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Children's selective information sharing based on the recipient's role

Judith H. Danovitch

Department of Psychological and Brain Sciences, University of Louisville, Louisville, Kentucky, USA

ABSTRACT

Two experiments investigate whether children ages 5 through 10 (n = 121) take into account an individual's role when choosing what information to share or with whom to share it. In Experiment 1, children heard statements about an unfamiliar animal's behavior and appearance. They then chose one statement to share with each of two characters with different job descriptions. Seven-year-olds consistently shared the information that aligned with each character's role, but 5-year-olds and a subset of 9-year-olds did not. Experiment 2 showed that children's decisions about what to share were not driven by their personal preferences for the information they were sharing. In addition, when children were provided with a single fact and had to choose with whom to share it, 7- and 9-year-olds shared information with the recipient for whom it was most relevant. Together, the findings suggest that by age 7, children can use information about an individual's occupational role in order to infer what information to share.

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In a world where the amount of available information constantly increases, the ability to filter through a stream of input and focus on the most useful facts is critical. Similarly, when sharing information with another person, it is essential to accurately infer what types of information would be most useful to that person. Effectively sharing information can make the difference between a productive interaction and a frustrating one, and can influence how the recipient of the information perceives the speaker (e.g., whether the speaker is knowledgeable, friendly, etc.). However, selecting information to share can be challenging. It requires coordinating judgments about the information itself with judgments about the recipient. It also requires understanding the recipient's knowledge state, as well as their characteristics and interests, and choosing the information that aligns best with their goals and expertise (which may differ from that of the speaker). Although by age 5, children have some understanding of others' knowledge states (i.e., theory of mind; see Wellman, Cross, & Watson, 2001) and they appreciate that individuals can have different goals and expertise (e.g., Danovitch & Keil, 2004), it is unclear how well they can reconcile their understanding of an information recipient's needs with their own preferences and interests. To address this question, the current studies examine whether children can select and share information that is most relevant to a recipient based on that person's role.

Children often rely on other people to provide them with useful and accurate information that they cannot access on their own (see Harris, 2012), but they do not seek out information indiscriminately. As early as age 3, children ask questions specific to the kind of object or entity that they face (Greif, Kemler Nelson, Keil, & Gutierrez, 2006; Kemler Nelson, Egan, & Holt, 2004).

CONTACT Judith H. Danovitch j.danovitch@louisville.edu Department of Psychological and Brain Sciences, University of Louisville, Louisville, KY 40208.

For instance, when faced with an unfamiliar animal, children are more likely to ask questions about behavior, whereas for unfamiliar artifacts, they are more likely to ask about purpose or function. By the end of preschool, children are capable of directing their questions to appropriate sources (Aguiar, Stoess, & Taylor, 2012; Mills, Legare, Bills, & Mejias, 2010) and asking questions that facilitate problem solving (Legare, Mills, Souza, Plummer, & Yasskin, 2013). Analyses of children's question-asking behaviors suggest that young children have at least a rudimentary sense of what information is most relevant or valuable for forming a new concept or understanding a new object, and that they selectively seek out this kind of information.

Children are capable not only of seeking out relevant information for themselves, but also of teaching it to others. By age 5, children can explain an unfamiliar procedure to a naïve learner (e.g., Ziv, Solomon, Strauss, & Frye, 2016) and can select effective exemplars to illustrate how a device works (Rhodes, Bonawitz, Shafto, Chen, & Caglar, 2015). In fact, in some situations, children appear to be more adept at choosing information to teach others about a concept than they are in choosing information for themselves (Rhodes, Gelman, & Brickman, 2010). Moreover, when children are faced with an ignorant or naïve learner, they consider their own understanding of the information (i.e., whether it is common knowledge), and prefer to teach information that is less obvious or readily apparent (Ronfard, Was, & Harris, 2016). Taken together, these findings provide evidence that children take into account what they know about an entity or concept to determine what information to share.

