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Says Who? Children Consider Informants' Sources When Deciding Whom to Believe

Rosie Aboody[1], Sami R. Yousif[1], Mark Sheskin[1, 2], and Frank C. Keil[1]
[1] Department of Psychology, Yale University
[2] Department of Social Sciences, Minerva University

To successfully navigate the world, we cannot simply accept everything we hear as true. We must think critically about others' testimony, believing only sources who are well-informed and trustworthy. This ability is especially crucial in early childhood, a time when we both learn the most, and have the least prior knowledge we can fall back upon to verify others' claims. While even young children evaluate testimony by considering whether agents' firsthand experiences license their claims, much of the time, our informants do not possess firsthand knowledge. When agents transmit information learned from others (rather than discovered firsthand), can children also evaluate their testimony's *social* basis? Across 3 experiments (N = 390), we manipulate the number of primary sources originating a claim, and the number of secondary sources repeating it. We find that by age 6, children understand that a claim is only as reliable as its original source, endorsing claims supported by more primary (rather than secondary) sources. While young preschoolers already understand the link between firsthand perceptual access and knowledge, these results suggest that a full understanding of testimony's social basis may be later-developing.

Keywords: social cognition, knowledge, consensus, testimony

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From the languages we speak to the norms we follow to the beliefs we hold, much of what we know is learned from other people. Although most of the information we hear from others is true, not everyone is equally well informed—and acting upon misinformation can be costly. So as we receive information from others, we need to be discerning about whom to trust and what to believe. This ability is particularly critical in early childhood: Children especially rely on teachers, parents, and other informants to learn, but often cannot independently evaluate the accuracy of their claims.

When unable to fact-check a claim by referencing our own prior knowledge, it can be helpful to seek information about the claim's grounding in fact. For instance, you might believe that the circus is in town if your friend says she saw it—and you might readjust that belief if you find out she only saw it in a dream. Early in preschool, children understand how informants' experiences lead to knowledge (Lockhart et al., 2016; Miller et al., 2003; Papafragou et al., 2007; Pillow, 1989, 1993, 2002; Pillow et al., 2000; Robinson et al., 2011), and use this understanding to evaluate others' testimony. For instance, preschoolers are more likely to believe agents whose claims are based on appropriate perceptual access (Brosseau-Liard & Birch, 2011; Butler et al., 2020; Hu et al., 2015; Robinson et al., 1999, 2011; Robinson & Whitcombe, 2003), judging their testimony (Butler et al., 2018) and beliefs (Koenig, 2012) as more acceptable.

However, agents often transmit information learned from others (rather than from their own firsthand experiences). Indeed, from deciding where to eat to deciding who will make the best president, we form many of our beliefs based on "communities of knowledge" (Sloman & Rabb, 2016). Although we cannot evaluate such secondhand claims by considering an informant's own perceptual access, information about their sources can help us decide whether to trust or reject their testimony. For example, if a coworker claims they know where to find the best pizza in town, you might be more likely to believe them if they received their tip from a long-time local, rather than from a tourist. When attempting to evaluate socially transmitted claims, do children understand that sources matter?

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Rosie Aboody https://orcid.org/0000-0002-7541-7746
Sami R. Yousif https://orcid.org/0000-0002-4126-3072
Link to data and materials: https://osf.io/asf8g/.

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Correspondence concerning this article should be addressed to Rosie Aboody or Sami R. Yousif, Department of Psychology, Yale University, Box 208205, New Haven, CT 06520-8205, United States. Email: rosie.aboody@yale.edu or sami.yousif@yale.edu

It is possible that even young preschoolers attend to source information, and use this input when deciding whom to trust. After all, preschoolers are attentive to a variety of features that distinguish good from bad informants, such as accuracy, reliability, and expertise (for a review, see Mills, 2013; Sobel & Kushnir, 2013), understand that agents can gain new knowledge from testimony (e.g., Miller et al., 2003; Papafragou et al., 2007), and distinguish good from bad reasons to hold a belief (Koenig, 2012). Four-year-olds prefer to learn from individuals who previously answered questions unaided (rather than someone who needed help from a third party; Einav & Robinson, 2011), and preschoolers pay attention to and copy those who are popular, dominant, and who they may expect to be more knowledgeable (e.g., older; Flynn & Whiten, 2012; McGuigan & Burgess, 2017).

But while preschoolers are able to identify reliable and trustworthy informants, they may not realize that a claim's initial source matters. Considering an agent's claims in light of their source requires both integrating information about multiple individuals, and about the flow of testimony between these individuals. Preschoolers can struggle to balance multiple pieces of information when deciding whom to trust (e.g., group size vs. information quality; Hu et al., 2015), and even adults can struggle to consider and integrate source information when judging others' claims (Pennycook & Rand, 2019; Yousif et al., 2019). Thus, evaluating agents' sources (and then using this information to evaluate claims) may pose a challenge for young children.

Current Study

In the current work, we test whether 4- to 7-year-olds look to agents' sources in order to evaluate their claims. We do so by manipulating the number of primary sources who make a claim, and the number of secondary sources that repeat it. In Experiment 1, we test whether children are more likely to endorse the testimony of an agent with three informants, rather than an agent with only one. In Experiment 2, we test whether children are swayed by repetition, asking whether children are still more likely to endorse the testimony of a group with three informants, rather than a group who all repeat the testimony of a single informant. And in Experiment 3, we test whether children and adults truly privilege a claim's initial source or simply prefer to align with the larger overall group, asking whether children and adults are more likely to endorse the testimony of an agent with three informants, rather than a group with a single informant (equating the overall number of individuals supporting each claim).

We test the abilities of 4- to 7-year-olds because, while even very young children prefer to align themselves with a straightforward majority (Corriveau & Harris, 2010; Corriveau et al., 2009; Haun & Tomasello, 2011), the ability to consider the strength of a majority or integrate majority information with other cues may develop only later (Einav, 2014; Hu et al., 2015; Otsubo et al., 2017). For instance, 4- and 5-year-olds prefer to endorse the testimony of an unreliable consensus above that of a reliable dissenter (Bernard et al., 2015), align themselves with a majority only when agreement is unanimous (Morgan et al., 2015), and are no more likely to side with a consensus who arrived at independent conclusions versus dependent ones (Einav, 2018).

Approach to Analyses

Following current recommendations for statistical best practices, we take an estimation approach to data analysis (Cohen, 1994). We estimate effect sizes by bootstrapping our data and obtaining 95% confidence intervals, taking confidence intervals that do not cross chance as evidence of a reliable effect. The preregistered sample size for all experiments was determined through a Monte Carlo power analysis. Assuming that 75% of participants are attentive (and thus answer the test question correctly), a sample of 30 participants per age group yields power = .899.

