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Brief Report

The impact of counter-perceptual testimony on children's categorization after a delay

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ABSTRACT

When preschoolers are presented with a label for an entity that conflicts with its appearance, they sometimes rely on the new label rather than on the entity's appearance to categorize the entity and to infer its properties. We examined whether children's learning from such claims is short-lived or long-lasting and whether the persistence of their learning depends on the degree of fit between those claims and the available perceptual evidence. Children aged 3–5 years ($N = 71$) were asked to categorize hybrids. These hybrids combined 75% of the features from one animal or object with 25% of the features from a different animal or object. After categorizing each hybrid, children heard an informant provide a contrary label. Immediately after they were provided with this new label, children often recategorized the entities accordingly, especially when the label matched the hybrid's predominant features. Children's endorsement of the informant's label proved to be long-lasting when it matched the hybrid's predominant features, typically persisting even after 5 weeks. In contrast, children's endorsement often faded over time when the informant's label did not match the hybrid's predominant features. Overall, children were more skeptical of testimony that was more discrepant with the perceptual evidence available to them, and they were less likely to continue endorsing it after a delay. The findings have implications for our understanding of how children eventually come to represent and believe in counter-perceptual and counterintuitive concepts.

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Introduction

Counterintuitive and counter-perceptual aspects of the biological and physical world are, by their nature, not readily apparent. Thus, when learning about these natural phenomena, children must rely on the testimony of others (Harris & Koenig, 2006; Lane & Harris, 2014). Indeed, testimony does appear to be an effective means of acquiring some of these concepts. In an influential set of studies, Gelman and Markman (1986) and Gelman and Markman (1987) showed that when preschoolers are presented with a label for an animal that conflicts with several of the animal's physical features, they often rely on that label rather than on its appearance to assign the animal to a category and to make inductive inferences about its properties. However, children do not blindly trust what they are told; their endorsement of counter-perceptual testimony is moderated by the fit between the claim and the perceptual evidence that is available to them. Young children are more willing to defer to an informant's claim when it is supported by (at least) some perceptual evidence than when it completely conflicts with that evidence (Bernard, Harris, Terrier, & Clément, 2015). Yet, it is noteworthy that, even in cases where entities are clearly discrepant from the informant's label, some young children will at times endorse that label (e.g., Lane, Harris, Gelman, & Wellman, 2014).

Children's endorsement of counter-perceptual testimony appears to reflect belief change rather than compliance given that children will subsequently pass on counter-perceptual labels to a naive experimenter (Jaswal, Lima, & Small, 2009). However, children's acceptance of counter-perceptual testimony has been examined only at brief delays. For example, in Jaswal et al. (2009), children were asked to teach a naive experimenter only minutes after receiving an informant's testimony (see also Chan & Tardif, 2013). Thus, we do not yet know whether such counter-perceptual testimony has only an immediate impact or a long-term impact on children's categorization. The current study was designed to address this question and to explore whether any long-term impact of such testimony depends on its fit with the perceptual evidence. Given that children have better recall for story details that are less counterintuitive rather than more counterintuitive (Banerjee, Haque, & Spelke, 2013), we hypothesized that over time children would be more likely to continue endorsing testimony that was less discrepant rather than more discrepant with the visual evidence. This would partially explain why children's acquisition of counter-perceptual ideas and concepts is so difficult; even when children endorse such ideas and concepts immediately following instruction, their endorsement may be short-lived as they struggle to represent and encode the testimony into memory.

Thus, we asked two questions about the impact of the fit between the testimony and the visual evidence on children's categorization. First, we asked whether children are more likely to immediately endorse counter-perceptual testimony that is mostly consistent rather than only moderately consistent with the perceptual evidence. Second, we asked whether the *persistence* with which children endorse counter-perceptual testimony also depends on the fit between the label and visual features.