Effectively sharing information that is both novel and relevant to the recipient requires children to appreciate others' mental states and to judge the recipient's knowledge and understanding (see Corriveau, Ronfard, & Cui, 2018). At a basic level, children need to bear in mind the information recipient's characteristics when sharing information. For example, by age 4, children consider with whom they are communicating and adjust their language accordingly. Children use shorter utterances and less complex speech when communicating information to younger children (Shatz & Gelman, 1973) and bilingual children alter their language choices based on their conversational partner's language (e.g., Nicoladis, 1998; Diesendruck, 2005; Petitto et al., 2001). In addition to the recipient's basic characteristics, children must also think about what their conversational partners do or do not know in order to communicate effectively (Clark, 1992). Children start to show this capacity early in development, but continue to refine it throughout the preschool years. As O'Neill (1996) has demonstrated, two-year-olds provide more verbal and non-verbal information about the location of a hidden object to a parent who is ignorant of its location than to a parent who witnessed it being hidden. Three-year-olds appear to be sensitive to whether they share knowledge with their conversational partner and they adjust the amount of information and explanation that they provide accordingly (Köymen, Mammen, & Tomasello, 2016). Five-year-olds also share different kinds of information depending on the recipient's knowledge state (e.g., they share generic information with an ignorant listener and specific information with a knowledgeable one; Baer & Friedman, 2018). Thus, children's information sharing appears to be guided by what they know about the recipient of the information.

Building on evidence that children consider another person's characteristics or knowledge state when sharing information, the current studies examine whether children select information to share with an unfamiliar individual based on a brief description of the individual's role in the division of labor. Providing information about a person's role should prompt children to draw inferences about what kinds of things that individual is likely to know or be interested in (Aguiar, Stoess, & Taylor, 2012; Lutz & Keil, 2002). Knowing about a person's role could also potentially signal what kind of information that individual would be interested in learning. In order to ensure that children did not rely on prior experience or associations with certain occupations, the information recipients in the current studies were described using relatively unfamiliar noun labels (i.e., "picture-maker" and "caregiver"). The use of noun labels (e.g., "doctor" or "carrot-eater") promotes strong inferences about an individual's behavior and traits among

children as young as 5-years-old (e.g., Gelman & Heyman, 1999; Kalish & Lawson, 2008). In the current studies, the use of a noun-label followed by a description of each information recipient's job was intended to prompt children to infer what kinds of information each character would find most relevant.

In Experiment 1, children were introduced to two characters with distinct labels and job descriptions and presented with two facts about an unfamiliar animal. One fact was about a physical feature of the animal, and the other was about the animal's behavior. For most items, the behavior was related to the physical feature (e.g., being able to see in the dark is a function of having large eyes). Given evidence that young children want to learn about the behaviors of novel animals (Greif et al., 2006) and that they prioritize information about causal properties over perceptual features when forming new concepts (e.g., Gopnik & Sobel, 2000), we expected children to show a stronger personal preference for or greater interest in the behavioral information and thus potentially to be biased toward sharing behavioral information. Furthermore, we expected that, because they have a stronger understanding of the division of cognitive labor (Danovitch & Keil, 2004; Keil et al., 2008), older children would be more likely to consider the recipient's role and share information about the surface features of an unfamiliar animal when that information was more relevant to the recipient.

Experiment 1

Methods

Participants

Twenty 5- and 6-year-old kindergarteners (5 male; $M = 5$ years 11 months; range = 5 years 5 months to 6 years 5 months), 20 7- and 8- year old second-graders (11 male; $M = 7$ years 10 months; range = 7 years 2 months to 8 years 3 months), and 17 9- and 10-year-old fourth graders (5 male; $M = 9$ years 11 months; range = 9 years 3 months to 10 years 4 months) were interviewed individually in a quiet area at their school or in a university laboratory. Fifteen university students (6 male) also completed a pencil-and-paper version of the task for credit in a psychology course. Children were recruited at elementary schools or from a laboratory database in a mid-size Midwestern city, and they were primarily Caucasian Americans from middle-class and upper middle-class families.