Experiment 1

Do children look to agents' sources when evaluating their claims? Experiment 1 contrasted the claims of two individuals (see Figure 1). One individual's testimony was based on that of three primary sources, while the other's was based on that of a single primary source. Participants judged which claim was more likely to be true. In direct testimony tasks (i.e., with no intermediate informants), even 3-year-olds tend to align themselves with a majority (Corriveau et al., 2009). So, if children consider agents' sources when evaluating their claims, participants in the task should endorse the claim of the agent who heard from more people.

Method

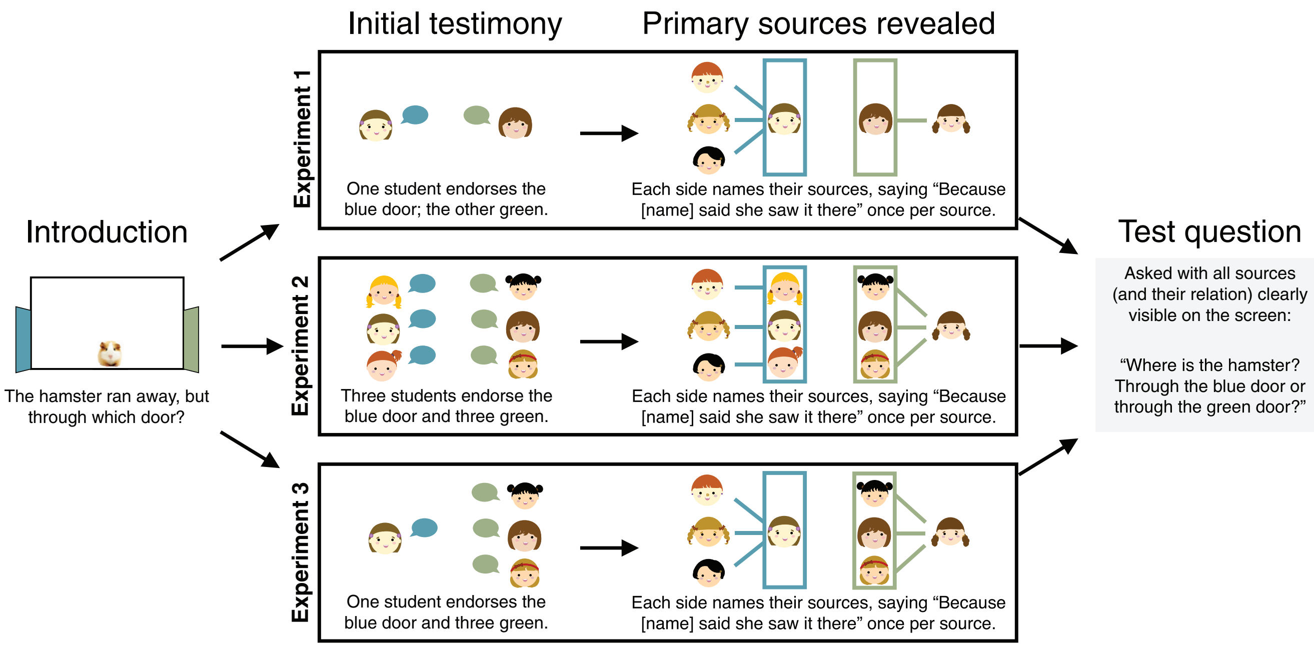
The procedure, predictions, and analyses of all experiments were preregistered. Preregistrations, stimuli with embedded scripts, data, and analysis scripts can be accessed at the OSF project page: https://osf.io/asf8g/. In addition to posting the exact stimuli we showed participants to the project OSF page (Powerpoint presentations, with scripts embedded in the slide notes), we also include the script of each experiment in the online supplemental materials. Methods for all experiments were approved by the Yale University IRB. Before participation, all parents/legal guardians and adult participants provided informed consent; child participants also provided verbal assent.

Participants

Participants were 120 4- to 7-year-olds (mean age: 6.06 years, range: 4.09–7.96 years; n = 30 participants per age group). An additional six participants were excluded from analyses and replaced due to experimenter error (n = 3), distraction (n = 2), or because the participant did not complete the study (n = 1).

To collect data most efficiently, we used all testing sites available, both in-person and online. Thus, approximately half of our sample (54.8%; n = 69 of 126) participated in person at the Yale Peabody Museum of Natural History. We did not collect demographic information directly from these participants, but on average, 3% of museum visitors are Asian, 19% are Black, 13% are Hispanic or Latino, 1% are Native American, 58% are White, and 6% are two or more races (Peabody Museum of Natural History, 2005). The rest of our sample (45.2%; n = 57 of 126) participated via The Child Lab, an online video-chat research platform (Sheskin & Keil, 2018). Forty-eight participants provided demographic information; of these, 3.3% were Asian, 6.7% were Black, 13.3% were Hispanic or Latino, 1.7% were Native American, 1.7% were Native Hawaiian or Pacific Islander, and 90% were White (participants who

Figure 1
Procedure of All Experiments



Note. In each experiment, participants saw students disagree about the location of the class hamster. Subsequently, the students explained the basis of their claims by identifying their sources. One side's testimony relied on that of three separate primary sources; the other side, on only one primary source. Finally, participants were asked to judge where the hamster actually was. See the online article for a color version of this figure.

reported two or more races were counted in each category). Note that for participants run online, only month and year of birth is collected, and participants are always assigned the first of the month as their date of birth. All data were collected between November 2018 and April 2019.

Stimuli

Stimuli consisted of a set of PowerPoint slides, which illustrated the story participants heard. The story was usually presented to children on a tablet or computer. In rare cases, the story was presented on a smartphone (if an online participant chose to connect via their phone).

Procedure

First, participants were introduced to a classroom, with the experimenter saying, "Look [participant name]. Here is a classroom! In the classroom there are two doors: the blue door and the green door." A hamster appeared, and the experimenter said, The class has a pet hamster. But today, the hamster got out of his cage, and he ran away." The hamster was replaced with an image of a teacher, and the experimenter said, "This is the teacher. She did *not* see where the hamster went. She needs to go look for him. So she needs to know if the hamster ran through the *blue* door, or if the hamster ran through the *green* door."

Two students joined the teacher. The experimenter said, "Because the teacher did *not* see where the hamster went, she decided to ask some students in the class. Let's see what they have to say." A solid blue speech bubble appeared in front of one of the students, and the experimenter narrated, "This student says, 'The hamster ran through the blue door,' so we'll put her here, on the blue side." The student then moved to the left side of the screen, into a blue box. The box served as a memory aid, so participants did not forget what each student said. Next, a solid green speech bubble appeared in front of the remaining student, and the experimenter narrated, "This student says, 'The hamster ran through the green door,' so we'll put her here, on the green side." This student then moved to the right side of the screen, into a green box.

