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***Children's Selective Learning from Others.* Review of Philosophy and Psychology,**  
**1 (4). pp. 551-561. ISSN 1878-5158.**

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## Children's Selective Learning from Others

Erika Nurmsoo · Elizabeth J. Robinson ·  
Stephen A. Butterfill

Published online: 30 November 2010  
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**Abstract** Psychological research into children's sensitivity to testimony has primarily focused on their ability to judge the likely reliability of speakers. However, verbal testimony is only one means by which children learn from others. We review recent research exploring children's early social referencing and imitation, as well as their sensitivity to speakers' knowledge, beliefs, and biases, to argue that children treat information and informants with reasonable scepticism. As children's understanding of mental states develops, they become ever more able to critically evaluate whether to believe new information.

When learning about the social and physical, one of the most valuable sources of information is other people. The ability to learn from others brings great advantages, allowing us to gain knowledge without relying exclusively on our own experience. Unfortunately we also run the risk of acquiring information that is inaccurate: people can give poor information when they are mistaken, ignorant, or being deliberately deceitful. To maximally benefit from information given by others, we need to evaluate the likely truth of what we are told.

The problem of assessing the truth of what we are told is particularly significant in childhood, when we are presented with large amounts of new information that we cannot check independently. Philosophers have speculated on the extent to which children depend on the truthfulness of adults and others in learning languages and finding their way around the world generally. Commenting on Michael Dummett's views (e.g. Dummett 1973) Donald Davidson (1984) has argued that children cannot depend on others' truthfulness:

Sometimes it is suggested that a language could never be learned except in an atmosphere of honest assertions (commands, promises, etc.). ... But I am ...

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E. Nurmsoo (✉)  
School of Psychology, University of Kent, Canterbury, Kent CT2 7NZ, UK  
e-mail: e.nurmsoo@kent.ac.uk

E. J. Robinson · S. A. Butterfill  
University of Warwick, Coventry, UK

skeptical ..., partly because so much language learning takes place during games, in hearing stories, and in pretence, and partly because the acquisition of language cannot to such an extent depend on our luck in having truthful, sober, assertive playmates and parents (p.274).

If Davidson is right, effective cultural transmission demands that children cannot simply accept what they are told but must decide whether to believe others in ways that reliably result in them gaining knowledge.

Here we argue that children do not simply accept what they are told. From a very early age, children selectively reject both statements and informants as unreliable. Such rejections are supported by the children's own developing understanding of others' mental lives. As they become better able to judge an informant's past accuracy, knowledge state, and biases, children bring these factors to bear in their judgments of who and what to believe. Evidence that children evaluate both potential informants and individual statements comes from social referencing, denials of false statements, and imitation, as well as their tracking of speaker knowledge, beliefs, biases and errors.

## 1 Social Referencing

Infants' sensitivity to the plausibility of sources of information is evident in their use of others' reactions. When confronted with an ambiguous situation, infants look to others to see how they should behave, a behaviour known as social referencing. Even when exploring the reactions of others, infants do not use the information indiscriminately but evaluate whether to accept it. For example, children are more likely to accept information from a trusted source; when a novel ambiguous object, a remote-controlled black spider, was introduced to 14-month-olds who were in a room with either their mother or a stranger, children were more likely to respond appropriately to their mother's reactions of fear or of happiness than they were to respond to the stranger's reactions (Zarbatany and Lamb 1985). That is, they considered the source of the information when deciding whether to accept it.