To address these questions, we asked 3- to 5-year-olds to categorize hybrid pictures of animals and objects (e.g., Bernard et al., 2015; Jaswal, 2004; Jaswal & Markman, 2007). These hybrids take 75% of their visual features from one animal or object and 25% of their visual features from a different animal or object (Jaswal et al., 2009). Immediately following children's initial categorization of each hybrid, an informant gave children testimony that ran counter to their initial judgment. Because children often choose to categorize these hybrids according to their predominant features, we can assess whether children are more likely to defer to an informant if the informant's classification of a hybrid is mostly consistent with the hybrid's visual features (because children initially selected the moderately consistent label) or only moderately consistent with the hybrid's visual features (because children initially selected the mostly consistent label). By asking children to recategorize the hybrids after a delay and varying the length of this delay between children, we can also answer our second research question: Is the persistence of children's endorsement moderated by the fit between the testimony and the hybrid's visual features?

Although previous research has not examined the long-term impact of counter-perceptual testimony, prior work does indicate that informant characteristics moderate children's encoding of testimony (Sabbagh & Shafman, 2009). As well, young children remember the characteristics of informants

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(e.g., their accuracy) after a delay and continue to use that information in deciding which informants to trust (e.g., Corriveau & Harris, 2009). Thus, it is possible that an informant's epistemic characteristics have both an immediate effect and a lingering effect on children's endorsement of claims made by that informant. Given this possibility, we presented children with two types of informants: a mother and a teacher. Each informant provided testimony about two object hybrids and two animal hybrids. We selected a teacher and a mother as informants because preschoolers understand teachers to be particularly knowledgeable (Cimpian & Markman, 2008; Ziv & Frye, 2004), and in some cases children endorse testimony from more knowledgeable experts over testimony from their own mothers (Boseovski & Thurman, 2014). This design allowed us to explore whether preschoolers place greater trust in one of these two types of informants immediately after receiving testimony and also after a delay.

Method

Participants

Children ($N = 71$) were recruited from three preschools in Boston, a city in the northeastern United States (36 girls; $M_{age} = 4.81$ years, range = 3.48–5.94). Parents reported having completed either some high school (13%), high school (14%), some college (13%), college (22%), or graduate school (34%); the remaining 4% did not report. Children were described by their parents as either White (39%), Hispanic (38%), Black (7%), Asian (3%), or other (13%). The surveys were completed by the children's mothers (87%), fathers (6%), or unspecified caregivers (8%). An additional 8 children were recruited but not included in analyses because they did not complete the delayed testing session.

Procedure

Two iPads were placed in front of the child, each displaying a picture of one of the two informants in front of a blue background. Both of the informants were women in their mid- to late 30s and wore similar clothing. The experimenter said, "I know these two women. This woman is a teacher. She teaches children the same age as you. This woman is a mom. She has a boy/girl the same age as you." Whether the teacher or the mother was introduced first and whether Informant 1 or Informant 2 was identified as the teacher or the mother were counterbalanced across children. Next, as memory checks, children were asked to point to the teacher and to the mother. All children passed these memory checks. Children were then told, "We're going to look at some animals and objects. Then, one of these two women will tell you about them. After that, I will ask you some questions."

Children were shown four laminated hybrid animal pictures and four laminated hybrid object pictures, each 8.5 by 11 inches (see Supplementary Online Material [SOM] 1). These hybrids, used in prior research, combine 75% of the features from one animal or object with 25% of the features from a different animal or object (Bernard et al., 2015; Corriveau & Harris, 2009; Jaswal, 2004; Jaswal & Markman, 2007). For example, the cat–dog is composed of 75% cat features and 25% dog features. We conducted pilot testing with these hybrids to create two sets (detailed in SOM 1). Each set was composed of two animals and two objects.

Before testing each child, the experimenter shuffled the eight pictures to randomize the order of their presentation. Children were shown the pictures one at a time and told, "I am going to show you a picture. Do you think this is a [75% label] or a [25% label]?" The order of the labels was counterbalanced across children. After children had categorized the hybrid by selecting a label, the experimenter said, "Let's ask the [teacher/mother]," and played the video of the informant naming the hybrid. The informant always stated that the hybrid was a different entity from what children believed. For example, if children stated that the cat–dog was "a dog," the informant in the video would say (holding the same picture of the cat–dog presented to children), "This is a cat." Conversely, if children stated that the cat–dog was "a cat," the informant in the video would say, "This is a dog."

