remaining dyads fell into the jointly-directed category).

We did not code parents' direct repetitions of their child's statement or their questions and general prompts. Yet, we did code parents' rhetorical and explicitly leading questions because, from our perspective, they serve a similar communicative purpose to statements, namely to convey and invite the endorsement of specific claims. In this way, our coding captured all claims that were initiated, or elaborated upon, by the parent and that *directly* communicated information about the entity to the child.

Our coding scheme was based on previous research showing subtle differences in the way parents talk about scientific entities relative to other endorsed entities (Canfield & Ganea, 2014). First, we conducted a fine-grained coding of parents' use of modulations of assertion

(e.g., *"to think", "to believe", "to figure", "to feel like", "to suppose", "to wonder"*) and other lexical cues to uncertainty (e.g., use of "*maybe", "might", "perhaps", "possibly", "could be", "kind of*") when discussing each entity. We counted the total number of uncertainty terms that were present in parental statements. For example, a parent who was discussing the topic of Angels and said: "*But supposedly they have wings and they are kind of like a ghost in a way, I guess*" was coded as producing three cues to uncertainty, i.e., use of "supposedly", "kind of" and "guess", within that statement.

We coded whether or not parents mentioned variation in people's beliefs when talking about each entity of interest. For example, a parent who said: "*But a lot of religions believe in Heaven. I don't think Judaism really believes in Heaven*" was coded as mentioning belief variation when discussing the topic of Heaven with their child.

Lastly, we coded whether or not a parent explicitly talked about the reality status of the entity ("*God does not exist*", "*Oxygen exists*", "*We should believe in Heaven*", "*Germs are real*") and the direction of that endorsement (1 = *Endorsed non-existence,* 2 = *Endorsed existence*).

Reliability

The first author and a trained research assistant coded all of the transcripts. A second research assistant, unaware of the predictions of the present study, performed reliability coding on approximately half of the transcripts (n = 12 families). Reliability coding was high for the total number of uncertainty terms produced when discussing the three religious entities (intraclass correlation coefficient (ICC) = .95, 95% CI [.91, .98]) and the three scientific entities (ICC = .97, 95% CI [.94, .98]). Coders agreed on 100% of cases for whether or not parents mentioned belief variation in the domain of science, and agreement was almost perfect in the domain of religion (97% agreement, κ = .94). Agreement was also high for the coding of reality

status statements for the religious (86% agreement, $\kappa = .72$) and scientific entities (92% agreement, $\kappa = .72$)[4]. Any disagreements were resolved by discussion between the authors.

Results

Preliminary Analyses

Using mixed-effects models, we found that child gender did not have any effects on children's existence judgements, on the time spent talking about each topic nor on the coded features of parent talk (all *p*'s > .31). We do not consider this variable further.

On average, parents spent approximately 1 min and 17 s discussing the individual scientific entities ($M = 70.14$ s, $SD = 44.73$, range = 5 s - 192 s) and 1 min and 22 s discussing each of the religious entities ($M = 72.36$ s, $SD = 38.76$, range = 8 s -193 s). There were no main effects of Domain or Parent Religiosity on the time spent discussing the six entities (both *p*'s > .70). We also checked whether the length of time that parents conversed with their child was associated with the three coded linguistic cues. There was no effect of total time for the mention of belief variation or reality status (both *p*'s > .29). There was, however, a main effect of total time for the number of uncertainty terms, $\beta = 2.47$, $SE = 5.96$, $p < .001$; the longer parents spent discussing an entity, the greater the number of uncertainty cues they produced. Accordingly, we retained this variable in the model investigating the effect of the main predictors on parents' use of uncertainty cues (see "Exploring the Transmission of Beliefs in the Existence of the Entities" below). All of the data files are openly available at https://osf.io/a7mrk/?view_only=187f0c9a3a8748c1b604c8e7f3bd1282

[4] Despite high agreement (92%) for the coding of reality status statements in the domain of science, the reliability test produced a lower kappa statistic score than expected ($\kappa = .72$). This result is likely explained by an imbalance in the coding distribution. Specifically, a substantial number of agreed upon cases fell under one modality (i.e., parents did not mention the reality status of the scientific entities).