In addition to judging sources of information, children's social referencing shows that they are sensitive to the plausibility of information. Infants are more likely to accept information that does not contradict what they know. In a slope-walking task, 18-month-old children faced a sloping walkway, with their mother at the bottom. Mothers offered either encouraging information (e.g., clapping and encouraging their children to walk down the slope) or discouraging information (e.g., wagging their fingers, saying "no", or "you'll fall"). Children ignored negative social information when the slopes were clearly easy to walk down, and they ignored encouraging social information when the slopes were clearly too difficult. When it was unclear to the children whether they could successfully walk down the walkway, however, they accepted the instructions from their mother, attempting the walk when given positive information, and refusing when being discouraged (Tamis-LeMonda et al. 2008). The same type of sensitivity was shown by 12-month-old children, who crossed a 'cliff' covered with plexiglass

more often when their mother signalled positive emotions (joy or interest) than when she signalled negatively (fear or anger) but ignored these signals when it was clear that the cliff was safe to cross (Sorace et al. 1985). In these studies, infants did not automatically accept the information from their parents. Rather, they accepted it only when the information did not contradict their own understanding of the situation and of their own abilities.

## 2 Corrections and Denials

Children as young as 16 months of age also use their existing knowledge in order to correct or deny false statements. In one study, children watched as a speaker labelled a familiar picture (e.g., a ball) either correctly or incorrectly. When an actor gave incorrect labels while looking at the objects, 94% of children responded by stating the correct name, as if they were attempting to correct her (Koenig and Echols 2003; see also Pea 1982). These findings show that the 16-month-old children rejected information that was inconsistent with their existing knowledge.

Importantly, children's developing understanding of the mental lives of the speakers was also evident in this study. Koenig and Echols measured children's looking behaviour when the actor, who either faced towards or away from the object, named it. Children looked longer when the actor gazed at an object while mislabelling it, as if surprised that she made the mistake. More interestingly, they also looked longer when she correctly labelled an object that she could *not* see. Children did not simply link the speaker's label to its referent, rejecting a mismatch, but also considered the conditions under which the speaker made her statement.

## 3 Imitation

The sensitivity of infants' behaviours to indicators of potential informants' mental states is also evident in their imitation behaviour. In a classic study illustrating infants' willingness to imitate unusual actions, Meltzoff (1988) showed 14-month-olds an actor who turned on a light box by pressing it with his head (the *head action*). The light could have just as easily been turned on by pressing it with a hand (the *hand action*). Even after a delay of a week, 67% of the children who saw the head action imitated it, although no children who did not see this demonstration did so. These findings illustrate that infants are quite prepared to copy the actions of others.

Further research shows that children do not blindly imitate but are sensitive in some ways to constraints on action. Gergely and colleagues (Gergely et al. 2002) note that even after faithfully copying the head action, infants often also produced a hand action, pressing the button using the more conventional means. Exploring this finding, they compared the imitation performance of 14-month-old children who saw the actor produce the original head action for no clear reason, or saw the actor produce the head action while her hands were wrapped in a blanket after she said she was cold. In the original condition, children copied the head action at the same rate as in the original study. In contrast, when the actor's hands were occupied, children

were much less likely to copy the head action, choosing instead to press the box using their hands, an action that they had not seen the actor perform. How children imitate appears to depend on the actor's reasons for acting, or on constraints governing what she could do.

In situations where social cues reinforce the learning situation, children might be more prone to imitate. Indeed, Csibra and Gergely (2005) argue that under normal teaching situations, such as when a speaker intends to provide generalizable knowledge like a label for an object, the speaker gives clear cues that they are about to do so. For example, they are likely to make eye contact and establish joint reference, and perhaps even add verbal cues ("watch this" or "I'm going to show you something"). In the initial study, when the actor used his head despite having free hands, children could have reasoned that he chose to use his head instead of his hand as part of a pedagogical exchange—trying to teach some new and important information—so they faithfully imitated the action. This interpretation is supported by a study reported by Gergely and Csibra (2005), in which they compared children's behaviour with and without pedagogical cues. Fourteen-month-old children who watched the actor use her head in an observational learning context, without any pedagogical cues, were significantly less likely to imitate the head action as compared to a condition that included the usual pedagogical cues. Similarly, Brugger and colleagues (Brugger et al. 2007) showed children an actor who modelled two actions (e.g., undo latch, open lid). In one condition, both actions were necessary to produce the goal, whereas in another, only the second action was necessary. Although 15-month-olds were more likely to imitate both of the actions, in order, when both actions were necessary than when they were not, they were also more likely to imitate the non-critical action when it was socially cued ("Watch what I can do") than when it wasn't ("Wow, it's nice outside"). Although imitating apparently irrelevant and unnecessary actions can be wasteful, a tendency to do so may also allow children to learn culturally significant rituals and procedures.