For each trial, children received testimony from only one informant. The mother provided information about four hybrids, and the teacher provided information about four hybrids. For half

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of the children within each age group, the teacher provided information about the hybrids in Set 1 and the mother provided information about the hybrids in Set 2 (see SOM 1). The reverse was true for the other half of the children within each age group. Because the pictures were presented in a random order, the claims made by a given informant were not blocked (i.e., the informant depended on which item was randomly selected for that set).

Following this testimony, children's receptivity to the informant's alternative categorization was assessed by asking them to make an inference about the hybrid. For example, for the cat–dog, children were asked, "Do you think this animal barks or meows?" Thus, children were asked to make an inference about the hybrid's characteristics—an inference they could base either on their initial categorization or on the subsequent counterclaim made by the informant (SOM 1 includes the inference questions).

To assess whether the testimony that children received influenced their longer-term categorization of the hybrid, children were questioned again in a second test session. The experimenter shuffled the eight hybrid pictures before testing each child to randomize the order of their presentation. Children were shown each picture one at a time and told, "I am going to show you a picture. Do you think this is a [75% label] or a [25% label]?" The order of the labels was counterbalanced across children. Children were not reminded that they had seen the pictures before, but the experimenter was familiar to them from the initial test session. Children were retested between 4 and 44 days (M = 22 days, SD = 14 days; for a stem and lead plot of this distribution, see SOM 2). In SOM 6, we provide plots of our raw data along with detailed information about the number of data points included at each time point.

Results

We first examined whether children were more likely to accept the informant's counter-testimony when it was mostly (i.e., 75%) consistent rather than only moderately (i.e., 25%) consistent with the perceptual evidence. We then turn to our second question of whether children's continued endorsement of the informant's label was moderated by the fit between the testimony and the hybrid's features.

All analyses employed multilevel logistic regression for two reasons. First, multilevel regression can account for the repeated-measures study design (i.e., children were asked about eight items on two successive occasions). Second, logistic regression can model dichotomous data (in this case the use of one label over another) and, therefore, is the most appropriate statistical model. We used Stata 14's "xtlogit" command to conduct these analyses. Regression coefficients are displayed as odds ratios.

Analyses of children's endorsement of the experimenter's counter-testimony in the first and delayed test sessions revealed no main effect of, or interactions with, participant's gender, item type (animal vs. object), informant type (mother vs. teacher), or participant's age (calculated as days/365). Thus, analyses are reported without these covariates. Regression models with these variables included as controls are included in SOM. Post hoc analyses are general linear hypothesis (GLH) tests.

Endorsement of counter-testimony in the first session

As expected, children initially categorized the majority of the hybrids, with a mean of 5.37 of 8 items (SD = 1.47, range = 3–8) or 67%, in terms of their predominant visual features. To assess whether children were more likely to defer to the informant's subsequent counter-testimony when making category-based inferences if that testimony was mostly (i.e., 75%) consistent rather than only moderately (i.e., 25%) consistent with the perceptual evidence, we coded children's inferences in terms of how often they reflected deference to the label provided by the informant. Thus, children received 1 point for each inference that was consistent with the informant's label (rather than their own initial categorization).

Children deferred 67% of the time when the informant's label did not match most of the hybrid's visible features and 77% of the time when it did, a marginally significant difference, odds ratio (OR) = .63, z = 1.80, p = .07, 95% confidence interval (CI) [0.38, 1.04] (see SOM 3 for full regression table).

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Thus, children frequently deferred to the informant's label rather than sticking to their initial categorization, but they were somewhat less likely to do so when that label clashed with most of the hybrid's features.

Endorsement of counter-testimony in the second (delayed) session

To assess the longer-term influence of the informant's counter-testimony on children's categorization of the hybrids, we coded whether children used the informant's label rather than their initial categorization when they were retested. We present two sets of analyses. In one set, we explored children's use of the informant's label after a delay if the informant's label (rather than the child's label) had been mostly consistent with the hybrid's predominant perceptual features. In the second set, we examined children's use the informant's label after a delay if the informant's label (rather than the child's label) had been mostly *inconsistent* with the hybrid's predominant perceptual features.

In both analyses, we assessed the probability that children used the informant's label (rather than their own initial label) as a function of whether they had either endorsed or rejected the informant's label immediately after first hearing that label. This allowed us to test whether children who initially endorsed the informant's label were significantly more likely to continue using it than children who did not initially endorse it.

