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Changing your mind about things unseen: Toddlers' sensitivity to prior reliability

Patricia A. Ganea [a,*], Melissa A. Koenig [b], Katherine Gordon Millett [b]

[a] Department of Psychology, Boston University, Boston, MA 02215, USA
[b] Institute of Child Development, University of Minnesota, Minneapolis, MN 55455, USA

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ABSTRACT

The goal of this research was to investigate the extent to which young children use the past reliability of another person's statements to make inferences about the accuracy of that person's claims about a hidden toy. When children interacted with a previously reliable speaker, both 30- and 36-month-olds searched in the new location of the toy, in line with the speaker's statement. When children interacted with an unreliable speaker, the 36-month-olds were less likely to rely on her false statement and instead searched either in the original location of the toy or in a neutral location. The 30-month-olds, however, searched in the location indicated by the speaker even when the speaker was unreliable. These results show that by 36 months of age, children begin to use reliability in processing a speaker's episodic claims and can flexibly update their representations of absent objects depending on the reliability of the speaker.

Introduction

Children learn a tremendous amount from people around them, beginning in infancy (Baldwin & Moses, 1996; Csibra & Gergely, 2009; Gelman, 2009; Harris, 2007; Koenig, 2010). Presumably, this learning accelerates and takes on new significance when language becomes a vehicle by which children can gain new information. However, communication systems carry with them certain well-known costs or risks. One such risk stems from the fact that not all informants are created equal; rather, speakers vary in their knowledge, beliefs, values, and areas of competence. For this reason, one

* Corresponding author. Fax: +1 617 353 6933.
E-mail address: pganea@bu.edu (P.A. Ganea).

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important developmental question concerns the extent to which children come to be open but discriminating consumers who learn about objects and events from what others tell them while being alert to the cues that signal potential misinformation.

Recent research indicates that by the end of their second year of life, children can update their knowledge of an absent object on the basis of another person's testimony (Ganea & Harris, 2010; Ganea, Shutts, Spelke, & DeLoache, 2007). For example, if told about a change in the physical property of an object when not in view, 23-month-olds subsequently select the object that displays the new property rather than the original unchanged object, indicating that they used the verbal input to update their representation of the object (Ganea et al., 2007). In addition, 30-month-olds who had seen an object placed in Location A subsequently searched at Location B if they were told, during their brief absence from the room, that the object had been moved from A to B. Thus, 30-month-olds are able to update their knowledge of a hidden object and search accurately when informed by another person that the object has been moved (Ganea & Harris, 2010).

When children update their existing knowledge based on another person's testimony, does it derive from an unchecked bias to believe what they are told? By 2 years of age, if not earlier, children do not extend an inflexible indiscriminate trust when learning new words (Koenig & Woodward, 2010). In addition, 16-month-olds look longer at a speaker who mislabels familiar objects than at one who labels objects truthfully (Koenig & Echols, 2003), and by 24 months of age children learn new object labels from previously accurate informants, not inaccurate ones (Koenig & Woodward, 2010). Also, a set of recent findings on children's selective learning shows that preschoolers adaptively track variable records in speakers' prior reliability and prefer to learn new object labels or functions from previously accurate informants (Birch, Vauthier, & Bloom, 2008; Corriveau & Harris, 2009; Jaswal & Neely, 2006; Koenig, Clement, & Harris, 2004; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007; Scofield & Behrend, 2008).

Semantic accuracy is central to these experiments; that is, a speaker's reliability hinges on his or her accuracy when labeling objects, and children's trust is typically measured by assessing their willingness to learn new object labels or functions from that person. However, the reliability of a particular speaker is also important in domains where the information is not semantic but rather episodic (as in object locations). Do children modulate their learning from an unreliable speaker whose inaccuracy derives not from semantic mistakes but rather from the inaccuracy of episodic claims that describe facts that happen in the "here-and-now"? This is an interesting question because, in contrast to the meanings of words, the locations of locally available objects can often be determined by direct observation, which might make assessing speaker reliability for these types of messages less important. On the other hand, relative to the domain of object naming for which veridical testimony is the norm, communication about episodic matters may be less reliable and more prone to innocent mistakes, memory failures, deliberate manipulation, gossip, and the like. The current study had two goals: (a) to assess whether toddlers monitor the prior (un)reliability of an informant who makes claims about an object's location and (b) to assess whether toddlers use an informant's past reliability to assess her current claims concerning the location of a hidden object. Specifically, we examine whether children, after having directly observed an object's location, can *resist* revising that knowledge when presented with information from an unreliable source.