Parents' Confidence in the Existence of the Entities

We first examined parental beliefs in the existence of the scientific and religious entities. One parent did not complete this section of the questionnaire and is not represented in the following analyses. Table 2 presents the mean ratings of each phenomenon, ranging from 1 = *Definitely does not exist* to 7 = *Definitely exists*. We compared the average existence score for each entity to the mid-point of the scale (i.e., 4) to check whether parents' ratings were significantly above or below this assumed level of belief neutrality. As shown, parents confidently believed in the existence of the scientific entities. We were unable to run the appropriate one sample *t*-tests for Germs and Electricity because all of the parents gave the highest existence score for these entities. By contrast, the mean ratings for the religious entities did not significantly differ from the assumed neutral mid-point, with considerable variation across parents around this mid-point, indicating that the sample held diverse beliefs about the existence of God, Heaven and Angels.

Table 2. *Parents' mean existence scores, and comparisons to the neutral mid-point of the scale, for the unobservable scientific and religious entities.*

	Mean (SD)	*t*
Science		
Germs	7.00 (.00)	n/a
Oxygen	6.96 (.20)	71.00***
Electricity	7.00 (.00)	n/a
Religion		
God	4.29 (2.66)	.54
Heaven	4.08 (2.47)	.17
Angels	4.12 (2.51)	.25

***$p < .001$

We then explored the effect of religiosity on parents' confidence in the existence of the unobservable entities using a mixed-effects linear regression model with the *lmer* function of the *lme4* package in R statistical software (version 3.4.2). The model included Domain (science, religion; categorical predictor), Parent Religiosity (index score ranging from 0-3; continuous predictor), and their interaction term as fixed effects, and family ID as a random effect to account for within-subject variability in ratings of the individual entities.

Confirming the pattern in Table 2, the final model revealed a significant main effect of Domain, $\beta = 5.26$, $SE = 0.25$, $p < .001$, demonstrating that parents were more confident in the existence of the scientific entities, as compared to the religious entities. There was also a significant main effect of Parent Religiosity, $\beta = 1.65$, $SE = 0.15$, $p < .001$, and a significant Domain x Parent Religiosity interaction, $\beta = -1.66$, $SE = 0.13$, $p < .001$. To follow up on this significant interaction, we conducted separate mixed-effects linear regression models within each domain: there was no effect of Parent Religiosity on parents' ratings of the three unobservable scientific entities. However, there was a significant main effect of Parent Religiosity on ratings in the domain of religion, $\beta = 1.65$, $SE = 0.27$, $p < .001$, revealing a positive association between the level of parental religiosity and confidence in the existence of various religious phenomena (see Figure 1, left panel).