Materials

Each question involved an unfamiliar, real animal drawn from Greif et al.'s (2006) set of six unfamiliar animals, with two additions (see Appendix for complete list). Each animal was accompanied by a color photo of the animal measuring approximately 2 inches by 1.5 inches. For each animal, there were two facts (see Appendix): one about the animal's behavior (e.g., a tarsier can see very well in the dark), and one about the animal's appearance (e.g., a tarsier has big round eyes). The fact statements were of approximately equal length.

Procedure

Participants were told that they were going to pretend to visit a store filled with unusual animals. The experimenter instructed each participant that they would hear two facts about each animal and that their task was to choose which fact would be better to share with another person. After the participant indicated that they understood these instructions, the experimenter introduced the first character by placing a line drawing of an adult male on the table and saying: "Now, you are going to share information with Henry. This is Henry [pointing to drawing]. Henry is the animal caregiver at the store. His job is to take care of the animals." Then participants heard four

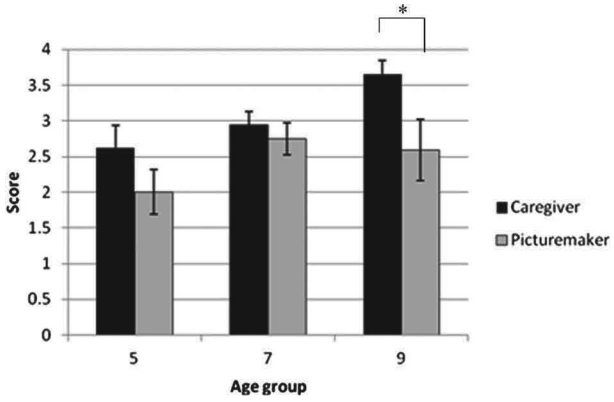

Figure 1. Number of trials (out of 4) in Experiment 1 where children selected the matching fact, shown according to type of trial. Error bars represent standard errors of the means. Asterisks denote significant differences between scores within each age group.

questions structured as follows: "This is a [name of animal]. Henry has never seen or heard of a [name of animal] before. What do you think Henry would want to know?" The experimenter then read both corresponding facts out loud (e.g., "A tarsier has big round eyes or a tarsier can see very well in the dark?") Children indicated their response verbally. After choosing what information to share about the first set of four animals, participants were introduced to a new character, Bob, accompanied by a different line drawing of a man, with the following statement: "Now, you are going to share information with Bob. This is Bob. Bob is the picture-maker at the store. His job is to make pictures of the animals." This introduction was followed by a second block of four questions structured the same way as in the first block. Note that the terms "caregiver" and "picture-maker" were used, rather than terms denoting familiar occupations such as "veterinarian" and "artist," in order to make it clear that these were not familiar individuals and to focus children's attention on the character's role rather than other factors (e.g., perceptions of intelligence or competence).

The order in which the characters and blocks were presented was balanced across subjects, as was the set of 4 animals presented in each block, yielding four different presentation orders. Within each block, the facts were presented so that children heard the appearance fact first or the behavioral fact first for an equal number of trials associated with each character.

Results and discussion

Piloting with adults revealed that adults shared information about each animal's behaviors with the caregiver 90 percent of the time and information about each animal's appearance with the picture-maker 95 percent of the time. Thus, adults perceived the information as well-matched with the target occupations. Participants received 1 point for each correct match between the character's occupation and the type of fact (e.g., selecting the behavioral fact for the caregiver), yielding a score of 0 to 4 for trials associated with each character. Preliminary analyses indicated no effects of presentation order. A 2 (character occupation) X 3 (age group) repeated measures ANOVA revealed main effects for character occupation, $F(1, 54) = 6.856$, $p = .011$, partial $\eta^2 = .113$, and age group, $F(2, 54) = 6.009$, $p = .004$, partial $\eta^2 = .182$, but no significant interaction of occupation and age, $F(2, 54) = .1.019$, $p = .368$, partial $\eta^2 = .036$. With respect to the character's occupation, children scored higher on the caregiver trials ($M = 3.05$, $SD = 1.03$) than on the picture-maker trials ($M = 2.44$, $SD = 1.35$), $t(56) = 2.533$, $p = .014$, Cohen's $d = .51$; see Figure 1). Bonferroni-corrected post hoc tests revealed that the effect of age group was driven by