All of these studies illustrate that children under the age of two will selectively imitate actions, evaluating whether the action is relevant and useful before deciding to imitate. They are also more likely to faithfully imitate an apparently unnecessary or irrelevant action when this behaviour is presented with clear pedagogical cues. In order to selectively copy necessary actions, children's imitation must involve sensitivity to the actor's goals and constraints on her actions.

#### 4 Tracking Speaker Inaccuracy

So far we have shown that even young children can evaluate both potential informants and individual statements, and that they understand something about an actor's goals and the constraints under which they act. But the studies considered so far are limited in that they consider only cases where it is relatively easy for children to evaluate the likely reliability of an informant or of communication. In many cases, however, children lack sufficient knowledge of the domain in question to work out directly whether an utterance is plausible. They may also be faced with informants of whom they have no long-term relationship. To what extent can children evaluate the reliability of statements and informants in such cases?

One way children could evaluate reliability is by tracking the number or proportion of a speaker's utterances which have been incorrect. In procedures exploring this ability, developed independently by Koenig, Harris and colleagues (Koenig et al. 2004; Koenig and Harris 2005; Pasquini et al. 2007), and by Birch and Bloom (Birch et al. 2008; see also Jaswal and Neely 2006; Nurmsoo and Robinson 2009b; Scofield and Behrend 2008), children as young as three watch as two speakers provide conflicting information, usually about the labels of familiar objects. For each of several different objects, one speaker is consistently accurate and the other consistently inaccurate. After establishing their history in this way, the two speakers give new information, usually the label of a novel, unfamiliar object (e.g. a blue toy made of plastic tubes might be called a 'blicket' by one speaker and a 'fendle' by the other). In these naming task studies, children prefer to learn the new word from the speaker with a history of accuracy, showing that they are keeping track of individual speakers' histories and preferentially believing the speaker with a good track record.

As adults we sometimes think of reliability as a characteristic of speakers, using the number or proportion of speakers' incorrect utterances as only a defeasible, rough and ready measure of reliability. When faced with a speaker who errs, we may reason about the speaker to try and determine why the errors might have occurred. We may decide that some errors are due to extenuating circumstances and do not bear on a speaker's overall reliability or, equally, that some errors are particularly negligent and strong evidence of general unreliability. Do children also think about reliability in this way?

Under a lean interpretation of the above findings, children do not think about reliability in the way that adults sometimes do. Rather than representing the causes of error and associated mental states, children are biased to reject utterances of speakers who are more frequently (or who are proportionately more often) incorrect, much as adults might ignore the chimes of an inaccurate clock without considering reasons for its inaccuracy. On this lean interpretation, children consider a speaker's past outputs as a guide to their future outputs, rather than as a defeasible guide to a characteristic which is in turn linked to their likely future correctness. On a richer interpretation, by contrast, children are sensitive to speaker reliability as such and not only to one type of consideration that happens to be a measure of reliability. This would mean that they treat the proportion of incorrect utterances as a defeasible indicator of reliability. If the rich interpretation is correct, there should be at least some circumstances in which children realise that an incorrect utterance does not bear on the speaker's general reliability.

The literature to date, while acknowledging that no decisive evidence has been offered either way, favours a rich interpretation of children's behaviour in the naming task. Under this interpretation, children use a speaker's reliability to form judgements about that individual speaker's general trustworthiness, as a person-specific, enduring trait. Koenig and Harris (2007) argue that children do not simply treat a speaker as a provider of 'good' or 'bad' output, disregarding an inaccurate speaker without reference to the underlying conditions leading to the inaccuracy. Rather, a speaker's reliability is taken as an indicator of an underlying trait, one that is mediated by that speaker's underlying mental states (see also Harris 2007; Koenig and Harris 2005). Birch et al. (2008) acknowledge that children's behaviour is

consistent with both rich and lean interpretations of speakers' errors, but similarly lean toward the rich explanation for children's success.