A recent study investigating children's understanding of deception indicates that until 4 years of age, children do not have the ability to appreciate another person's statement as false and subsequently infer the location of an object on the basis of that false statement. In Mascaro and Sperber's (2009) study, children needed to infer the location of a marble from a puppet's false statement that "the marble is in the red box." Because children had been previously informed that the puppet always told lies, it was appropriate to look elsewhere (in the blue box) than where the puppet said the marble was located. However, only the 4-year-olds in this study made this inference. The 3-year-olds trusted the lying character and searched in the indicated red box on several repeated trials. Further evidence for credulity among 3-year-olds comes from research by Jaswal, Croft, Setia, and Cole (2010), who found that children of this age repeatedly chose to search for a sticker in the wrong place based on assertions made by an inaccurate and "tricky experimenter." According to Jaswal and colleagues, children's difficulty in discounting testimony received from another speaker may stem from a highly specific bias to trust what other people say.

In the current research, we similarly asked whether children defer to statements about an object's location without regard for the speaker's prior reliability. However, three important differences characterize the current research design. First, the executive demands of the task were reduced by removing the hiding locations from view as the relevant location information was given. In the studies by Mascaro and Sperber (2009) and Jaswal et al. (2010), children could see the containers at the time when the puppet or the experimenter informed them that "the sweet/sticker is in the red box." Children may have had difficulty inhibiting a search in the red box given that it was jointly attended to and part of the common ground when the information was given. If children's difficulty in discounting others' false testimony stems from an inability to inhibit the expectation that what others say is true, we should expect that reducing the inhibitory demands of the task would help children to overcome the "trust bias." Other research has shown that children are more likely to inhibit their search in misleading locations if the executive demands are reduced, for example, by the use of an arrow or a marker rather than an ostensive finger point or an overt message (Couillard & Woodward, 1999; Jaswal et al., 2010). Yet another way to reduce the task demands is to have the containers out of view when relevant claims are made (Ma & Ganea, 2010).

Second, at the time of search, the speaker was not in view, thereby eliminating the possibility that children complied with the speaker due to demands of interacting with an authority figure. Third, when faced with false information, children in this research could revert to their own existing knowledge as a basis for their search. We provided children with two locations as alternatives to the named location: the original location of the toy and a third neutral location. If children were suspicious of the unreliable informant's false claims, they could either revert to their knowledge of the event as previously stored in memory or infer that the toy must be in a different location from the one communicated by the informant. Thus, under conditions of uncertainty regarding something not directly perceived, children could either decide not to follow the speaker's testimony at all or use that information to infer an alternative location of the toy.

Given evidence that by 30 months of age children can use others' information about a change in an object's location (Ganea & Harris, 2010), we tested 30- and 36-month-olds to examine whether they can selectively update their representation of an object's location depending on the reliability of the speaker. Based on prior findings indicating that infants and toddlers are sensitive to the reliability of a person (Koenig & Woodward, 2010; Poulin-Dubois & Chow, 2009; Zmyj, Buttelmann, Carpenter, & Daum, 2010), we expected children to resist searching for an object in the stipulated location when interacting with an unreliable speaker. Instead, we expected children to search in either the original location of the toy or an alternative location in the room. If children in this study are capable of inferring the alternative location of a toy when they have reason to doubt a speaker, it would provide evidence that they bring an "epistemic vigilance" toward others' messages (Mascaro & Sperber, 2009): That is, they may appreciate the falsity of another person's statement and use that information to reason about alternative possibilities to that stipulated reality.