When the informant's label was consistent with most of the hybrid's visible features, children who had initially endorsed that label were likely to continue doing so. In addition, children who had not initially endorsed that label remained *unlikely* to do so. Fig. 1 illustrates this stable pattern of responding over delay time.

If children had initially endorsed the informant's label rather than rejecting it, they were 4.1 times more likely to continue endorsing that label during the delayed session, $OR = 4.10$, $z = 3.57$, $p < .001$, 95% CI [1.89, 8.90] (see SOM 4 for full regression table). As is clear in Fig. 1, children's level of endorsement remained constant no matter how many days had elapsed between the first session and the delayed session, $OR = .99$, $z = .51$, $p = .61$, and there was no interaction between the delay time and whether children had initially endorsed or rejected the informant's testimony, $OR = 1.00$, $z = .01$, $p = .99$.

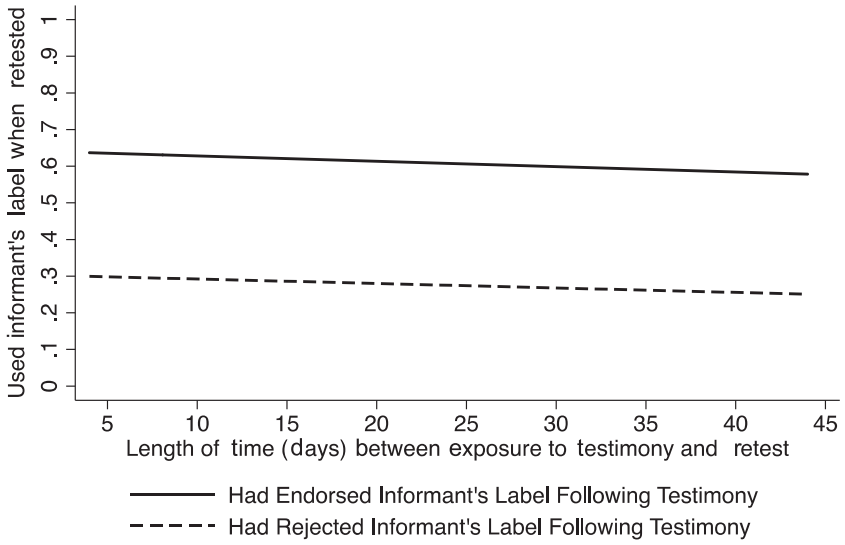

Fig. 1. Probability that children used the informant's label to categorize the hybrid at varying delay lengths, as a function of whether they had initially endorsed or rejected that label, when the informant's label matched the hybrid's predominant features.

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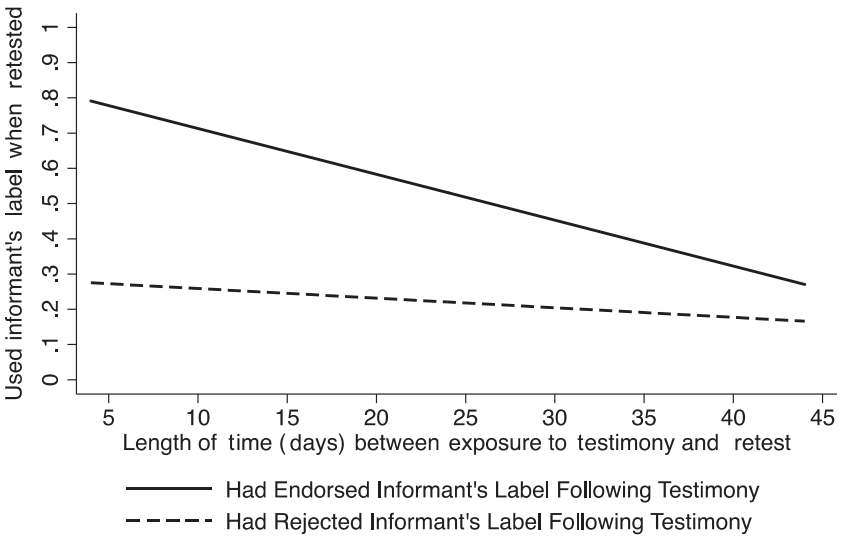

Fig. 2. Probability that children used the informant's label to categorize the hybrid at varying delay lengths, as a function of whether they had initially endorsed or rejected that label, when the informant's label did not match the hybrid's predominant features.