If the rich interpretation is correct, children's estimations of reliability must be sensitive to at least some conditions under which speakers err. From an adult point of view, ignorance is one potential cause of reliability. Interestingly, it does not appear that children forgive errors due to ignorance, at least in these types of naming tasks. Nurmsoo and Robinson (2009b) presented 3- and 4-year-old children with a speaker who erred repeatedly while blindfolded. It is important to note that the game was designed so that it was clear that both speakers were to take turns providing labels, despite the blindfolded speaker's inability to see. At test, after the blindfold was removed, both speakers gave contrasting labels for an unfamiliar object. There was no evidence that they excused the blindfolded speaker, even though post-tests confirmed that they understood the blindfold was the reason for her errors. The same findings held even when the blindfolded speaker was paired against an inaccurate speaker who mislabelled objects for no apparent reason. In short, children did not excuse a speaker who had a history of past inaccuracy due to circumstances that no longer held. Instead, it appears as though children simply used the speakers' prior output to predict their future output, much as one might use a clock's current accuracy to decide whether to rely on it in the future. These findings suggest that children's predictions about long-term reliability may not incorporate an understanding of the circumstantial explanations for a speaker's errors.

## 5 Tracking Speaker Knowledge

Although children do not appear to use a speaker's access to information to explain away her repeated errors in the naming task, they are sensitive to a speaker's input in tasks where they must decide on a given trial whether to believe a speaker's utterance based on that speaker's current information access. In Robinson and Whitcombe's (2003) *tunnel game* procedure, children are shown pairs of toys that differ either in colour (e.g., a brown or white teddy bear) or hardness (e.g., a hard or soft duckling). One of the two toys is hidden in a tunnel, and the game is to identify which one. The hidden toy could be seen through a window, or felt through the end of the tunnel. Children take turns with an experimenter or a puppet to feel or see the toy. In this way, one participant could have uninformative access (e.g., feeling the toy to identify whether it was brown or white) and the other informative access (e.g., looking through the window). Again, it was clear from the design of the game that both the child and the speaker had to provide an answer even when they were poorly-informed. Three- and 4-year-old children were more likely to believe a speaker who has had informative access than one who has not (Robinson and Whitcombe 2003, see also Robinson et al. 2008; Whitcombe and Robinson 2000). That is, they did not simply believe the speaker, but evaluated whether the speaker had the relevant knowledge before deciding to believe her.

Interestingly, children are also sensitive to a speaker's prior errors in this type of task. Children who witnessed a speaker making multiple errors for no obvious reason (e.g., she looked at the toy and incorrectly announced that it was brown) were much less likely to believe that speaker in the future than those who witnessed a

speaker making multiple errors because of uninformative access (e.g., she felt the toy and incorrectly announced that it was brown; Nurmsoo and Robinson 2009a). In this tunnel task, children used their understanding of the relationship between a speaker's input and her output when evaluating whether to believe new information from that speaker. This is evidence that children are not simply biased to reject information from speakers who have been incorrect in the past.

It remains unclear why children performed well on the tunnel task while failing to consider a speaker's reasons for error in the blindfold naming task. This difference in performance raises some interesting possibilities concerning children's use of mentalistic reasoning in tasks such as these. Perhaps children are more conservative in the naming task because they are learning generalizable information such as words or object functions. Under these conditions, it may be preferable to minimize false positives, so they discount utterances of speakers who have been incorrect in the past regardless of why they were incorrect. When trying to identify the temporary hidden contents of a box, however, since the information to be learned is not relevant outside the context of the game, children might be more willing to accept information from a previously inaccurate speaker when he erred for a good reason. Another possibility is that children find it easier to judge the knowledge state of a single speaker, as in the tunnel task, than to monitor two different characters, as in the naming task. Perhaps the additional difficulty involved in tracking multiple speakers causes children to fall back to using simple heuristics in deciding who to believe. Further research is needed to explore these questions.

