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ARTICLE

Children Show Selective Trust in Technological Informants

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Although children are often exposed to technological devices early in life, little is known about how they evaluate these novel sources of information. In two experiments, children aged 3, 4, and 5 years old ($n = 92$) were presented with accurate and inaccurate computer informants, and they subsequently relied on information provided by the previously accurate computer to identify novel objects and answer questions about unfamiliar facts. In a third experiment, 4- and 5-year-olds also expressed a preference for using the accurate computer to find answers on their own and for explaining the inaccurate computer's errors as a function of problems with the device, rather than errors on the part of the human user. These results suggest that young children use prior history of accuracy as a domain-general means of evaluating informants and that children can apply this understanding outside of interactions with other people.

During the past few decades, there has been a dramatic change in how people access information. With the debut of personal computers and the Internet, information has become available to more individuals with greater ease and at greater speeds than ever before. Less than 10 years after the World Wide Web was created, the majority of American adults had accessed the Internet at least once (Pew Internet & American Life Project, 2000), and by June 2012, an estimated one-third of the Earth's population had access to the Internet (Miniwatts Marketing Group, 2012). As technological informants (defined here as devices used to access information via the Internet, including computers and portable devices such as smart phones) grow faster, better, and more ubiquitous, it is critical to understand how people evaluate them and the information that they provide.

One aspect of evaluating information is to determine whether it is accurate. Given that the content of the World Wide Web is generated by people, it is reasonable to assume that some of the information found on the Internet is inaccurate or misleading. Adults report a great deal

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of trust in information accessed via the World Wide Web (Pan et al., 2007), and this trust is not necessarily misplaced: At least one investigation has found that facts found on Web sites such as Wikipedia are about as accurate as those obtained through traditional printed sources such as the Encyclopedia Britannica (Giles, 2005). Furthermore, reliance on technological informants can have potentially life-altering implications when individuals use information found online to make major life decisions, such as when to visit a doctor and where to invest their money (Horrigan, 2006).

As with other information sources, the reliability of information obtained via technological informants is of concern to adult users (see Metzger, 2007). However, there is growing evidence that children who have grown up immersed in modern technology do not consider the quality of information they find online to be an important issue nor are they skilled at judging its veridicality. For instance, many fifth and sixth graders believe that all the information they find on Web sites is true (Schacter, Chung, & Dorr, 1998), and they are insensitive to cues that adults use to judge a Web site's reliability, such as the presence of advertisements or the absence of a named source (Eastin, Yang, & Nathanson, 2006).

A recent survey of American families found that the average age at which children began using computers was 3.5 years old, and more than one third of children ages 2 to 4 used a computer at least once per week (Common Sense Media, 2011). By age 5, children have a basic understanding of the differences between computers and people. For example, they indicate that computers do not have brains (Scaife & Van Duuren, 1995), that they are inanimate, and that they do not share characteristics of social beings, such as mental states, desires, or emotions (Mikropoulos, Misailidi, & Bonoti, 2003). This understanding is also evident in that children attribute similar properties to a computer and a television (Subrahmanyam, Gelman, & Lafosse, 2002). Similarly, 5-year-olds indicate that computers are useful for obtaining factual information, but that they are much less useful for making emotional or moral judgments (Danovitch & Keil, 2008). Despite understanding the basic properties of computers by age 5, children do not develop an accurate understanding of how computers function or generate responses until age 11 or later (Van Duuren, Dossett, & Robinson, 1998). Furthermore, despite experience using technological devices such as computers, cell phones, and video game consoles for purposes other than information seeking (e.g., playing games, communicating with friends), children do not appear to have a very sophisticated understanding of the information that can be accessed via technological devices or how these devices retrieve information. For example, children do not understand the technological and social complexity of the Internet until late elementary school, regardless of their amount of experience using technology (Yan, 2005, 2006, 2009). Thus, existing research suggests that a mature understanding of technological informants and the Internet may take a relatively long time to develop, yet it remains unclear how children develop their initial beliefs about technological informants and the information accessed through them.