9-year-olds scoring significantly higher than 5-year-olds. Thus, children became more adept at choosing the appropriate facts with age.

Planned comparisons of scores on each type of trial to chance performance (score of 2) revealed that each age group exhibited a different response pattern. Five-year-olds chose to share the behavioral fact with the caregiver at rates higher than chance, $t(19) = 2.459$, $p = .024$, Cohen's $d = 0.55$, but responded at chance on the picture-maker trials, $t(19) = 0$, $p = 1.00$, Cohen's $d = 0$. Seven-year-olds were significantly above chance for both types of trials, $t(19) = 5.146$, $p < .001$, Cohen's $d = 1.15$ and $t(19) = 3.290$, $p = .004$, Cohen's $d = .74$, respectively. In contrast, 9-year-olds consistently chose the behavioral facts on the caregiver trials, $t(16) = 8.641$ $p < .001$, Cohen's $d = 2.10$, but their responses in the picture-maker trials were no different from chance, $t(16) = 1.370$, $p = .189$, Cohen's $d = .33$. Because it is unlikely that older children had more difficulty following the instructions or understanding the statements than younger children, the results suggest that 9-year-olds may have reasoned differently about the picture-maker trials than their younger counterparts.

Examining individual scores among participants in each age group revealed that 5- and 7-year-olds' scores showed a normal distribution for both types of trials. Among 9-year-olds, the majority of participants (16 out of 17) scored a 3 or 4 on the caregiver trials, but there was a bimodal distribution of scores on the picture-maker trials, with six children (35%) choosing to share facts about behaviors with the picture-maker character on every trial or all but one trial. Thus, the average responses of the 9-year-olds on the picture-maker trials resembled those of 5-year-olds, but instead of representing random responding, these data instead reflected a bimodal distribution. The majority of 9-year-olds consistently matched information to occupation as expected, while a subset of that age group exhibited a consistent preference for sharing information about the novel animal's behaviors with both characters. This latter group may have inferred that the behavioral information could still be useful to the picture-maker in order to meet his goals.

Experiment 2

In Experiment 1, children in all age groups shared information about animal behaviors with the caregiver character. However, when sharing information with the picture-maker character, the 5-year-olds' random response pattern suggests that they were uncertain about which information to share. In addition, a subset of 9-year-olds appeared to have decided to share the behavioral facts regardless of the recipient's role, perhaps because they viewed information about an animal's behavior as more valuable for identifying an unfamiliar animal (Shipley, 2000) or because they were more interested in behaviors than appearances (see Greif et al., 2006). In order to determine whether a preference for behavioral information over surface feature information was driving children's choices in Experiment 1, Experiment 2 began with a measure of children's preferences for each type of information.

Five-year-olds' random choices in the picture-maker trials in Experiment 1 may have reflected the challenge of remembering and coordinating multiple pieces of information, or difficulty comprehending the picture-maker's role. Thus, the second goal of Experiment 2 was to reduce the cognitive demands of the original task by asking children to indicate which of two potential recipients would find a particular fact more useful, rather than choosing which information to share with a given recipient. This design reduced the working memory demands of the experiment by reducing the number of facts that children had to maintain in working memory from two to one and simplified the procedure by presenting the same instructions for all questions.