Method

Participants

The participants were 64 children: 32 30-month-olds (16 girls and 16 boys, mean age = 30.9 months, range = 28.8–33.0) and 32 36-month-olds (16 girls and 16 boys, mean age = 36.9 months, range = 34.6–38.6). Half of the children in each age group were randomly assigned to the reliable informant condition, and half were assigned to the unreliable informant condition, with equal numbers of boys and girls in each condition. An additional 19 children were excluded from the study due to fussiness (3), unwillingness to point out locations in the room (9), failure of memory check (2), and experimenter error or technical failure (5). All children were English-speaking and were recruited from a database of volunteers and birth records published in the local newspaper. The majority were from White middle-class families. Half of the children in each condition were tested at Boston University, and the other half were tested at the University of Minnesota.

Materials

The experimental setup was similar to the one used by Ganea and Harris (2010). Three hiding locations were used: a three-drawer cabinet, a green cloth bag placed on top of a blue ottoman (referred to as a "bag"), and a beige box with a removable lid. An opaque curtain was hung in the room to create an inner space (218 × 113 inches) containing the hiding locations and an outer space (34 × 113 inches). A transparent plastic window was inserted in the curtain (8.5 × 11 inches) 44 inches from the floor; children could not see through it unless lifted by an adult. Two stuffed animals served as hiding objects: a blue hippopotamus and a brown monkey. An identical second hippo and monkey were also used. The purpose of the second set of toys is explained below. One camera was placed near the curtain to record the experimental session.

Procedure

The procedure consisted of four components: a familiarization phase, a reliability phase with three trials, a hiding event, and a test phase with two trials.

Familiarization phase

The familiarization phase was designed to ensure that the child was familiar with the three hiding locations. Two experimenters played a hiding game with the child. One experimenter (E1) hid a toy in one of the three locations (e.g., in the drawer) while the second experimenter (E2) was sitting behind the curtain. The child sometimes helped E1 hide the toy, depending on how willing the child was to play the game. After the toy was hidden, one of the experimenters asked the child to indicate the location of the toy (half of the children were asked by E1, and the other half were asked by E2). This activity was repeated for all three locations. Then the child was asked three reminder questions to ensure knowledge of the three locations (e.g., "Where is the drawer?"). At the end of this phase, the toy was left in the middle of the room. Then E1 and the child moved behind the curtain for the reliability trials while E2 stayed in the main room. The parent either stayed in the main room or went with the child behind the curtain.

Reliability phase

Three reliability trials[1] were conducted to establish E1 as either a reliable informant or an unreliable informant. At the end of the familiarization phase, E1 (the informant) told the child, "Now E2 will hide the monkey and we will go behind the special curtain. Ready? Let's go behind this special curtain." As E2 hid the monkey in one of the three hiding locations, the informant said to the child, "Oh look, this curtain has a window in it. I'm going to look through this window and tell you what I see. Guess what! I see E2. E2 is moving the monkey. E2 is moving the hippo to the drawer. Now the monkey is in the drawer." When giving the child this testimony, the informant alternated looking through the window and making eye contact with the child. Then the informant opened the curtain and asked the child to go find the monkey. While the child searched, the informant remained behind the curtain to ensure that the child would not be pressured to search in a particular location because the adult informant was present. She told the child, "Can you find the monkey? I'm going to stay back here."

The only difference between the two conditions was that in the reliable condition the informant identified the true location of the toy, whereas in the unreliable condition she identified one of the two remaining locations. In the reliable condition, after the child searched in the location indicated, the informant reinforced her status as an accurate informant (e.g., "I was right. I told you it was in the drawer and it was there. I was right."). If the child searched in a different location from the one indicated by the informant, the child was shown the correct location of the toy. This occurred on only 15 of 108 reliability trials for all children. In the unreliable condition, after the child searched in the location indicated by the informant, E2 retrieved the object from the correct location by saying, "Here

[1] Based on previous research, we considered that children would need more than one trial of a mistaken behavior to infer that the person is not reliable. An analysis of children's behavior after one instance of mistaken behavior confirmed that one reliability trial was not enough to induce mistrust on the subsequent trials (the next two reliability trials and test trials).

it is!'' Then the informant got the child's attention and said, for example, ''Oh no, I was wrong! I told you it was in the drawer and it was not there. I was wrong. Let's do it again.'' If the child searched in a different location from the one indicated by the informant, she then found the toy (to ensure that this was the case, E2 surreptitiously placed the same kind of toy in each of the remaining two locations). At the completion of this reliability trial, E1 and the child went behind the curtain again and the same procedure was repeated using the other two hiding locations. After three reliability trials, the stuffed animal was switched and the hiding event followed by the two test trials began.