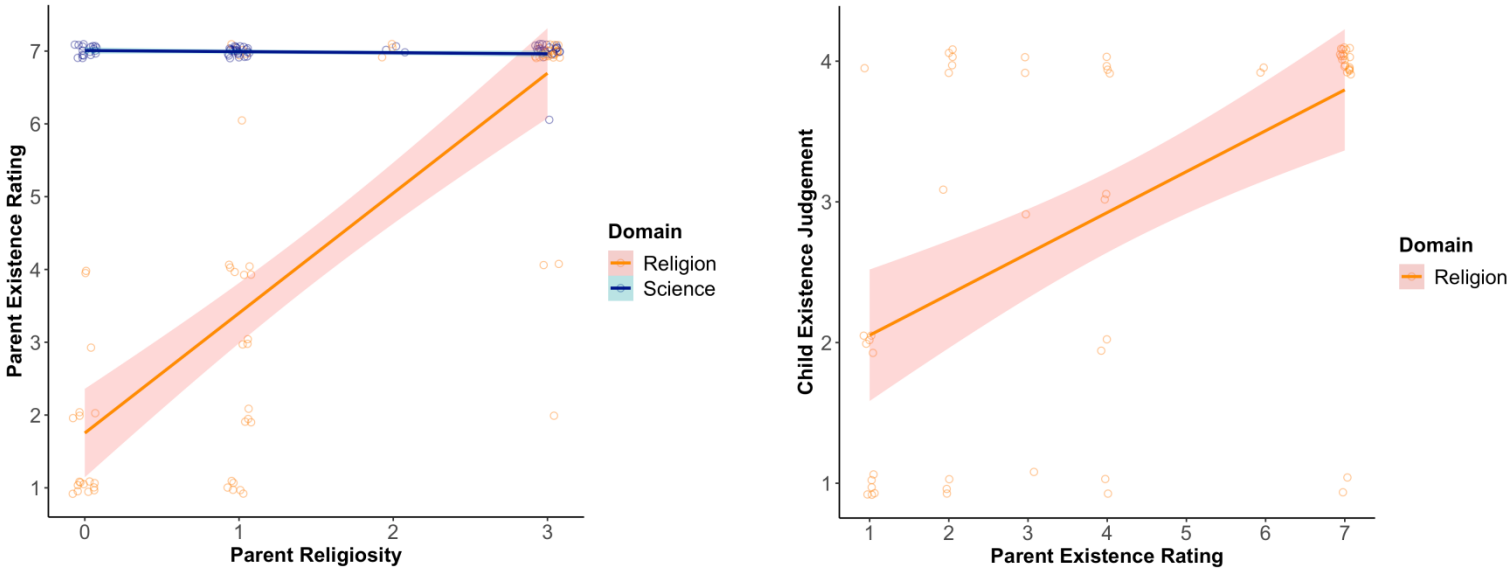


Figure 1. The relations between parental religiosity and existence ratings of the unobservable entities by domain (left panel) and between parental existence ratings and children's existence judgements in the domain of religion (right panel).

Children's Confidence in the Existence of the Entities

Recall that before children gave their existence judgement about each entity, the experimenter asked if they were familiar with the entity in question. If a child was not familiar with an entity, they were not asked to provide an existence judgment. If they were familiar with the entity, they were asked to provide both an existence and a certainty judgement. Table 3 presents the number of children who were familiar with each entity and the distribution of children's judgements across the four existence categories (1 = *very sure about non-existence*, 2 = *not very sure about non-existence*, 3 = *not very sure about existence* or 4 = *very sure about existence*) in both domains.

Table 3. *Children's existence judgements for the unobservable scientific and religious entities.*

	Heard of entity? (out of total *N*)	**Very sure of existence**		**Not very sure of existence**		**Not very sure of non-existence**		**Very sure of non-existence**	
		N	%	*N*	%	*n*	%	*n*	%
Science									
Germs	23/25	21	91.3	1	4.4	1	4.4	0	0.0
Oxygen	19/25	19	100.0	0	0.0	0	0.0	0	0.0
Electricity	25/25	25	100.0	0	0.0	0	0.0	0	0.0
Religion									
God	22/25	15	68.2	2	9.1	1	4.6	4	18.2
Heaven	17/25	14	82.4	1	5.9	1	5.9	1	5.9
Angels	20/25	11	55.0	1	5.0	3	15.0	5	25.0

To explore the hypothesized differences in children's existence judgements by domain, as well as the potential relation between parent and children's existence beliefs, we conducted mixed-effects ordinal logistic regression models with the *clmm* function of the *ordinal* package in R statistical software (version 3.4.2). The outcome variable was treated as an ordered categorical variable. The model included Domain (science, religion; categorical predictor), Parent Existence Beliefs (score ranging from 1-7; continuous predictor), and their interaction term as fixed effects, and family ID as a random effect to account for within-subject variability.

Confirming the pattern depicted in Table 3, the results revealed a main effect of Domain, $\beta = 4.33$, $SE = 2.07$, $z = 2.09$, $p = .036$, indicating that, similar to the adults, the children were more confident in the existence of the scientific as compared to the religious entities. There was also a significant positive main effect of Parent Existence Beliefs on children's existence judgements, $\beta = 1.01$, $SE = 0.32$, $z = 3.22$, $p = .001$, but the final model with the interaction term could not be tested (most likely due to the low variability of children's responses in the domain of science).