Because 7-year-olds appeared to have no difficulty understanding the task in Experiment 1, the bimodal pattern of responses among 9-year-olds was unlikely to reflect problems comprehending the instructions or remembering the facts. Instead, some of the older children may have

made assumptions that led them to overestimate the scope of the picture-maker's role. That is, the 9-year-olds who consistently shared behavioral information with the picture-maker may have inferred that in order to portray each animal in his pictures, the picture-maker character would also need to know about the animal's behavior (e.g., where the animal sleeps) and, since behavioral information is less readily accessible than information about surface features, it would be the most valuable piece of information to share with the picture-maker as well. In order to address this possibility and ensure that children understood each of the character's roles, in Experiment 2, children had an opportunity to explain each character's occupation before hearing the job description and children who went beyond the job "title" were corrected to ensure that they understood the scope of the each character's role.

Methods

Participants

Twenty-four 5- and 6-year-old kindergarteners (12 male; $M = 5$ years 10 months; range = 5 years 3 months to 6 years 4 months), 20 7- and 8-year-old second-graders (10 male; $M = 7$ years 11 months; range = 7 years 2 months to 8 years 4 months), and 24 9- and 10-year-old fourth-graders (13 male; $M = 9$ years 11 months; range = 9 years 2 months to 11 years 0 months) were interviewed individually in a quiet area at their school or in a university laboratory. Children were recruited at elementary schools or from a laboratory database in a mid-size Midwestern city, and they were primarily Caucasian Americans from middle-class and upper middle-class families.

Materials and procedure

Fact preference task. The experimenter began by stating: "Pretend you are an explorer and you are discovering all kinds of new animals. You are learning a lot of new things about each animal, but since you don't have such a great memory and it's going to be a long time before you get home, you need to decide which fact you are going to keep in your animal book. I'm going to tell you two facts about each animal, and you decide which one you want to put in your book. Collect the most important facts for your animal factbook because you can only keep one fact for each animal." The experimenter then presented an image of an unfamiliar animal and asked: "This is a [name of animal]. Which fact about a [name of animal] do you want to keep?" This question was followed by a statement about the animal's behavior and a statement about the animal's appearance. There were eight trials using the same animals, images, and facts as in Experiment 1. The animals were presented in one of two random orders. The order in which children heard each fact statement was balanced across participants, with children hearing statements about behavior or surface features first on half of the trials.

Recipient selection task. Immediately after completing the fact preference task, children were told that they were going to be playing a different game and introduced to "two people who work in a store that has all sorts of unusual animals." The experimenter then placed a line drawing of a man on the table and said: "This is Bob. Bob is the picture-maker at the store. What kinds of things do you think Bob does?" After the child responded to this question, the experimenter said "His job is to make pictures of the animals." Then the experimenter introduced a second character, accompanied by a similar drawing, and said: "This is Henry. Henry is the animal caregiver at the store. What kinds of things do you think Henry does?" After recording the child's response, the experimenter said: "His job is to take care of the animals." Participants were then told that there were some new animals coming to the store and that Henry and Bob needed to learn certain things about them so that they could do their jobs. They were told that there was only enough time to tell one of them each fact, so the participant should decide who needs to know

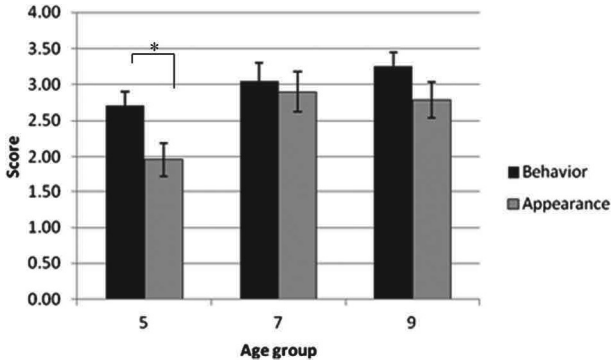

Figure 2. Number of trials (out of 4) in Experiment 2 recipient selection task where children selected the appropriate character, shown according to type of fact presented. Error bars represent standard errors of the means. Asterisks denote significant differences between scores within each age group.

that fact so that he can do his job. In order to emphasize the need to choose the best recipient for the information, the experimenter also pointed out that the two characters could not talk to each other and that only one of them could hear each fact. The experimenter then presented a statement about each of the eight novel animals, accompanied by a picture, in the following format: "This is a [name of animal]. [Statement about the animal's behavior or appearance.] Who do you think needs to know that fact?" The animal names, images, and statements were identical to the previous experiment. Four of the statements described the animal's behavior and four described the animal's surface features.