Hiding event and test trials

At the end of reliability phase, the informant (E1) encouraged the child to hide the animal in one of the three locations. The location in which the toy was hidden during the first and second test trials was randomized across trials. After the toy was hidden, the informant asked the child to point to the three locations (e.g., ''Can you show me the box? Where is the box?'') and to where the toy was hidden (e.g., ''Can you show me where the hippo is?''). To be considered in the final analysis, the child needed to state or point to the location of the animal and of the other hiding places in the room. If the child did not remember the location of the toy, the experimenter showed the child where the toy was and then repeated the question. If the child was incorrect again, the experimenter continued with the procedure but the child's data were excluded for not passing the memory check. After the memory check, the child went behind the curtain with the informant (E1) while E2 remained inside the room. While behind the curtain, the informant told the child about the change in location while looking through the window in the curtain: ''Guess what! E2 is moving the hippo! E2 is moving the hippo from the [*old location*] to the [*new location*]. Now the hippo is in the [*new location*].'' Then the experimenter pulled the curtain and asked the child to go find the hippo while she remained behind the curtain. The new location that the informant indicated to the child was randomized across children.

In the reliable condition, E2 placed the object in the new location. Thus, if children established that the informant was trustworthy during the reliability trials, they were expected to go to the *new* location and find the toy on searching. By contrast, in the unreliable condition, if children doubted the reliability of the informant, they were expected to disregard her testimony about the new location and instead search in either the *old* location (where children had left the toy) or the third (*neutral*) location. Given these two plausible search strategies, it was important that children find the toy in either of these two locations on their search. Accordingly, in the unreliable condition, E2 left the hippo in its original location (the old location) and also placed a second hippo in the neutral location. Thus, in both the reliable and unreliable conditions, children's decisions to search in the correct location (either by following the accurate speaker or by not following the inaccurate speaker) were immediately rewarded by finding the toy. On the other hand, children's incorrect decisions (i.e., failing to follow accurate testimony in the reliable condition or following inaccurate testimony in the unreliable condition) were met with not finding the toy initially. If children did not search a second time spontaneously, the informant (E1) simply said, ''Where is the hippo? Look for it again!'' until the children found the toy in one of the locations.

Coding

Films of test sessions were coded to identify whether children searched in the location indicated by the speaker. Interrater agreement ranged from 98.75% for the reliability trials to 100% for the test trials (Cohen's kappa = .971). Disagreements were resolved by a third person.

Results

There were no significant differences in children's searching behaviors across the two testing sites; thus, the data were collapsed. First, we used nonparametric procedures to examine differences in children's test performance between the reliable and unreliable conditions. Children's scores across the two test trials were summed for a total score ranging from 0 to 2 depending on the number of trials on which they searched where the informant told them to search. A Mann–Whitney *U* test on

Table 1
Number of children who followed the speaker's statement across zero, one, or two test trials as a function of age and condition.

Reliable				Unreliable			
Age (months)	0 trials	1 trial	2 trials	Age (months)	0 trials	1 trial	2 trials
30	1	2	13	30	4	2	10
36	1	2	13	36	5	5	6

the total score indicated a main effect of condition, $U = 341$, $df = 63$, $p = .006$. Overall, children did as they were told significantly more in the reliable condition (on 88% of trials) than in the unreliable condition (on 60% of trials). Thus, children were more likely to search at the new (informed) location of the toy when the information came from a previously accurate speaker than when it came from a previously inaccurate speaker. A Mann–Whitney *U* test on the total test score did not reveal a main effect of age ($p = .35$).