The experimenter continued on, "'Oh no,' the teacher said, 'I don't know where to look to look for the hamster! The student on the blue side says he ran out the blue door, and the student on the green side says he ran out the green door. Hmm. Maybe I can ask one more question to figure out where the hamster went.'" Still narrating, the experimenter continued, "First, the teacher asked the student on the blue side, 'Can you tell me *why* you said the hamster ran through the blue door?' The student said, 'Because Mary said she saw it there, because Kayla said she saw it there, and because Sarah said she saw it there.'" As each source was named, she appeared on the left side of the screen (see Figure 1). The experimenter repeated, "So this student said blue because Mary, Sarah, and Kayla all said they saw the hamster on the blue side. Next, the teacher asked the student on the green side, 'Can you tell me *why* you said the hamster ran through the green door?'" Still narrating, the experimenter continued, "The student said, 'Because Annie said she saw it there.'" As the source was named, she appeared on the right side of the screen (see Figure 1). The experimenter repeated, "So this student said green because Annie said she saw the hamster on the green side." Thus, the color of the endorsed side was mentioned an equal number of times by each group; the only thing that differed was the number of primary sources who said they saw the hamster on this side.

Finally, the experimenter asked the test question: "[participant name], we need your help! Can you tell me, where is the hamster? Through the blue door, or through the green door?" The experimenter repeated the participant's answer, and then asked them to explain their choice. The blue side was always referenced first, but the number of sources was counterbalanced: The student on the blue side heard from more sources only half of the time. To see the full script and stimuli side-by-side, refer to the slides on our OSF page.

Although the color of the endorsed side was mentioned an equal number of times by each group, it is true that mentioning three people's names takes more time than mentioning a single person's name. We chose not to control for this feature for two main reasons. Practically, we wanted to be certain participants actually noticed that one side had more primary sources than the other; naming each primary source independently assisted with this. Theoretically, we felt that this was part of the phenomena: Naming multiple sources will always take longer than naming one, both in everyday life and in our experiment. In the Discussion of this experiment we consider whether this or other low-level cues can explain our results.

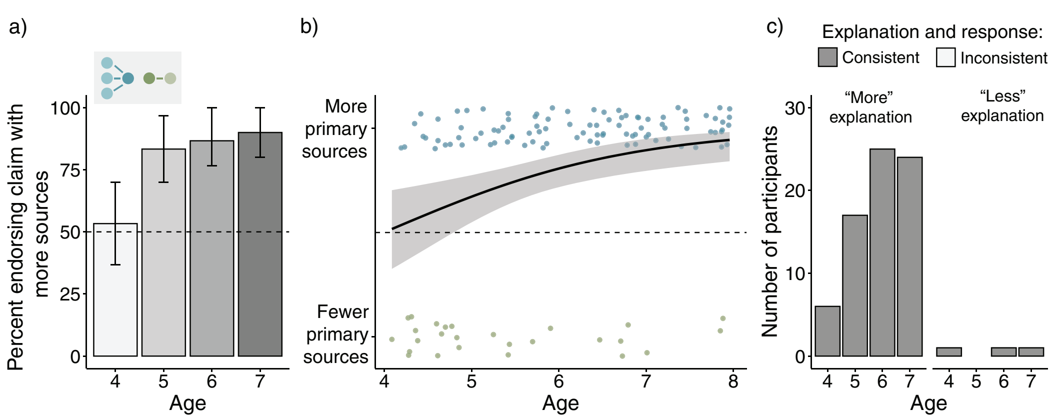
Results

For the 93.7% of participants whose sessions were video or audio taped (n = 118/126), two coders determined exclusions according to preregistered criteria. The first coder determined whether the experiment had been run correctly, blind to participants' final answers. The second coder determined whether participants answered the test questions, and whether they received any external cues. For participants who were not video or audio taped, the first author determined exclusions by comparing the experimenter's notes to the preregistered exclusion criteria. Six participants were excluded and replaced (see Participants). Note that for participants who were video (rather than audio) recorded, the second coder was not actually blind to counterbalance as preregistered: The tablet or computer was usually within view of the camera, thus revealing which side had more primary sources. Nevertheless, our exclusion rate across all experiments is quite low, and participants were only excluded according to stringent preregistered criteria.

Overall, 78.3% of participants judged that the hamster was in the location endorsed by the agent with more sources, a proportion reliably above chance (94 of 120; 95% CI [70.8, 85.8]). A binomial logistic regression predicting performance based on age (with age treated as a continuous independent variable) revealed a significant age difference (β = .71, p = .002). Only 53% of 4-year-olds preferred to endorse the testimony of the consensus-supported agent (16 of 30; 95% CI [36.7, 70]), whereas 83.3% of 5-year-olds (25 of 30; 95% CI [70, 96.7]), 86.7% of 6-year-olds (26 of 30; 95% CI [76.7, 100]), and 90% of 7-year-olds (27 of 30; 95% CI [80, 100]) endorsed this agent's testimony (see Figure 2). A binomial logistic regression predicting performance based on method of participation (in person vs. online; not preregistered) revealed no difference between the two (β = .34, p = .45).

Explanations were coded post hoc for completeness by the first and second authors. For more information on the coding scheme and for the raw explanations from all experiments, see online supplemental materials. For the 98 participants who provided an explanation (81.6%), coders identified whether the explanation referenced a greater (e.g., "Because there's three"; "Because there's more"; "Because more is better"; n = 72) or lesser (e.g., "Because one is better"; "Because there's only one"; n = 3)

Figure 2
Results of Experiment 1



Note. (a) The proportion of participants who endorsed the claim supported by more primary sources, visualized by age group. The dotted line indicates chance performance; vertical bars show 95% bootstrapped confidence intervals. The gray box at the top of the plot is a procedure schematic. In this experiment, two students initially disagreed (the darker circles); one student heard from three separate sources, and the other student heard from only one individual (the lighter circles). (b) The claim participants chose to endorse, plotted as a function of age, along with a logistic regression fit to the dataset. Points are jittered along the Y axis (but not the X axis). The gray band shows a 95% confidence interval in the regression. (c) Of the participants who provided a codable explanation, the correspondence between participants' responses to the test question and their explanation, visualized by age group. The fill of each bar indicates whether participants' response and explanation were consistent. See the online article for a color version of this figure.

number of informants, or whether the explanation was ambiguous or otherwise uncodable (e.g., "Because I saw it go through the blue door"; "Because when *I* went through the green door, I smelled hamster smells, then I sneezed"; $n = 23$). Interrater reliability was high (96.6%; Cohen's $\kappa = .94$; $p < .001$); disagreements were resolved by discussion. Irrespective of age, all 72 participants who justified their response by pointing out that their chosen side had more sources in fact endorsed the testimony of the agent who heard from multiple sources. And all three who referenced a lesser number of sources endorsed the testimony of the agent with only one source (see Figure 2). Thus, for 100% of these participants, their explanation was consistent with their judgment. In contrast, participants who provided uncodable explanations showed no consistent preference: approximately half endorsed the testimony of the agent who heard from multiple sources ($n = 11$ of 23, 47.8%). And of participants who provided no explanation, precisely half also endorsed the testimony of this agent ($n = 11$ of 22; 50%).