Given the very recent introduction of technological informants, one way that young children may evaluate these novel sources of information is by applying the same criteria they use for the most prevalent source of information during the course of human history: other people. Young children are highly sensitive to the reliability of human informants, and they choose their sources accordingly (e.g., Birch, Vauthier, & Bloom, 2008; Koenig, Clément, & Harris, 2004). For instance, children trust a person who was previously accurate when naming familiar objects to subsequently name novel objects correctly. In addition to prior accuracy, children take into account factors such as familiarity (Corriveau & Harris, 2009), age (Jaswal & Neely, 2006), and previous access to information (Nurmsoo & Robinson, 2009) when choosing who to trust. Likewise, young children are adept at identifying appropriate informants. They know that different people have different areas of expertise, and they can determine who is best suited to answer different questions (Danovitch & Keil, 2004, 2008; Keil, Stein, Webb, Billings, & Rozenblit, 2008; Koenig & Jaswal, 2011; Lutz & Keil, 2002; VanderBorght & Jaswal, 2009). These skills are critical because it is impossible to obtain direct evidence for many phenomena (e.g., scientific or historical facts); thus, successful learning depends on choosing knowledgeable and accurate sources, whether the sources are human or not.

One interpretation of the existing research on trust in human informants is that children's reasoning about informants is grounded in their understanding of other people's minds. This view implies that children do not simply classify people as accurate or inaccurate and make decisions accordingly. Instead, they take into account dynamic characteristics such as prior access to information (Nurmsoo & Robinson, 2009), adherence to rules of conventionality (e.g., Diesendruck, 2005), and both verbal and nonverbal signs of confidence (e.g., Birch, Akmal, & Frampton, 2010; Sabbagh & Baldwin, 2001). If this interpretation is correct, then one might expect information sources that do not possess mental states or provide socially mediated cues to accuracy (i.e., machines) to be much more difficult for children to evaluate.

From an evolutionary standpoint, recent findings suggest that precursors to selective trust in informants may be apparent as early as infancy (e.g., Hamlin, Wynn, & Bloom, 2007; Kinzler, Dupoux, & Spelke, 2007) and that this may be a fundamental element of social cognition. Consequently, if evaluating human informants is an ability that evolved to enable learning, then the presence of new, highly interactive, yet nonhuman sources of information may present a unique problem for children who need to determine whether these sources are trustworthy. Understanding how children evaluate technological informants presents an important opportunity to examine whether children's trust in information sources is rooted in domain-general mechanisms that apply to many types of sources, or whether these mechanisms are limited to social sources only. If children apply the same heuristics that they use to select human informants to technological informants, it would suggest that these heuristics are not unique to reasoning about people and do not depend on appreciating mental states, but rather that they are domain-general methods of evaluating competing sources of information. Conversely, if children do not apply the same heuristics to technological informants as they do to human informants, this would imply that these heuristics are domain-specific and that children must develop independent means of reasoning about nonhuman sources. Thus, by examining how young children reason about technological informants and the information they provide, the current study presents a theoretically valuable test of whether children's reasoning about accuracy and trust is restricted to the social domain, or whether it is applied broadly to other nonsocial sources of information, including but not limited to computers.

The design of the current study is based closely on prior work showing that children as young as age 3 show differential trust in human informants based on prior accuracy. Specifically, the current experiments present children with a choice between technological informants that were previously accurate or inaccurate, and they examine whether children trust the information provided by the previously accurate technological informant. Based on informal observations that preschool-aged children are more familiar with the term ''computer'' than ''Internet'' or ''World Wide Web'' and that children use these terms interchangeably, these experiments use computers as a proxy for Internet search engines or Web sites. This substitution may not be entirely realistic, but given the young age of the participants and the exploratory nature of this work, our priority was to ensure that the technological informants would be familiar and comprehensible to young children. Similarly, although allowing children to interact with the computer informants directly would correspond more closely to real-life experiences, we presented children with brief videos of an unfamiliar adult accessing information via two computers. This design was chosen for several reasons. First, it parallels prior studies of children's trust in human informants, where children watched videos of an unfamiliar adult seeking answers from two other adults (e.g., Koenig et al., 2004; Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007). Second, given the variability in preschoolers' prior experience using computers, some children would have likely required extensive training and guidance to be able to successfully access information on two different computers. Third, had they used the computers on their own, children may have attributed each computer's accurate or inaccurate response to their own actions or computer skills (or lack thereof), potentially confounding their judgments.