To check this explanation for the model error, we conducted separate regression models in each domain, but were not able to test the model for children's scientific judgements. In the domain of religion, there was a significant main effect of Parent Existence Beliefs: the children of parents who expressed more confident beliefs in the religious entities were more likely to endorse the existence of the religious entities, $\beta = 1.07$, $SE = 0.40$, $z = 2.72$, $p = .007$, OR = 2.93, 95% CI = [1.35, 6.34] (see Figure 1, right panel).

In sum, the results thus far have demonstrated that parents and children were more confident in the existence of the unobservable scientific phenomena compared to the unobservable religious phenomena. The strength of parental religious views was positively related to their belief in religious entities frequently endorsed by Christian communities in the United States. Further, parental existence beliefs significantly predicted their children's beliefs in the religious domain.

In the next section, we explored the potential role of parental testimony in the transmission of ontological beliefs. First, we checked whether the coded linguistic cues varied across domain and based upon the speaker's personal stance towards religion. Second, we tested the relations between the nature of parental testimony and their child's judgements.

Exploring the Transmission of Beliefs in the Existence of the Entities

The Nature of Parental Testimony by Domain and Religiosity

Using mixed-effects linear and logistic regression models, we examined the influence of Domain and Parent Religiosity, and their potential interaction, on parents' use of *uncertainty* terms (continuous variable), whether or not they mentioned *variation in people's beliefs* (categorical variable) and whether or not they explicitly mention the *reality status* of each entity

(categorical variable). Family ID was entered as a random effect in the main models to account for within-subject variability in the discussion of the six entities.

The mean number of uncertainty terms that parents produced when discussing each entity is presented in Figure 2 (left panel). The results of a mixed-effects linear regression model revealed a main effect of Domain, $\beta = -3.82$, $SE = 0.69$, $p < .001$: parents communicated more uncertainty when discussing the three religious entities compared to the three scientific entities[5]. There was also a significant main effect of Parent Religiosity, $\beta = -0.87$, $SE = 0.28$, $p = .002$, and Domain x Parent Religiosity interaction effect, $\beta = 0.94$, $SE = 0.36$, $p = .01$. We conducted separate follow-up linear regression models in each domain. The results revealed a significant main effect of Parent Religiosity in the domain of religion, $\beta = -0.95$, $SE = 0.40$, $p = .029$: controlling for time spent talking about the entities, the more religious parents produced fewer cues to uncertainty when talking about the religious entities. Thus, the parents reporting higher levels of religiosity talked about the religious and scientific unobservables in a similar manner – with few cues to uncertainty. There was no effect of Parent Religiosity in the domain of science (see Figure 2, right panel).

[5] As noted in the "Preliminary Analyses" subsection, the model for parents' use of uncertainty cues included the control variable of time spent (entered in seconds; continuous variable) discussing an entity.