A different pattern emerged when the informant's label was inconsistent with most of the hybrid's features. When children had initially endorsed that label, they were likely to continue doing so at shorter delays but less likely to do so over time. In contrast, when children initially rejected the label, they were unlikely to endorse it at all delay intervals. Fig. 2 illustrates this interaction.

Regression analyses confirmed the presence of a significant interaction between children's initial endorsement or rejection of the informant's testimony and the number of days between tests, $OR = .96$, $z = 1.83$, $p = .07$, 95% CI [0.92, 1.00] (see SOM 5 for full regression table). When children had endorsed the informant's label, they often used that label at retest after a shorter delay but were significantly less likely to do so after a longer delay, $OR = 2.34$, $z = 3.92$, $p < .001$, 95% CI [1.17, 3.50]. In contrast, when children had rejected the informant's label immediately after hearing it, they rarely endorsed the informant's label at retest both after a shorter delay and after a longer delay, $OR = .98$, $z = .82$, $p = .41$. More specifically, if children had endorsed rather than rejected the informant's label immediately after hearing it, the probability that they used that label 1 week later was 48 percentage points higher (75% vs. 27%)—a highly significant difference, GLH test, $\chi^2 = 18.36$, $p < .001$. In contrast, the probability that they used that label 5 weeks later was only 19 percentage points higher (38% vs. 19%)—a much less significant difference, GLH test, $\chi^2 = 6.26$, $p = .01$.

In sum, children's continued endorsement of the informant's label was moderated by the fit between that label and the hybrid's visual features. Children's endorsement of an informant's label that was mostly consistent with the visual evidence was particularly robust; it did not fade with time. In contrast, children's endorsement of an informant's label that was less consistent with the visual evidence faded over time.

Discussion

We examined whether children's learning from an informant's counter-perceptual claim is short-lived or long-lasting and whether the persistence of their learning depends on the degree of fit between that claim and the available perceptual evidence. Following their own categorization, children frequently deferred to the informant's alternative claim, although they were less likely to do so when that alternative claim clashed with most of the stimuli's visible features, a finding that is con-

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sistent with prior research (e.g., Bernard et al., 2015). Children's endorsement of the informant's claim was relatively stable over time when that claim was mostly consistent with the perceptual evidence. However, when it was only modestly consistent with the perceptual evidence, children's endorsement of the informant's label faded over time. Nonetheless, even after 5 weeks, there was still a difference in children's endorsement of the informant's label if children had initially endorsed rather than rejected that label, suggesting that the counter-perceptual testimony was still exerting an influence (albeit a small one) on children's beliefs.

An important implication of this study is that, in some cases, a single exposure to counter-perceptual testimony from an adult is enough to shift some children's beliefs over a month-long period. This extends prior work in two ways. First, it demonstrates that children's endorsement of counterintuitive testimony may reflect sustained rather than temporary belief change (Chan & Tardif, 2013; Jaswal et al., 2009). Second, it reveals that the fit between testimony and perceptual evidence influences not only children's initial acceptance of testimony but also their *continued* acceptance of it. In other words, the findings demonstrate that the inherent difficulty of representing counter-perceptual claims influences not only children's willingness to accept such claims but also their ability to encode such claims into memory. This helps to explain why the acquisition of counter-perceptual concepts and ideas is a protracted process (Lane & Harris, 2014); children's initial acceptance of such ideas does not necessarily lead to stable long-term representations in memory. An important methodological implication of these findings is that researchers should consider assessing the longer-term impact of testimony on children's beliefs; indeed, children may revert to their initial beliefs after a delay.

One objection to our claim that the counter-testimony had a lasting influence is that the experimenter was the same for both testing sessions. It could be argued that children at the delayed test simply responded with what they thought the experimenter wanted to hear or that children simply learned that the counterintuitive labels should be used in the presence of the experimenter. However, this seems unlikely for two reasons. First, the experimenter never gave feedback to children and the experimenter was not the one who had provided children with the testimony. Therefore, it is unlikely that children would infer that the experimenter preferred one label or another. Second, the long-term effect of the testimony differed depending on whether children had initially endorsed or rejected it and also on whether the informant's claim had been consistent or inconsistent with the majority of the hybrid's perceptual features. If children were making categorization decisions only to please the experimenter, it is unlikely that they would exhibit this response pattern.