## 6 Tracking Speakers' Beliefs

As children's understanding of the mental lives of others grows, they become better able to reason about the long-term trustworthiness of potential informants. Children could begin with the basic heuristic of avoiding learning from a speaker with a history of inaccuracy, as shown in the blindfold naming task, and move toward explaining speakers' errors in terms of their input conditions, as seen in the tunnel task.

Some support for developmental change in children's understanding of speakers who err is found in Robinson and Nurmsoo's (2009) *false belief study*. Three- to 5-year-olds were shown a series of four boxes, each with a reasonable expectation about its contents based on its appearance (a small cereal box, a box featuring a well-known make of building blocks, a DVD case, and a crayons box). Children were shown the contents of the first three boxes, and were surprised to find that each container held a small toy cat. After the cats were replaced in their boxes, a puppet speaker was introduced. The puppet was then given a history of unreliability: he mislabelled the contents of each of the three boxes. As in the tunnel task, one group of children saw the puppet make inexcusably incorrect statements about the contents of the boxes after looking inside them. A second group of children saw the puppet mislabel the contents out of ignorance, reporting the expected contents without seeing inside the containers. Again, as in the tunnel task, children who witnessed the poorly-informed puppet make excusable errors were more likely to later believe that puppet when he was better informed than were children who witnessed the puppet



make errors despite being well-informed. The new feature of this experiment concerned the group for whom the puppet's errors could be excused by ignorance. There are two levels at which children could have explained the puppet's errors. At the lower level, children could understand that the puppet was ignorant of the true contents of the boxes, explaining his errors as due to ignorance. However, children who understand that a speaker could have a false expectation about the boxes' contents would additionally understand why the puppet made the precise errors that he did—the puppet expected the contents to match the external appearance of the boxes. At the end of the study, children were asked to explain why the puppet made errors on the initial boxes. Those who were explained why the puppet made the precise errors that he did (e.g., 'because it's got Cornflakes on the front') were much more likely to believe the puppet when he was subsequently well-informed than were children who did not explain the puppet's errors with reference to his false expectations (e.g., 'he likes DVDs and he doesn't like cats,' or 'he doesn't know, he just said it wrong').

The results of the false belief study suggest that as children develop an understanding of the mental states of speakers, they begin to understand more about the speakers' errors and are able to use this information to appropriately evaluate the future reliability of a speaker.

## 7 Information Seeking

Children are not limited to waiting until an adult initiates an interaction, but can solicit information from others. Even under these circumstances, however, children are at risk of being given inaccurate information, and recent research suggests that children evaluate potential informants before seeking information. In a game designed to elicit information seeking, 3- through 6-year-olds, together with an experimenter, attempted to identify which of three toys was hidden in a box. The players, separated by a small barrier, privately marked their answers on individual answer sheets. On some trials, one of the players was permitted to look inside the box before placing an answer. Before giving their final judgment, children were significantly more likely to look at the experimenter's answer first by peeking over the barrier, or by asking the experimenter to move it, when she had seen inside the box than when she had not (Robinson et al. *in press*). Even 3-year-old children were sensitive to the experimenter's access to the relevant information when deciding whether to seek this information.