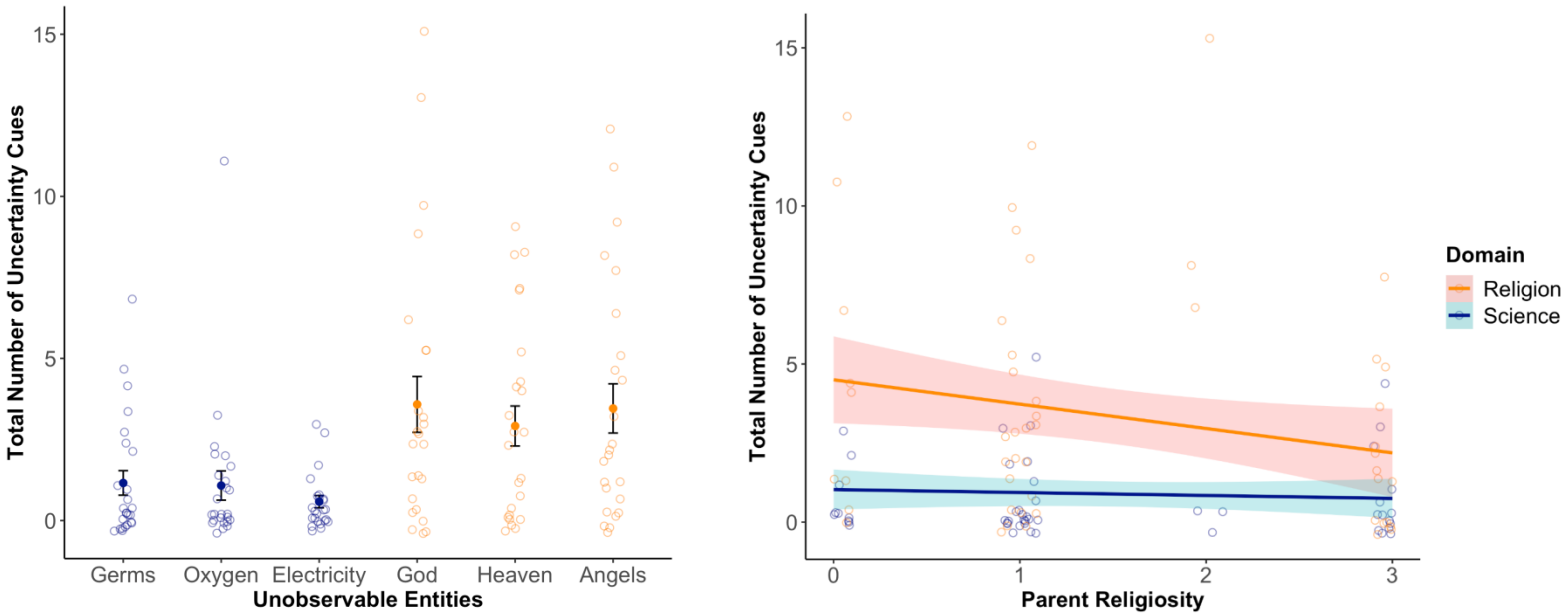


Figure 2. The total number of uncertainty cues that parents produced in conversation with their children as a function of entity type (left panel) and the religiosity index (right panel).

The proportion of parents that mentioned variation in beliefs about the respective entities is presented in Figure 3 (left panel). As depicted, none of the parents mentioned variation in beliefs in the domain of science. Hence, we only examine the potential influence of Parent Religiosity on this feature of parental testimony in the religious domain. The results of a mixed-effects binomial logistic regression model revealed a main effect of Parent Religiosity such that with a unit-increase in the religiosity index, parents were less likely to refer to belief diversity in the religious entities, $\beta = -1.22$, $SE = 0.47$, $z = -2.59$, $p = .01$, OR = 0.30, 95%, CI = [0.12, 0.74].

The proportion of parents that mentioned the reality status of the entities is depicted in Figure 3, right panel. The results of a mixed-effects binomial logistic regression model revealed only a main effect of Domain, $\beta = -2.09$, $SE = 0.50$, $z = -4.17$, $p < .001$, OR = 0.12, 95%, CI = [0.05, 0.33], showing that parents were more likely to explicitly discuss the reality status of entities in the domain of religion. There was no effect of Parent Religiosity nor any interaction between variables.

Of the parents who mentioned reality status for the three religious entities, 45.7% of the individual responses endorsed existence, 31.4% of responses endorsed non-existence, and 22.9% of individual responses expressed both existence and non-existence (for e.g., "I'm not sure if that is real or not"). Of those who explicitly discussed the reality status of the three scientific entities, 91.7% of responses endorsed existence and .08% (n = 1 parent) endorsed non-existence.