Might children have failed to distinguish between primary and secondary sources, simply preferring to side with the more numerous group? To further investigate, a blind research assistant recoded all explanations for mention of number (not preregistered). Of the 75 participants who provided codable explanations, 23 mentioned a number. Recall that a single secondary source endorsed each side, and was supported by either one or three primary sources. Participants who distinguish between primary and secondary sources should thus either mention the numbers one or three; participants who do not should mention either the numbers two or four (as these are the total number of individuals in each group). Consistent with the former, 22 of the 23 participants mentioned the numbers one, three, or both—numbers that participants should only use if they distinguished between primary and secondary sources, referring to each type of source separately. One final participant also mentioned the number two, but only because they were counting primary sources: "Because there's a lot of people on that side but not on that side; one-two-three, but there's only one on the other side."

Discussion

In this experiment, two agents produced conflicting testimony, but participants learned that their claims were not equally well-supported. One agent's claim was based on the testimony of three primary sources; the other's was based on the testimony of a single source. By age 5 (but not before), children preferred to endorse the better-supported claim, judging that someone who heard from multiple eyewitnesses was more likely to be right than someone who heard from only one. Moreover, participants' explanations were in line with their choices: Every participant who justified their choice by referencing a greater number of individuals indeed endorsed the testimony of the side with more sources, and vice versa.

But did children truly distinguish between primary and secondary sources, and decide that a claim generated by more primary sources was more trustworthy? Or did they simply side with the larger overall group, making no distinction between a claim's originators and those who repeat it? Our developmental trajectory suggests that the larger overall group strategy is unlikely: Four-year-olds failed to align themselves with the larger overall group (the side with more primary sources). But children as young as 3 reliably side with a straightforward majority (Corriveau et al., 2009; Corriveau & Harris, 2010; Haun & Tomasello, 2011), and in a 4-year-old baseline condition, we confirm that this is true of our paradigm as well (children were reliably more likely to endorse the testimony of a straightforward three-person majority vs. that of a single dissenter; $n = 20$ of 30; 95% CI [50, 83.3]; see online supplemental materials). Thus, if participants simply sided with the more numerous group as a rule, it is unclear why 4-year-olds—who usually prefer to align themselves with a majority—had no preference for this group.[1] Additionally, the 23 participants who mentioned quantities in their explanations did not seem to be combining the primary and secondary sources, but instead referred to them separately (mentioning the numbers one and three, rather than two or four). This response pattern suggests that participants did distinguish between a claim's sources and its intermediaries; however, to further investigate, the next experiment continues to test whether children distinguish those who originate a claim from those who merely repeat it.

Experiment 2

In Experiment 1, each claim was repeated by a single secondary source; but in the real world, we must also contend with more complex situations. An individual's testimony can often be repeated by multiple others—and even adults can struggle to appropriately evaluate such repeated claims, finding well-sourced arguments just as convincing as those that are merely oft-repeated (Sulik et al., 2020; Yousif et al., 2019). When evaluating a claim, do children truly prioritize its sources? Or are they swayed by other salient cues, such as repetition? To investigate, we replicate Experiment 1, but simply increase the number of secondary sources repeating each claim. If children attend to sources above cues like repetition, participants should again endorse the testimony of the group with more primary sources. But if participants also consider how many times a claim is repeated, participants may be unsure whom to believe—because each claim is repeated by three secondary sources.

Method

For all following experiments, the materials, design, and procedure were identical to Experiment 1, except as noted.

Participants

Participants were 120 4-, 5-, 6-, and 7-year-olds (mean age: 5.97 years, range: 4.0–7.9 years; $n = 30$ participants per age group). An additional seven participants were excluded from analyses and replaced due to Internet connectivity issues that disrupted critical parts of the experiment ($n = 3$), distraction ($n = 2$), parental interference ($n = 1$), or experimenter error ($n = 1$).

As before, we used all testing sites available to collect data most efficiently. Thus, approximately half of our sample (48%; $n = 61$ of 127) participated at the Yale Peabody Museum of Natural

[1] Similarly, if participants preferred the more numerous group because more time was spent discussing this group (as citing three sources takes more time than citing one), it is unclear why reliance on this simple heuristic would take until age five to emerge.

History; see Experiment 1 for summary demographics of museum visitors. The remainder of our sample (52%; n = 66 of 127) participated via The Child Lab. Fifty-nine of these participants chose to provide demographic information; 8.5% were Asian, 5% were Black, 6.8% were Hispanic or Latino, and 91.5% were White (participants who reported two or more races were counted in each category). All data were collected between November 2018 and June 2019.

Procedure

The task was identical to Experiment 1, with the only difference that the number of secondary sources increased from two (with one initially endorsing each side) to six (with three initially endorsing each side).

As in Experiment 1, participants were introduced to a classroom with a blue and green door, learned that the class hamster had run away, and that the teacher needed to know which door the hamster had escaped through. However, rather than two students joining the teacher, six students now appeared on the screen. As before, after the students appeared the experimenter said, "Because the teacher did *not* see where the hamster went, she decided to ask some students in the class. Let's see what they have to say." A solid blue speech bubble appeared in front of three of the students, and the experimenter narrated, "These students say, 'the hamster ran through the blue door,' so we'll put them here, on the blue side." All three students then moved to the left side of the screen, into a blue box (which served as a memory aid). Next, a solid green speech bubble appeared in front of each of the three remaining students, and the experimenter said, "These students say, 'the hamster ran through the green door,' so we'll put them here, on the green side." These three students then moved to the right side of the screen, into a green box.

As before, the experimenter explained that the teacher was confused, and decided to ask one more question to figure out where the hamster went. The experimenter narrated, "First, the teacher asked the students on the blue side, 'Can you tell me *why* you said the hamster ran through the blue door?' The students said, 'Because Mary said she saw it there, because Kayla said she saw it there, and because Sarah said she saw it there.'" As each source was named, she appeared on the left side of the screen (see Figure 1). The experimenter repeated, "So these students said blue because Mary, Sarah, and Kayla all said they saw the hamster on the blue side. Next, the teacher asked the students on the green side, 'Can you tell me *why* you said the hamster ran through the green door?'" Still narrating, the experimenter continued, "The students said, 'Because Annie said she saw it there.'" As the source was named, she appeared on the right side of the screen (see Figure 1). The experimenter repeated, "So these students said green because Annie said she saw the hamster on the green side."

Finally, the experimenter asked the same test question as in Experiment 1: "[participant name], we need your help! Can you tell me, where is the hamster? Through the blue door, or through the green door?" The experimenter repeated the participant's answer, and then asked them to explain their choice. As in Experiment 1, the color of the endorsed side was mentioned an equal number of times by both groups (and was not repeated more frequently by the group with more primary sources); the side with more primary sources was counterbalanced.

Results

Results were coded as in Experiment 1, according to the same preregistered criteria. Most participants were video or audio taped (92.9%; n = 118/127). Seven participants were excluded and replaced (see Participants).