Animals were presented in one of two random orders, where behavioral facts were presented for half the animals and appearance facts were presented for the other half of the animals. The facts were presented in pseudo-random order with no more than two of the same type of fact in a row. Which fact was presented with each animal was also balanced between subjects, as was the order in which the characters were introduced, yielding a total of eight different combinations of character and fact presentation.

Results and discussion

Fact preference task. Children received 1 point each time they chose the behavioral information, yielding a score of 0 to 8. Preliminary analyses showed no effect of presentation order. A one-way ANOVA revealed no effect of age group, $F(65) = 4.93$, $p = .613$. Planned comparisons to chance (score of 4) revealed that only the 7-year-olds chose the behavior facts significantly more often than chance, $M = 5.20$, $SD = 1.58$, $t(19) = 3.405$, $p = .003$, Cohen's $d = .76$. The 5-year-olds' ($M = 4.63$, $SD = 1.74$) and 9-year-olds' ($M = 4.92$, $SD = 2.30$) scores were not significantly different from chance, $ts \leq 3.405$, $ps \geq .063$, Cohen's $ds \leq .40$. There was no evidence of a bimodal distribution of scores in any age group. Hence, when identifying the most valuable information about each unfamiliar animal, only 7-year-olds showed a clear preference for behavioral information. Although young children show a preference for learning about causal properties over superficial features (e.g., Gopnik & Sobel, 2000), it may be that this particular set of animal characteristics was of sufficient novelty or interest that the 5-year-olds found it difficult to choose between the facts. Older children (i.e., the 9-year-olds) may have also recognized the correspondence between the physical features and the animal behaviors and thus found the facts to be of similar value (e.g., assuming that if one kept the information that the animal has big eyes, then one could later infer that the animal sees well in the dark.)

Recipient selection task. All children generated a reasonable description of each character's job (e.g., that the caregiver's job was to feed and care for the animals) during the introduction to the recipient selection task. Children received 1 point for each correct match between the statement and the character (e.g., selecting the caregiver to hear the statements about behavior), yielding a score of 0 to 4 for trials associated with each type of fact. Preliminary analyses showed no effects of order. A 2 (statement type) X 3 (age group) repeated measures ANOVA revealed main effects for statement type, $F(1, 65) = 6.662$, $p = .012$, partial $\eta^2 = .093$, and age, $F(2, 65) = 5.022$, $p = .009$, partial $\eta^2 = .134$, but no significant interaction of statement type and age, $F(2, 65) = .947$, $p = .393$, partial $\eta^2 = .028$ (see Figure 2). Overall, children scored higher on trials involving statements about behaviors ($M = 3.00$, $SD = 1.01$) than on trials involving statements about the animal's appearance ($M = 2.53$, $SD = 1.25$, $t(67) = 2.695$, $p = .009$; Cohen's $d = .41$). Post-hoc Bonferroni tests revealed that the effect of age group was driven by significant differences between the 5-year-olds and each of the other two age groups.

Planned comparisons revealed that both the 7- and 9-year-olds chose the appropriate character for each type of fact more often than chance, all $ts > 3.192$, $ps \leq .005$, Cohen's $ds > .65$, but 5-year-olds only did so for the behavior facts, $t(23) = 3.635$, $p = .001$, Cohen's $d = .74$. Thus, even though the task demands were reduced from the prior experiment, 5-year-olds only partially understood the correspondence between the information to be shared and with whom to share it. However, in contrast to Experiment 1, 9-year-olds showed a consistent understanding of the correspondence between information about the animal's appearance and the picture-maker's role and there was no bimodal pattern of individual responses. This result supports the explanation that some of the 9-year-old's responses in the previous experiment were driven primarily by misunderstanding the scope of the picture-maker's role rather than an inability to appreciate the correspondence between each type of information and each character's role.