Children also ask questions, and gain knowledge from asking questions, as early as their second year (e.g., Chouinard 2007). By asking questions, children can direct their own learning. Interestingly, however, they do not seem to be sensitive to a potential informant's access to the relevant information when deciding whether to ask her. In a game similar to the hidden-box task described above, 3- to 5-year-olds were to guess the hidden contents of a box. They were permitted to ask for help from the experimenter, who had seen the contents on some trials. When the child asked for help, the experimenter would say, for example, "would you like me to tell you what *I* think is inside? *I* think it's the cat." Surprisingly, children were just as likely to ask the experimenter when she had

seen inside the box as when she had not (Robinson et al. [in press](#)). This is in stark contrast to children's very good performance when they could look at the experimenter's answer instead of asking. Although children seemed to understand that when the experimenter had seen inside the box she would give an accurate answer (as seen in the barrier task), they did not use this information when deciding whether to ask her for her answer.

Overall, children's sensitivity to a speaker's knowledge state is less clear in child-initiated learning. Perhaps as children's understanding of mental states develops, they begin to understand how a person's knowledge can be tapped by asking questions rather than by simply evaluating her output.

## 8 Sensitivity to Speaker Bias

Older children share the adult intuition that an informant might give poor information when they have a bias or a vested interest. For example, a speaker who makes a statement in accord with his own self-interest may be considered to be less believable than one who makes the same statement despite it going against his own interests.

Mills and Keil (2005) presented children with stories in which a speaker had a chance at winning a prize, and either said he won, or that he had not. In one story, the protagonist was in a race in which he and another boy finished very close together. Without knowing who actually won, children heard that the protagonist either announced that he did, or did not, win the race. Children then judged the believability of the speaker's statement. Children aged 7 to 8 were more likely to believe the speaker when he spoke against his own self-interest (when he said he lost) and to discount his statements aligned with his self-interest. Similarly, Gee and Heyman (2007) found that 6- and 7-year-olds were sensitive to a character's motives when deciding whether to believe her statements. For example, they were more likely to believe a story character who said she was sick (and would therefore miss a day of camp) if she wanted to go to camp, than if she did not. These children considered a speaker's motives and bias when deciding whether to believe her statement.

## 9 Conclusions

Children do not simply believe what they are told, but evaluate the likely truth of new information by considering the speaker's informedness, the relevance of her behaviour, her history of accuracy or inaccuracy, and her access to the relevant knowledge. Together, these processes minimize the chances of accepting false information as true, while also decreasing the risk of rejecting true information given by a previously unreliable speaker or one who does not have the relevant information.

One key issue is the extent to which children's skill in deciding whether to accept information depends on biases or heuristics such as disbelieving utterances from a speaker with a history of incorrectness. We argued that children show some flexibility, for in the tunnel and false belief tasks they treat a speaker's information access as modulating the extent to which inaccuracy is a sign of unreliability. This is

incompatible with the view that children rely exclusively on simple biases or heuristics. However, since similar competence was not found in the naming paradigm, it is possible that this competence is fragile and that children do rely on simpler heuristics when faced with demanding situations.

A second key issue is the extent to which children can draw on an understanding of mental states such as knowledge and ignorance in deciding whether to believe a speaker. We might expect that children's decisions about whether to believe a speaker are guided by more complex strategies as they understand more about mental states. While drawing on an understanding of mental states may allow for more sophisticated strategies, it may also require greater cognitive resources and larger risks than simpler heuristics. As noted above, current paradigms do not provide decisive evidence on to what extent children can make use of their understanding of others' mental lives when deciding whether to accept a statement.

On the whole, children's behaviour appears to be well-balanced. They do not simply believe what they are told, but evaluate the likely truth of new information by considering the speaker's history of accuracy or inaccuracy, under some circumstances taking into account the speaker's informedness. Together, these processes minimize the chances of accepting false information as true, while also decreasing the risk of rejecting true information given by a previously unreliable speaker. As children become better able to judge a speaker's prior accuracy, knowledge state, and biases, they may bring these factors to bear in their judgments of who—and when—to trust, allowing them to enjoy the maximum benefits of learning from others.

**Acknowledgements** We would like to thank Christophe Heintz and two anonymous reviewers for their very helpful comments. The research was supported by a grant from the Economic and Social Research Council, U.K. (RES-000-22-1847) to the second author.

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