Overall, 67.5% of participants judged that the hamster was in the location indicated by the consensus-supported agent, a proportion reliably higher than chance (81 of 120; 95% CI [59.2, 75.8]). However, a binomial logistic regression predicting performance based on age (with age treated as a continuous independent variable) revealed a significant age difference (β = .51, p = .006). Only 56.7% of 4-year-olds (17 of 30; 95% CI [40, 73.3]) and 46.7% of 5-year-olds (14 of 30; 95% CI [30, 63.3]) endorsed the testimony of the consensus-supported group, whereas 90% of 6-year-olds (27 of 30; 95% CI [80, 100]), and 76.7% of 7-year-olds (23 of 30; 95% CI [63.3, 93.3]) endorsed this group's testimony (see Figure 3). A binomial logistic regression predicting performance based on method of participation (in person vs. online; not preregistered) revealed no difference between the two (β = .08, p = .85).

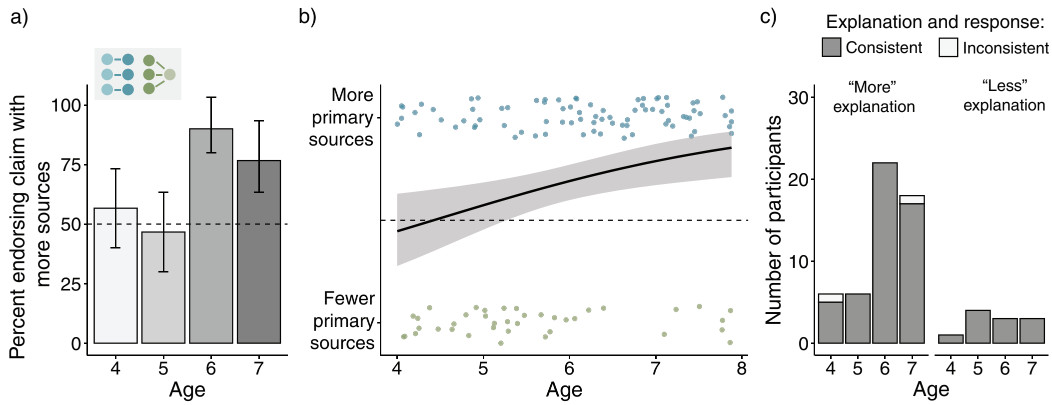
Explanations were coded post hoc for completeness by the first and second authors. Of the 91 participants who provided an explanation (75.8%), 52 referenced a greater number of informants, 11 referenced a lesser quantity, and 28 produced ambiguous or otherwise uncodable explanations. Interrater reliability was high (90.8%; Cohen's κ = .87; $p < .001$). Fifty of the 52 participants who justified their response by referencing a greater number of sources indeed endorsed the testimony of the group who heard from multiple sources, and all 11 who referenced a lesser number of sources endorsed the testimony of the group with only one source (see Figure 3). Of the 28 children who provided uncodable explanations, a little over half endorsed the testimony of the agent who heard from multiple sources (n = 17 of 28, 60.7%), and of the 29 children who provided no explanation, a little under half also endorsed the testimony of this agent (n = 14 of 29; 48.3%).

As in Experiment 1, a blind research assistant recoded all explanations for mention of number (not preregistered). Of the 63 participants who provided codable explanations, 28 mentioned a number. Here, three secondary sources endorsed each side, and were supported by either one or three primary sources. Participants who distinguish between primary and secondary sources should thus either mention the numbers one or three; participants who do not should mention either the numbers four or six (as these are the total number of individuals in each group). Twenty-five of the 28 participants mentioned the numbers one, three, or both—numbers that participants should only use if they distinguished between the primary and secondary sources, referring to each type of source separately. Two participants mentioned the numbers four, six, or both, and one participant mentioned the numbers one, four, and six, first pointing out the numbers of primary sources on each side, and concluding by summarizing the number of overall individuals who endorsed each side. One additional participant produced an explanation coded as "other" and mentioned the number two.

Discussion

Here we replicated Experiment 1, with one key difference: Instead of two students initially providing conflicting testimony,

Figure 3
Results of Experiment 2



Note. (a) The proportion of participants who endorsed the claim supported by more primary sources, visualized by age group. The dotted line indicates chance performance; vertical bars show 95% bootstrapped confidence intervals. The gray box at the top of the plot is a procedure schematic. In this experiment, six students initially disagreed (the darker circles); one group heard from three separate sources, and the other heard from only one individual (the lighter circles). (b) The claim participants chose to endorse, plotted as a function of age, along with a logistic regression fit to the dataset. Points are jittered along the Y axis (but not the X axis). The gray band shows a 95% confidence interval in the regression. (c) Of the participants who provided a codable explanation, the correspondence between participants' responses to the test question and their explanation, visualized by age group. The fill of each bar indicates whether participants' response and explanation were consistent. See the online article for a color version of this figure.

two groups of three students disagreed. Again, participants learned that their claims were not equally well-supported: While one group based their testimony upon that of three primary sources, the other group based their testimony upon that of a single primary source. It was not until age 6 that participants reliably endorsed the testimony of the group with more primary sources—although even 5-year-olds endorsed a claim supported by more primary sources when each claim was subsequently repeated by only one individual (Experiment 1). These results hint that 5-year-olds may not prioritize source over repetition, and may instead consider both the number of primary sources and the number of intermediaries repeating their testimony when evaluating claims. By age 6, however, children appear to prioritize source information above repetition, primarily considering the number of sources originating a claim rather than the number of times it was subsequently repeated. As in Experiment 1, children's explanations were in line with their judgments: Nearly every participant who mentioned a greater number of individuals in their explanation endorsed the testimony of the side with more primary sources, and every participant who mentioned that there were less people indeed endorsed the testimony of the side with fewer primary sources. In addition, children did not seem to combine primary and secondary sources in their explanations, but again referred to them separately. Specifically, 28 participants produced codable explanations referring to number; but only three mentioned the number of overall individuals in each group. As in Experiment 1, this suggests participants did distinguish between a claim's sources and its intermediaries.

By increasing the number of secondary sources to investigate how children balance source versus repetition, we also reduced the overall difference in size between the two groups. In Experiment 1 the group with more primary sources was twice the size of the other group (four vs. two students); in Experiment 2, the group with more primary sources was only half again as large (six vs. four). Nevertheless, this experiment did not aim to fully control for group size; thus, it is still possible that some older children simply aligned themselves with the larger overall group, rather than specifically preferring to endorse claims supported by more primary sources. While this still does not account for participants' explanations, or explain why 4-year-olds did not prefer the more numerous group in either experiment and why 5-year-olds did in Experiment 1 but not in Experiment 2, it is important to fully rule out this possibility. Additionally, while 5-year-olds in this experiment did not seem to prioritize source information above repetition, the reverse could still be true. Each claim was repeated by the same number of secondary sources, and thus our results cannot reveal whether children may paradoxically favor widely-repeated rather than well-sourced claims. Experiment 3 addresses both of these possibilities.