The distribution of responses clearly indicated that, of the parents who explicitly discussed reality status in each domain, there was a higher proportion of affirmations for the three scientific entities (91.7% of responses; all but one response endorsed existence) compared to the three religious entities (45.7% of responses). Accordingly, we proceeded to conduct regression models to probe the effect of Parent Religiosity on the nature of parent endorsements separately within each domain. The model could not be tested in the domain of science due to the limited variance in the pattern of endorsement. For responses regarding the religious entities, we opted to collapse the mixed responses (i.e., the responses that expressed both existence and non-existence or when the parent was unsure of an entity's existence) with the non-existence category for the purpose of analysis[6]. There was a significant main effect of Parent Religiosity on whether parents explicitly affirmed the existence of the religious entities, $\beta = 1.95$, $SE = 0.66$, $z = 2.97$, $p = .003$, OR = 7.01, 95%, CI = [1.94, 25.33]. With a unit-increase in the religiosity index, parents were more likely to explicitly endorse the existence of the religious entities rather than question or explicitly negate their existence.

[6] The rationale for this decision was to allow us to appropriately equate the explicit existence statements for the religious entities with those for the scientific entities (e.g., "God is real", "Germs are real") in our final models that explored the broader effects of such claims on children's ontological judgements.

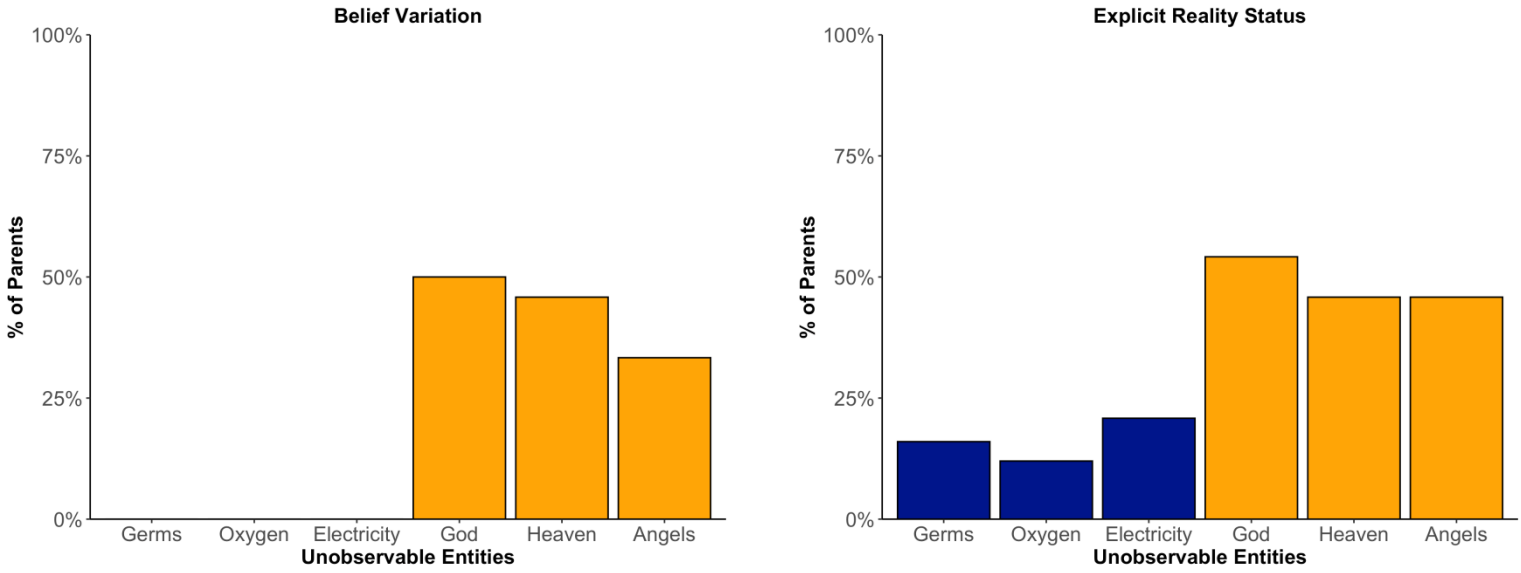


Figure 3. The percentage of parents that discussed variation in people's beliefs (left panel) and explicit reality status (right panel) as a function of entity type.