Because no overall age effect was found, we examined whether the percentage of trials on which the two age groups followed the speaker's testimony within each condition was significantly different from chance (.33). In the reliable condition, both the 30- and 36-month-olds followed the speaker's accurate testimony on 88% of trials, a level significantly above chance ($p < .01$, binomial test). However, in the unreliable condition, whereas the 30-month-olds used the misleading information on 68% of trials ($p < .01$), the 36-month-olds did so on only 53% of trials ($p = .90$). Thus, although both age groups followed the speaker significantly in the reliable condition, only the 30-month-olds did so in the unreliable condition.

We also analyzed the robustness of children's tendency to consider or disregard the speaker's testimony by analyzing the consistency of their performance across the two trials. Table 1 shows the number of children who searched at the new location on zero, one, or two trials. A chi-square by association indicated that the number of 36-month-olds who went to the location indicated by the speaker on two consecutive trials was significantly different across the two conditions, $\chi^2(1, 31) = 8.32$, $p < .05$. The majority (81%) of 36-month-olds in the reliable condition consistently followed the testimony of the speaker, whereas in the unreliable condition only a minority (37.5%) did so. However, this was not the case for the 30-month-olds; the majority went to the new (informed) location on two consecutive trials in each condition ($p = .43$).

Given the two search alternatives that children had when presented with the misleading information, we also considered what children did when they did not follow the testimony of the unreliable speaker. Across the two test trials, the majority of searches (18 of 25) were in the original location of the toy (9 of 10 30-month-olds and 9 of 15 36-month-olds), with fewer searches (7 of 25) in the neutral location (1 of 10 30-month-olds and 6 of 15 36-month-olds). The percentage of searches in the original location of the toy was significantly different from chance ($p < .05$, binomial test).

To summarize, the accuracy of the speaker had an impact on whether children used her statement about the object's location to update their representation of the object. Children's search behaviors across the two conditions in this research suggest that between 30 and 36 months of age, children's willingness to revise their knowledge of something not directly perceived begins to be influenced by their level of trust in the speaker.

Discussion

The goal of this research was to investigate the extent to which young children use a speaker's reliability when evaluating episodic claims about the world. We found that the past accuracy of the speaker had an impact on whether children used a person's current statement about an object's location when searching for a concealed object. By 36 months of age, children were less willing to update their representation of an absent object's location when the speaker had previously given inaccurate information about object location. Instead of searching in the location indicated by the speaker, children searched either in the original location of the toy (where they themselves had hidden it) or in a

neutral location, suggesting that they encoded her false statement and then reasoned that the toy must be elsewhere in the room. When children interacted with a reliable speaker, both the 30- and 36-month-olds searched in the object's new location, in line with the speaker's statement. This is consistent with previous research showing that children as young as 30 months of age update their representation of an absent object's location on the basis of another person's testimony and search in the new location of the toy (Ganea & Harris, 2010).

This set of findings adds to previous research in two important ways. First, it shows that by 36 months of age children prove to be sensitive to the (un)reliability of a speaker's claims about episodic events and not just to semantic inaccuracy as in most previous studies. Second, it shows that by this age children also use an informant's past reliability as a guide to his or her reliability with respect to episodic (location) information and not just with respect to object names and functions (Nurmsoo & Robinson, 2009). When learning specific information such as the location of a hidden toy, children might weigh the benefit of gaining new information more heavily than the risk of learning something false. However, consistent with previous research, the current study indicates that despite their initial credulity (Couillard & Woodward, 1999; Jaswal, 2010; Jaswal et al., 2010; Ma & Ganea, 2010), by the end of their third year of life children begin to appreciate that other people may provide unreliable information about the world and they take this as relevant to their future interactions with such people (Koenig & Woodward, 2010; Ma & Ganea, 2010; Poulin-Dubois & Chow, 2009).

The evidence presented here further suggests that children can reason rather flexibly about others' false statements earlier than previously thought. According to Mascaro and Sperber (2009), full-fledged vigilance toward deception requires an understanding of the intention to deceive in addition to the ability to recognize the falsity of statements and to draw appropriate inferences from them. However, as the authors argued, one could in principle lack the ability to understand an informant's intention to deceive but nonetheless be able to draw appropriate inferences from a false statement. The current findings suggest that without the ability to take into account the deceptive intent of the informant and the moral significance this carries, by 3 years of age children have developed the ability to assess the falsity of another person's speech content.