It is important to emphasize that children were provided with testimony that was only *partially* counter-perceptual. Thus, at a minimum, the testimony was consistent with a minority of the stimuli's perceptual features. It remains to be seen how long-lasting children's beliefs would be following more dramatically counter-perceptual testimony, for example, when informed that an object belongs to a category that is completely different from the one it appears to belong to (e.g., Lane et al., 2014).

We found no difference in children's initial and delayed endorsements of the counter-testimony as a function of informant type (i.e., mother vs. teacher). This suggests that preschoolers perceive mothers and teachers to be equally trustworthy when faced with these entities and labels. Future research should directly assess children's attribution of knowledge to mothers and teachers to confirm this interpretation. Moreover, additional research on children's recall of counter-testimony should be conducted using informants who differ more dramatically in their expertise.

In conclusion, we found that young children tend to initially endorse an informant's labels for novel entities, even when those labels conflict with their own prior categorization. However, the long-term impact of such conflicting testimony depends on its fit with the available perceptual evidence. If the label is consistent with most of that evidence, children continue to endorse it—even after several weeks—with the same probability. However, if the label is inconsistent with most of the visible evidence, its impact on children's belief weakens substantially over time.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jecp.2017.06.006.

References

Banerjee, K., Haque, O. S., & Spelke, E. S. (2013). Melting lizards and crying mailboxes: Children's preferential recall of minimally counterintuitive concepts. *Cognitive Science, 37*, 1251–1289.
Bernard, S., Harris, P. L., Terrier, N., & Clément, F. (2015). Children weigh the number of informants and perceptual uncertainty when identifying objects. *Journal of Experimental Child Psychology, 136*, 70–81.
Boseovski, J. J., & Thurman, S. L. (2014). Evaluating and approaching a strange animal: Children's trust in informant testimony. *Child Development, 85*, 824–834.
Chan, C. C., & Tardif, T. (2013). Knowing better: The role of prior knowledge and culture in trust in testimony. *Developmental Psychology, 49*, 591–601.
Cimpian, A., & Markman, E. M. (2008). Preschool children's use of cues to generic meaning. *Cognition, 107*, 19–53.
Corriveau, K. H., & Harris, P. L. (2009). Preschoolers continue to trust a more accurate informant 1 week after exposure to accuracy information. *Developmental Science, 12*, 188–193.
Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition, 23*, 183–209.
Gelman, S. A., & Markman, E. M. (1987). Young children's inductions from natural kinds: The role of categories and appearances. *Child Development, 58*, 1532–1541.
Harris, P. L., & Koenig, M. A. (2006). Trust in testimony: How children learn about science and religion. *Child Development, 77*, 505–524.
Jaswal, V. K. (2004). Don't believe everything you hear: Preschoolers' sensitivity to speaker intent in category induction. *Child Development, 75*, 1871–1885.
Jaswal, V. K., Lima, O. K., & Small, J. E. (2009). Compliance, conversion, and category induction. *Journal of Experimental Child Psychology, 102*, 182–195.
Jaswal, V. K., & Markman, E. M. (2007). Looks aren't everything: 24-month-olds' willingness to accept unexpected labels. *Journal of Cognition and Development, 8*, 93–111.
Lane, J. D., & Harris, P. L. (2014). Confronting, representing, and believing counterintuitive concepts: Navigating the natural and the supernatural. *Perspectives on Psychological Science, 9*, 144–160.
Lane, J. D., Harris, P. L., Gelman, S. A., & Wellman, H. M. (2014). More than meets the eye: Young children's trust in claims that defy their perceptions. *Developmental Psychology, 50*, 865–871.
Sabbagh, M. A., & Shafman, D. (2009). How children block learning from ignorant speakers. *Cognition, 112*, 415–422.
Ziv, M., & Frye, D. (2004). Children's understanding of teaching: The role of knowledge and belief. *Cognitive Development, 19*, 457–477.

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