Experiment 3

Experiment 3 was very similar to the prior experiments, but fully equated the overall size of the two groups. Specifically, participants first saw four students disagree about the hamster's location: A group of three students endorsed one door, and one student dissented, endorsing the other door. However, participants then learned that the group all relied on the testimony of a single primary source—whereas the apparent dissenter had in fact heard from three separate primary sources. If participants succeeded in the prior experiments by simply following the overall majority, their performance should fall to chance, because group size is now perfectly equated (with four individuals endorsing each option). And if younger children in fact prioritize repetition above source information, they should prefer to side with the group who heard from only one primary source, rather than the individual who heard from three primary sources.

Finally, even adults struggle to discount widely-repeated claims, although little prior work has explicitly contrasted merely repeated versus well-sourced testimony. To interpret the developmental results, it is critical to understand whether adults in this situation prefer to endorse claims supported by more sources, or whether they may actually prefer to endorse more widely-repeated claims. Thus, we also recruited an adult sample.

Method

Participants

Participants were 120 4-, 5-, 6-, and 7-year-olds (mean age: 6.05 years, range: 4.01–8.0 years; n = 30 participants per age group), as well as 30 adults. An additional six child participants were excluded from analyses and replaced due to interference (n = 3), distraction (n = 2), or experimenter error (n = 1). Note that one of these participants was excluded based on the experimenter's notes: The source of interference (a prior participant whispering the answer) was not loud enough to be evident from the recording.

As before, we used all recruitment methods available; for the duration of this study, these included several in-person testing sites. Most child participants were recruited and tested at the Yale Peabody Museum of Natural History (88%; n = 111 of 126; see Experiment 1 for summary demographics of museum visitors). The remaining 12% of child participants (n = 15) were recruited and tested in preschools in Los Angeles County during a data collection trip. We did not collect demographic information directly from participants, but compute demographic information by preschools' zip codes. On average, 13.9% of adults in these areas were Asian, 6.1% were Black, 21.5% were Hispanic or Latino, .57% were Native American, .16% were Native Hawaiian or Pacific Islander, 54.8% were White, and 14.23% were two or more races, or marked "Other."

Adult participants (n = 30) were undergraduate students at Yale University and participated in-lab. We did not collect demographic information directly from participants. On average, 19.3% of Yale students are Asian, 7.7% are Black, 13.3% are Hispanic or Latino, .4% are Native American, .1% are Native Hawaiian or Pacific Islander, and 52.7% are White (Yale University, 2019). All data were collected between August 2018 and December 2019.

Procedure

The task was very similar to that of the prior experiments. As before, participants were introduced to a classroom with a blue and green door, learned that the class hamster had run away, and that the teacher needed to know which door the hamster had escaped through. However, rather than two or six students joining the teacher, four students now appeared on the screen. As before, after the students appeared the experimenter said, "Because the teacher did *not* see where the hamster went, she decided to ask some students in the class. Let's see what they have to say." Unlike the previous experiments, however, these students did not endorse the two sides equally. Rather, a solid blue speech bubble appeared in front of one of the four students, and the experimenter narrated, "This student says, 'the hamster ran through the blue door,' so we'll put her here, on the blue side." The single student then moved to the left side of the screen, into a blue box (which served as a memory aid). Next, a solid green speech bubble appeared in front of each of the three remaining students, and the experimenter said, "These students say, 'the hamster ran through the green door,' so we'll put them here, on the green side." The three students then moved to the right side of the screen, into a green box. Thus, one student endorsed the blue side, and three students endorsed the green side (or vice versa; counterbalanced).

As before, the experimenter explained that the teacher decided to ask one more question to figure out where the hamster went. The experimenter narrated, "First, the teacher asked the student on the blue side, 'Can you tell me *why* you said the hamster ran through the blue door?' The student said, 'Because Mary said she saw it there, because Kayla said she saw it there, and because Sarah said she saw it there.'" As each source was named, she appeared on the left side of the screen (see Figure 1). The experimenter repeated, "So this student said blue because Mary, Sarah, and Kayla all said they saw the hamster on the blue side. Next, the teacher asked the students on the green side, 'Can you tell me *why* you said the hamster ran through the green door?'" Still narrating, the experimenter continued, "The students said, 'Because Annie said she saw it there.'" As the source was named, she appeared on the right side of the screen (see Figure 1). The experimenter repeated, "So these students said green because Annie said she saw the hamster on the green side."

Finally, the experimenter asked the same test question as in the prior experiments: "[participant name], we need your help! Can you tell me, where is the hamster? Through the blue door, or through the green door?" The experimenter repeated the participant's answer, and then asked them to explain their choice. As in the past experiments, the color of the endorsed side was mentioned an equal number of times by both groups (and was not repeated more frequently by the group with more primary sources); the side with more primary sources was counterbalanced.

Adult participants were run in-person. The procedure was identical, except that before the study commenced the experimenter encouraged participants to pay close attention and take the experiment seriously, saying, "This study was originally designed for children. But please pay attention and try to do your best."

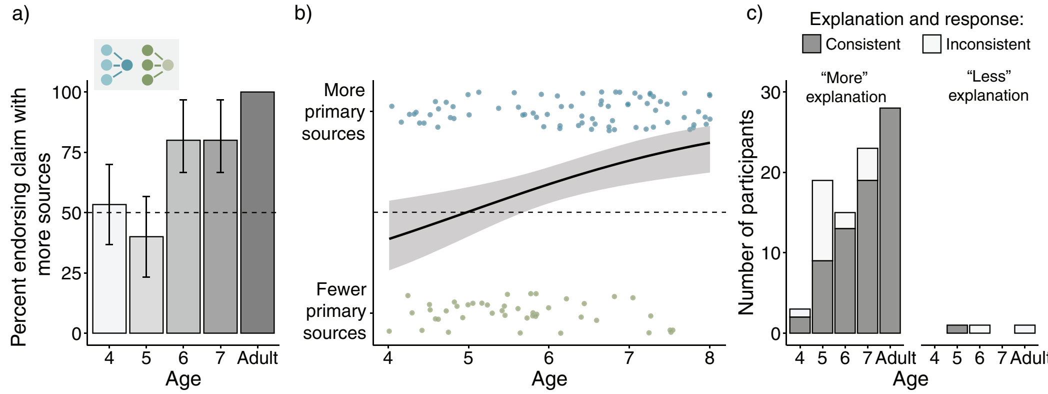
Results

All adult participants (n = 30 of 30) and 92.1% of child participants (n = 116 of 126) were video or audio taped. Six child participants were excluded and replaced (see Participants).