In the current study, the majority of 36-month-olds searched in a location other than the one the speaker indicated on at least one trial, suggesting that (a) they were skeptical about what the speaker had told them and (b) they had made the inference that the toy was *not* in the informed location. During the test trials, when the same speaker who had given them false information in the past told them about a toy's new location, the 36-month-olds frequently searched either in the original location of the toy or in a neutral location rather than where they had been told to search. Whether children in the current research further reasoned about the possible alternative location of the toy ("The toy is not in B; therefore, it must be in C") or simply searched in the two remaining locations randomly ("The toy is not in B; therefore, it must be somewhere else in the room") is an interesting question for future investigation. Children's searches revealed that on the majority of trials, they chose to search in the original location of the toy, indicating that children preferred to revert to their initial knowledge of the object's location when faced with an unreliable speaker.

One factor that may have contributed to children's level of vigilance in our study is that when children received the false information, the containers were not in view. In the studies by Mascaro and Sperber (2009) and Jaswal et al. (2010), children may have had difficulty inhibiting a search in the box that was named by the experimenter (or puppet) because it was jointly attended to at the time the information was received by the children. This would be consistent with previous research showing that children have difficulty in responding correctly in tasks that place high demands on their inhibitory control skills (Carlson & Moses, 2001). Although children could not see the sticker in the red box, the red box was emphasized when the information about where to look for the sticker was given (Jaswal et al., 2010). These inhibitory demands were reduced in the current research by having the containers out of view when the information was given and by having the speaker out of view at the time of search (see also Ma & Ganea, 2010).

One interesting goal for future research is to assess the role of the speaker's intention in how children judge other people's trustworthiness. In the current research, the unreliable speaker apologized and verbalized that she was mistaken when children discovered her statement to be wrong, and this may have led the children to interpret her intentions as benevolent. When a person signals his or her

intention to help, children may be more forgiving and trusting even in the face of the person's mistakes. If, on the other hand, the person's intention is to hinder, children may stop trusting the person more readily. Future research is needed to see whether toddlers would be less likely to follow the speaker's statements when given evidence of malevolence.

Another issue that deserves attention is the fact that the 30-month-olds in this research were not sensitive to the speaker's tendency to give false information. In both the reliable and unreliable conditions, the 30-month-olds tended to search at the new location in line with the speaker's testimony. Together with the results of Ganea and Harris (2010) regarding children's ability to use another person's statement about location to update their object representation, the current findings suggest an interesting developmental story. As shown previously, at 23 months of age, children often perseverate to an object's previous location, thereby showing difficulty in updating on the basis of another person's verbal input. By 30 months of age, children can update across a variety of conditions (Ganea & Harris, 2010; Ganea & Harris, 2011), but as shown here, they may do so without regard to the speaker's past accuracy. Thus, although 30-month-olds no longer perseverate to the object's previous location, they do not inhibit their reliance on the verbal information given by the adult even when that information is likely to be false. By 36 months of age, however, children become able to take into account both the verbal information the speaker provides with respect to a hidden object's location and the past accuracy of the speaker.

In conclusion, the current study shows that by 36 months of age, children begin to use reliability information when processing a speaker's episodic claims and can flexibly update their representations of absent objects depending on the reliability of the speaker. Children were less likely to rely on verbal information about an object's new location when the information came from someone who had been inaccurate in her past reports about object location. Previous research on young children's use of informant testimony has centered largely on the domains of language learning (e.g., Koenig & Woodward, 2010) and object functions (Birch et al., 2008; Zmyj et al., 2010), domains in which principles of conventionality guide our practices. The finding that young children appeal to prior reliability when interpreting specific episodic messages about an object's location confirms that children regard conventional and semantic violations not only as potent signals of unreliability but also as local idiosyncratic mistakes. Thus, even in a domain where children can typically rely on their own direct search procedures and their own firsthand knowledge, children's use of testimony proved to be sensitive to the accuracy of the informant. These findings call attention to the importance of examining a wide variety of domains (both social and nonsocial, both idiosyncratic and conventional) to develop a comprehensive account of the appraisal processes children use to evaluate testimony throughout development.

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