General discussion

The current studies demonstrate that children's recognition of what information to share based on the recipient's occupational role undergoes substantial development during the elementary school years, and that even older children may struggle to make these decisions at times. When provided with a noun-label and a description of an information recipient's occupation, 5-year-olds had more difficulty than 7- and 9-year-olds in determining which statements to share. Moreover, even when the task was modified so that it required keeping less information in memory and the child's own information preferences were no longer a factor, there was still a marked improvement between ages 5 and 7 in children's consideration of the recipient's role when sharing information.

Making the leap from what you want to know to putting yourself in the place of your conversational partner may require more than a basic appreciation of other individual's knowledge states or inhibiting your personal preferences. It requires recognizing the pieces of your own knowledge that are most important for understanding a new concept and disregarding those that lie at the periphery. The results of the current studies suggest that although 5-year-olds have some understanding of how to share information effectively (e.g., Baer & Friedman, 2018; Köymen et al., 2016), they may find it challenging to coordinate the information they receive with what they know about the recipient. Moreover, although children younger than age 5 have some understanding of novel experts (e.g., a bicycle expert, Lutz & Keil, 2002), in the current studies, the novel label and description of the character's role and the absence of any reference to "expertise" may have compounded the challenge of inferring what the character would want to know. Perhaps if the characters had been described as a "veterinarian" or "artist" instead, 5-year-olds would have had more consistent intuitions about what type of information to share with each one. Likewise, 5-year-olds' overall preference for sharing information with the caregiver in

Experiment 2 may reflect a bias toward caregivers, which aligns with evidence that children this age view animal caregivers as more competent or knowledgeable than other people (see Boseovski & Thurman, 2014).

Finally, it may be no coincidence that children's ability to share relevant information appears to improve as they gain more experience with formal education. As children progress through elementary school, they are exposed to and expected to acquire information about diverse topics, and their success may rely on learning how to efficiently identify and communicate what is most important about new concepts. Consequently, these findings have implications for how we teach young children, and what we expect from them in the context of everyday conversation, educational testing, and, importantly, legal testimony. For instance, rather than asking a kindergartener to tell you what they know (e.g., "tell me about frogs"), it may be helpful to scaffold children's information sharing by asking specific probing questions (e.g., "what do frogs look like?"). For adults, knowing what information to share (and not to share) with other people can determine one's social and legal standing in the community. This ability is no less critical for children. However, although children are able to seek out information by the time they enter elementary school, this skill does not necessarily translate to knowing how to effectively share information in turn.

ORCID

Judith H. Danovitch http://orcid.org/0000-0002-6405-5786

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Appendix

Animals and statements used in Experiments 1 and 2.

Animal name	Fact about behavior	Fact about appearance
Orycteropus	An orycteropus digs burrows to sleep in at night.	An orycteropus has large feet with pointy toes.
Tarsier	A tarsier can see very well in the dark.	A tarsier has big round eyes.
Saiga	A saiga can run really fast.	A saiga has tall thin legs.
Tapir	A tapir likes to know the smell of its food.	A tapir has a large pointy nose.
Pangolin	A pangolin rolls into a ball when it is scared so its hard shell can protect it.	A pangolin has scales all over its body that are each about 1 inch wide.
Civet	A civet likes to eat fruits.	A civet has a nose with whiskers.
Mara	A mara is able to gallop or bounce on its feet.	A mara has three toes on its back feet.
Cantorii	A cantorii comes out of the sand twice a day to breathe.	A cantorii's shell has small black dots that are hard to see.