Overall, 63.3% of child participants judged that the hamster was in the location indicated by the consensus-supported agent, a proportion reliably higher than chance (76 of 120; 95% CI [55, 71.7]). However, a binomial logistic regression predicting performance based on age (with age treated as a continuous independent variable) revealed a significant age difference (β = .56, p = .002; note that this analysis was unintentionally omitted from our preregistered analysis plan and thus was not preregistered). Only 53.3% of 4-year-olds (16 of 30; 95% CI [36.7, 70]) and 40% of 5-year-olds (12 of 30; 95% CI [23.3, 56.7]) endorsed the testimony of the consensus-supported group. In contrast, 80% of 6-year-olds (24 of 30; 95% CI [66.7, 93.3]) and 80% of 7-year-olds (24 of 30; 95% CI [66.7, 93.3]) endorsed this group's testimony, demonstrating that older children's performance cannot be explained by a simple preference to side with a larger overall group (see Figure 4).

Of the 89 child participants who provided an explanation (74.2%), 60 referenced a greater number of informants, two referenced a lesser

Figure 4
Results of Experiment 3



Note. (a) The proportion of participants who endorsed the claim supported by more primary sources, visualized by age group. The dotted line indicates chance performance; vertical bars show 95% bootstrapped confidence intervals. The gray box at the top of the plot is a procedure schematic. In this experiment, four students initially disagreed (the darker circles); one student heard from three separate sources, and the other group of three heard from only one individual (the lighter circles). (b) The claim participants chose to endorse, plotted as a function of age, along with a logistic regression fit to the dataset. Points are jittered along the Y axis (but not the X axis). The gray band shows a 95% confidence interval in the regression. (c) Of the participants who provided a codable explanation, the correspondence between participants' responses to the test question and their explanation, visualized by age group. The fill of each bar indicates whether participants' response and explanation were consistent. See the online article for a color version of this figure.

quantity, and 27 produced ambiguous or otherwise uncodable explanations. Interrater reliability was high (98.3%; Cohen's κ = .97; $p < .001$). In contrast to the prior studies, only 71.7% of participants referencing a greater number of informants (n = 43 of 60) endorsed the testimony of the agent who heard from multiple primary sources. This result appeared to be primarily driven by 5-year-olds (see Figure 4). While 19 5-year-olds explained their choice by appealing to a greater number of informants, only nine of these participants actually endorsed the testimony of the agent who heard from multiple sources. The others endorsed the testimony of the group with only one source, suggesting that their explanations may have referred to the greater number of agents who *repeated* the single primary source's testimony. Of the two participants who referenced a fewer number of informants, one endorsed the testimony of the agent with multiple primary sources, and one endorsed the testimony of the group with a single primary source. Finally, of the 27 children who provided uncodable explanations, just over half endorsed the testimony of the agent who heard from multiple sources (n = 14 of 27, 51.9%), and of the 31 children who provided no explanation, a little over half also endorsed the testimony of this agent (n = 18 of 31; 58.1%).

To confirm the mature end-point of these judgments, we replicated the same experiment with an adult sample. Consistent with older children's judgments, 100% of adult participants (n = 30 of 30) judged that the hamster was in the location indicated by the consensus-supported agent. It is not possible to compute bootstrapped confidence intervals over data with no variance, but adults, like older children, are clearly more likely to endorse the testimony of an individual who heard from three sources, rather than the testimony of a group who heard from a single individual. For completeness, we also coded adults' explanations (Cohen's κ = 1; $p < .001$). All 30 participants provided an explanation; 28 referenced a greater number of informants, one a lesser number, and one provided an uncodable explanation.

Although referring to the number of overall individuals in each group was uninformative in this experiment (as overall group size was equated), for completeness a blind research assistant recoded all explanations for mention of number (not preregistered). Of the 62 child and 29 adult participants who provided codable explanations, 29 and 10 mentioned a number, respectively. All of these mentioned only the numbers one, three, or both, save for one adult and two child participants.

Discussion

These findings suggest that 6- and 7-year-olds did not solve our task by simply siding with the larger overall group: With group size equated, older children still preferred to endorse a claim supported by more primary sources, rather than repeated by more individuals. These results also hint that 5-year-olds do not prioritize repetition above source, but may attend to both cues when deciding who to trust: unlike in Experiments 1 and 2, some 5-year-olds who referenced a greater number of individuals in their explanation actually endorsed the testimony of the group with fewer sources. Given that some 5-year-olds' explanations appeared to focus on the number of primary sources and some on the number of secondary sources, it is possible that before age 6, different children prioritize different cues. By age 6, however, children seem to reliably prioritize source information when deciding what to believe, replicating our findings from Experiments 1 and 2. Finally, we show that when a well-sourced claim is explicitly contrasted against a claim that is merely repeated more often, adults prioritize source information above repetition, preferring to endorse a claim supported by more eyewitnesses.

General Discussion

The ability to learn new information from others and effectively pass on our knowledge in turn may be at the core of our species' success: Because each generation need not reinvent the wheel, we are able to develop complex institutions, cultures, and technologies (Boyd et al., 2011; Tomasello et al., 1993). But not everything we are told is true. Sources can be mistaken or even malicious, and information can be easily distorted through transmission (e.g., Bartlett, 1932). In order to learn (and later pass on) true information, it is critical to both understand and evaluate the social origins of others' beliefs.

Across three experiments, we find that an appreciation of the importance of source information develops throughout the preschool years. By age 5, children prefer to endorse a claim supported by more primary sources, as long as each claim is repeated by only one secondary source (Experiment 1). When each claim is repeated by multiple intermediaries, it is not until age 6 that children reliably privilege source information (preferring to endorse the claim supported by more primary sources; Experiment 2). This choice did not reflect a simple preference to side with the larger overall group; with group size equated, 6- and 7-year-olds still preferred to endorse the testimony of an individual who heard from three primary sources (above the testimony of three individuals who heard from a single primary source; Experiment 3). Thus, by age 6, children stably evaluate agents' claims by considering the origins of their beliefs, preferring to endorse testimony supported by a greater number of primary sources.

These findings have three main implications. First, although the information we learn is often socially mediated (sometimes passing through long chains of individuals before reaching our ears), this work is among the first testing whether children track the flow of information between multiple people and use this social history to evaluate claims. Our results suggest that even younger children may have distinguished a claim's sources from those who merely repeated it: Five-year-olds succeeded in prioritizing source information when no other cues were in conflict (Experiment 1), but showed no preference when one or both claims were repeated by multiple secondary sources (Experiments 2 and 3). These results suggest that younger children may notice the distinction between primary and secondary sources, but may not be sure which cue to prioritize when evaluating claims. Thus, we show that by age 6 (if not before), children already have a sophisticated understanding of the social processes that construct the knowledge of those around them—understanding which lead to reliable testimony, and which do not.