Relations between Parental Testimony and Children's Existence Judgements

In the final set of analyses, we explored the effect of parental testimony on children's existence judgements (ordinal variable) using a series of mixed-effects ordinal logistic regression models. Critically, we checked whether the pattern of testimony - based on uncertainty cues, references to belief variation, and explicit reality status - accounted for significant variance in children's confidence in the existence of the unobservables, irrespective of domain type and religious background. We reasoned that any observed relations would provide evidence that young children might rely on the presence (or absence) of the coded parental linguistic markers when constructing their beliefs about the entities.

The first model revealed a significant main effect of uncertainty cues, $\beta = -.20$, SE = 0.07, $z = 2.99$, $p = .003$, OR = 0.82, 95% CI = [0.71, 0.93]: fewer cues to uncertainty in parental testimony significantly predicted children's confidence in the existence of the entities. Separate models also yielded main effects of references to belief variation, $\beta = -3.59$, SE = 0.81, $z = -4.45$,

$p < .001$, OR = 0.03, 95% CI = [0.01, 0.13] and reality status, $\beta = -1.24$, SE = 0.56, $z = -2.15$, $p = .032$, OR = 0.29, 95% CI = [0.09, 0.90]. When US parents *did not* mention variation in community beliefs, and *did not* explicitly discuss the reality status of the entity, children were more likely to be confident in their existence..

We also checked the potential effect of reality endorsement among the parents who explicitly discussed the real or fictional nature of the entity. This model revealed a significant main effect, $\beta = 9.68$, SE = 4.38, $z = 2.21$, $p = .027$, suggesting that the children of the parents who endorsed (as compared to those who expressed doubt about or explicitly denied) the reality of the entities were more likely to endorse their existence.

Discussion

Taken together, these results provide compelling evidence to support the hypothesis that subtle variation in adult testimony surrounding scientific and supernatural unobservable entities contributes to children's developing beliefs in their existence. Aligning with previous research in the US and other cultural contexts (Clegg et al., 2019; Cui et al., 2019; Davoodi et al., 2018; Davoodi et al., 2020; Harris et al., 2006; Guerrero et al., 2010), parents and 5- to 7-year-old children were more confident in the existence of the scientific entities in comparison to religious entities. Parents who scored higher on the religiosity index professed more confidence in the existence of the religious phenomena, and their beliefs predicted their children's existence judgements in the domain of religion.

In a conceptual replication of Canfield and Ganea (2014), we found consistent cross-domain differences in the ways in which parents talked about the entities with their children. Parents conveyed more doubt, were more likely to recognize a lack of consensus in community beliefs and explicitly mention (as well as question or deny) the reality status of the religious

entities, compared to the scientific entities. In a direct extension of the earlier study, our findings revealed an association between parental epistemic views and their use of particular cues to existence: less religious parents expressed more uncertainty, and often mentioned disparate sources of belief, when talking about the religious concepts. Another way to characterize these findings is that the parents who identified as more religious spoke about unobservable entities in a similar fashion across the domains of science and religion; this pattern most likely reflects their confidence in the existence of both types of entities.

Of the dyads who explicitly discussed reality status, the parents who reported higher levels of religiosity were more likely to endorse the religious entities. Yet, we did not find that parental religiosity was associated with the prevalence of parent-child discussions about reality status – only that parents were generally less likely to converse about the existence of scientific entities. This provides some support for the prediction that adults might not deem it relevant to bring up the ontological status of entities in conversation when there is wide societal consensus that the entity exists (Harris et al., 2006).

Importantly, in a substantive contribution to the body of research exploring testimony as a potential mechanism through which children learn about typically unobservable causal phenomena (Harris & Corriveau, 2014; Harris & Koenig, 2006), the present results showed that the coded linguistic variation in parental talk was significantly associated with the strength of children's beliefs in the individual entities. The children of the parents who produced fewer uncertainty cues, were less likely to discuss belief variation in the wider community, or make explicit references to reality status, expressed greater confidence in their ontological judgements. Further, among the dyads who discussed reality status, children were more confident in their judgements when their parent explicitly affirmed the entity's existence.