Second, our results are consistent with prior findings that 4- and 5-year-olds do not reliably prioritize independent over repeated testimony (Hu et al., 2015; Kim & Spelke, 2020; Otsubo et al., 2017), and raise one possible explanation for these findings. Our results suggest that 5-year-olds do not yet rely on a stable strategy to evaluate socially-mediated testimony, and may find repetition as salient as information about a claim's source. Attending to repetition may not be irrational: People generally repeat claims they think are true. For instance, both preschoolers and chimpanzees prefer to imitate those they expect are more likely to be knowledgeable (Flynn & Whiten, 2012; Kendal et al., 2015), and are more likely to faithfully copy repeated actions (rather than actions performed only once by one individual; Herrmann et al., 2013). Furthermore, a greater number of primary sources isn't always correlated with accuracy; it is probably better to learn from someone who queried one expert, rather than an entire group of laypeople (for discussion, see Yousif et al., 2019). If young children find repetition as salient as source information when evaluating testimony, this could explain why they do not place greater trust in independently sourced claims (vs. repeated ones). Our results are consistent with research showing that even adults can struggle to reject socially-mediated disinformation (Pennycook & Rand, 2019; Yousif et al., 2019; see also Pilditch et al., 2020), suggesting that a propensity to trust widely-repeated claims may have roots early in development.

Finally, the more extended developmental trajectory we observed across our experiments is also consistent with a wider body of work on social consensus. This work finds that children's ability to integrate consensus with other cues (Bernard et al., 2015; Burdett et al., 2016; Einav, 2018; Morgan et al., 2015), and understand what can be learned from testimony (Fitneva et al., 2013; Lockhart et al., 2016; Miller et al., 2003) continues to develop throughout preschool and perhaps even beyond. These capacities likely depend, at least in part, on an understanding of others' epistemic states. Similarly, recent work suggests that an ability to understand or infer what others know may also have a more extended developmental trajectory than previously thought. While 3-year-olds expect an agent who is told what's in a container to know what's there (Papafragou et al., 2007), and 4-year-olds infer others' epistemic states from their actions in simple cases (Aboody et al., 2021; Jara-Ettinger et al., 2017), more nuanced epistemic reasoning takes time. For instance, 4-year-olds do not seem to distinguish informative from uninformative testimony, whereas 6-year-olds do (Miller et al., 2003). A full ability to infer or appropriately respond to others' epistemic states appears to continue developing between age 4 and 6 (Aboody et al., 2019; Baer & Friedman, 2018; Wu & Schulz, 2018). Taken together, these results suggest that while children begin reasoning about the basis of others' testimony early on, they continue to refine their approach throughout the preschool years. As children gain more social experience themselves, and a fuller grasp of the origins and nature of others' epistemic states, they may arrive at more stable and universal strategies for evaluating the social basis of others' testimony.

Open Questions

Our findings raise two primary questions for future work. First, much prior research has investigated why adults place greater trust in repeated claims, regardless of their basis in fact (identifying mechanisms such as fluency and familiarity; for a review see Unkelbach et al., 2019). But it remains unclear whether children and adults sometimes make rational epistemic inferences from repetition, especially in rich social contexts—for instance, inferring that a person who is trusted by more individuals may be particularly knowledgeable or trustworthy (see Pilditch et al., 2020). Such inferences may actually be common. In a recent experiment, for example, 50% of adult participants explicitly judged that repeated testimony was either as convincing or more convincing than independently sourced testimony (Yousif et al., 2019, Experiment 4).

Consistent with this possibility, our results begin to suggest that 5-year-olds (and perhaps even 4-year-olds) may attend both to a claim's source and the number of times it was subsequently repeated. A simple inability to recognize the difference between primary and secondary sources likely cannot explain younger children's chance performance: At baseline, 4-year-olds preferred to side with a consensus above a dissenter in our task (see online supplemental materials). Thus, if 4- and 5-year-olds did not distinguish between primary and secondary sources, they should have sided with the larger overall group in both Experiments 1 and 2 (the group with more primary sources). And if children did not look beyond the secondary sources they initially encountered, in Experiment 3 they should have preferred the group with more secondary sources (where three agents initially endorsed one option, and a single individual dissented). It is possible, then, that younger children considered both primary and secondary sources, but did not know which piece of information to privilege when making their choices—or, that different children relied on different strategies (as in Burdett et al., 2016). Future work will investigate whether children and adults sometimes value repetition because they expect it signals widespread trust in a claim. If this is the case, it could suggest novel interventions on belief in fake news (e.g., better highlighting how a source's credibility was evaluated, and whether repeated testimony was independently verified).

Second, and relatedly, beyond situations involving the repetition of others' claims, it is important to understand how children make third-party epistemic judgments. While much prior work has investigated how children reason about primary sources, little research has tested the inferences children make about agents upon observing others' decisions to trust or seek information from them. As adults, we make such third-party judgments all the time: If Amanda asks Michael a question, we assume she thinks Michael is knowledgeable. But if she then turns around and asks somebody else the same question, we can both infer that Michael was not as knowledgeable as Amanda first thought, and that Amanda thinks her new source might know better. Our results suggest that young children may attend to such dynamics, making inferences about sources based on others' decisions to trust them. Future work will continue to explore how children evaluate potential informants in third-party contexts more broadly, testing whether children can infer how trustworthy or knowledgeable an agent is even without directly interacting with this agent themselves.

Limitations

There are two key limitations to the current work. First, while the flow of information between individuals was straightforward in our experiments—the primary sources were eyewitnesses, and provided direct testimony to the secondary sources participants heard from—the real world is not always so simple. For example, we commonly receive (and must evaluate) information transmitted through long or even untraceable chains of testimony. And primary sources do not always agree. In these cases, we may need to figure out the cause of the disagreement to decide whether we trust our informant's interpretation of such conflicting testimony. A full understanding of the social processes that construct knowledge should allow children to evaluate testimony in more complex situations: for instance, inferring that information may degrade as it passes through more and more intermediaries (see Bartlett, 1932), that the originator of an inaccurate claim may be more untrustworthy than someone who merely had the misfortune to learn from her, and that it's better to ignore dissent among primary sources in some situations (the dissenter stumbled and missed a critical event) than others (the dissenter was the only one who witnessed the critical event; e.g., Einav, 2014).

Second, we tested children's abilities in an objective situation: The hamster was in either one location, or the other. But often we are forced to reason about information that has no ground truth (e.g., what's the best pizzeria in town? How likely is the regional airport to ice over this December?) Adults, at least, are sensitive to this distinction: They are much more likely to rely on primary sources in objective cases (like the ones we tested) than in subjective ones (Yousif et al., 2019). Consistent with this possibility, prior work suggests that children and adults' reliance on consensus may vary as a function of domain (Hu et al., 2013; Pham & Buchsbaum, 2019; Yousif & Keil, 2018). Future work will continue to investigate how children evaluate testimony in more naturalistic and varied contexts.

Conclusion

As we navigate the world, we gather information from a wide array of sources, each of which helps us learn more than we ever could by ourselves. But to be discerning rather than blind consumers of information, we must track how testimony flows between people, and understand how to evaluate secondhand claims. We show that by the end of preschool, children already track how information flows between individuals, and use this social history to evaluate claims. These abilities may be at the foundation of our capacity to learn and transmit the accumulated knowledge of those before us, allowing us to decide whom to believe, what to learn, and whether information is reliable enough to pass on to others.

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