Why might children rely on the presence (or lack thereof) of cues to ontological status when reasoning about the existence of unobservables? Experimental studies suggest that the ability to gauge important epistemic characteristics from the claims of other people emerges early in development (see Harris et al., 2018; Mills, 2013 for reviews). For example, 4- and 5-year-olds are less likely to learn and seek information from an adult informant who is hesitant about their knowledge of a subject, as compared to a confident informant (Einav & Robinson, 2010; Jaswal & Malone, 2007; McLoughlin, Finiasz, Sobel, & Corriveau, 2020; Sabbagh & Baldwin, 2001). Furthermore, children in this age range are sensitive to consensus information, and show preferences for beliefs held by the consistent majority in their environment (Chen, Corriveau, & Harris, 2013; Corriveau & Harris, 2010). These experimental findings help to make a plausible interpretation of the patterns observed in the current study. Children who are exposed to adult testimony that conveys uncertainty in the existence of a particular phenomenon, as well as subjectivity or diversity in others' beliefs, might become dubious about their own judgements. By comparison, exposure to testimony that is devoid of such cues could highlight the consensus regarding the presence of a given unobservable entity in a child's everyday life.

Contrary to past empirical studies (e.g., Dore et al., 2018; Woolley et al., 2011), we found that explicit belief claims were not a necessary feature of testimony for supporting children's judgements (see also Dore, Jaswal, & Lillard, 2015 for complimentary findings with older children). Nevertheless, further inspection of the coded responses showed that the children of parents who did articulate their belief in an entity, compared to the parents who were skeptical about or negated its existence, were more confident in their ontological judgements. Future work is needed to discern the specific influence of explicit claims on children's beliefs in the unobservable. Though the present results draw attention to the possibly powerful influence of

discussions involving belief variation surrounding an entity's existence, future research should isolate, and compare, the impact of the various linguistic cues and claims used by parents to transmit information about the ontological status of unobservable entities to their children.

The current study opens up many other interesting routes for future research. We focused our investigation on beliefs and conversations about topics that tend to be widely endorsed in the United States. For instance, even the religious entities are highly endorsed by majority religious communities. One important question is how parents discuss beliefs in unobservable agents and causal processes that are more contentious in this culture (e.g., climate change), less widely endorsed across households (e.g., reincarnation) or only in special contexts (e.g., Santa Claus, Tooth Fairy). Exploring the social learning mechanisms for beliefs that garner inconsistent verbal claims across different private and public settings would be useful in teasing apart the socio-cultural influences on children's conceptual development.

Moreover, and consistent with calls in the developmental science community (e.g., Nielsen, Haun, Kärtner, & Legare, 2017), future work should examine the role of adult testimony in the transmission of beliefs in the unobservable in cultures beyond the United States. Specifically, the results of the present US sample suggest that cues to uncertainty, belief variation, and discussion of reality status are related to children's ontological judgments of familiar entities. It would be vital to explore whether these linguistic markers are prevalent, and related to children's developing beliefs, in contexts where the cultural endorsement of unobservable concepts – for example, religious figures - is more or less homogenous in the community.

Finally, we focused on the testimony that children hear within their nuclear family unit. Yet as children develop, they have access to interactions with extended family, peers and other

members of their cultural groups. Indeed, there is some evidence that US parents conceive of their influence on the development of children's religious beliefs in terms of a combination of sources (e.g., grandparents, community institutions; McLoughlin et al., in press). Future work should expand the scope of our investigation to social interactions outside of the home. This endeavor could be especially informative for understanding the trajectory of beliefs in the unobservable throughout middle childhood.

In conclusion, the current study offers a window into how beliefs about unobservable scientific and religious entities are transmitted via subtle linguistic cues in parental testimony. This research replicates previous studies showing that adults and children often hold similar beliefs about unobservable and endorsed beings (Cui et al., 2019; Davoodi et al., 2018; Harris et al., 2006), and that parents talk differently about these entities (Canfield & Ganea, 2014) but takes a substantial step forward to emphasize testimony as one of the primary sociocultural mechanisms through which such beliefs develop. Our findings have implications for understanding the development of belief in the ontological status of invisible agents and processes in childhood.

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