EXPERIMENT 1

Method

Participants

Twenty-one 3-year-olds (*M* = 3;6; range = 3;0–3;11) and twenty 4-year-olds (*M* = 4;6; range = 4;0–5;0) participated. Approximately half of the children were girls. Parents identified approximately 6% of children as Hispanic, and children were approximately 75% Caucasian American, 15% Asian American, and 9% African American. Children were recruited from child-care centers and preschools in a medium-sized Midwestern city and were tested individually in a quiet area of their school or in a university laboratory during a 10-minute session.

Materials

The visual stimuli consisted of six 45-second videos representing three familiarization trials and three test trials. Videos were presented on a black and silver laptop computer with a 14-inch screen. Following closely from Koenig et al. (2004), each video displayed an adult male actor wearing a black shirt seated at a table with his back to the camera. He was seated between two desktop computers, one with its monitor and keyboard framed in red cardboard and the other framed in blue cardboard. In all trials, the actor viewed pairs of images with one image appearing on each computer screen. For *familiarization* trials, the images were of familiar objects: a ball and a shoe, a cup and a dog, a book and a chair, respectively. For *test* trials, the images were of unfamiliar objects: a circular purple plastic object and a square-shaped orange plastic object, a brown cork object and a green plastic object, and a circular silver metal object and a black windmill-shaped plastic object, respectively. The order of trials within familiarization and test trials was maintained across participants.

Design and Procedure

Familiarization trials. To introduce the task, the experimenter said, ‘‘I've got these two computers at home. One is blue, and one is red. I am going to show you a video of a person using the two computers to find pictures of things. Are you ready? OK, let's watch.'' Then, in each of three familiarization trials, the actor stated that he wanted to find a picture of a particular object and that he was going to use the computer on his left (identified by color) to do so. For example, ''I want to find a picture of a ball. I'm going to use the red computer to find a picture of a ball.'' He then turned to the left-hand computer, typed on its keyboard, and an image appeared on the screen. The actor then repeated this action for the computer on his right. Only the color of the computer referenced in the statement and the man's direction differed. After using both computers, the man returned his hands and gaze to the center of the table. At this point, while the images were visible on both computer screens, the experimenter paused the video and asked the participant, ''Can you show me a picture of a [object name]?'' For half of the participants, the red computer was consistently accurate, and for the other half, the blue computer was consistently accurate. The position of the computers (right vs. left side of the actor) was counterbalanced across participants.

First explicit judgment trial. After the last familiarization trial, children were asked to identify which computer was accurate or inaccurate. The experimenter showed the child a screenshot with both computers displaying a white screen and said, ''The computers showed you pictures of a lot of things. Did any of them show something right/wrong?'' Half of the children were asked to identify the reliable computer and the other half were asked to identify the unreliable computer. If the child responded ''yes,'' the experimenter prompted the child to identify which one was right or wrong. If the child responded ''no,'' the experimenter corrected them and said, ''Actually, one of them did show something right/wrong. Which one showed something right/wrong?''

Test trials. Following the explicit judgment trial, participants were presented with three novel test trials, identical in format to the three familiarization trials. The actor's novel objects of interest were labeled a *toma*, a *wug*, and a *dax*. At the end of each trial, the experimenter paused the video while the images of both objects were visible on the computers. The experimenter then removed the two unfamiliar objects from a box (kept out of the child's sight), placed them on the table in front of the child, and asked the child to identify the object corresponding to the actor's object of interest (e.g., ''Can you point to the *toma*?'').

Second explicit judgment trial. Following the final test trial, children were asked to identify the accurate or inaccurate computer again by answering the same explicit judgment question that was presented earlier.

Preference and explanation questions. Following the second explicit judgment, participants were asked, ''If you were going to look something up, which computer would you want to use?'' The experimenter then stated which computer had been wrong, and asked, ''Why do you think it was getting things wrong?''

Results

All children identified all three objects correctly in the familiarization trials. The explicit judgment trials were summed for a total score of 0, 1, or 2, with 1 point awarded for each correct answer. Overall, children performed well above chance levels on the explicit judgment trials, $M = 1.83$, $SD = 0.442$, $t(40) = 12.021$, $p < .001$. Only one child (age 3) answered both explicit

TABLE 1
Mean Scores by Question Type, Experiment, and Age Group (Standard Deviations in Parentheses)

	n	*Familiarization (max = 3)*	*Explicit judgments (max = 2)*	*Test* N	*Test (max = 3)*
Experiment 1					
3-year-olds	21	3.00**	1.71 (0.56)**	16	2.50 (0.89)**
4-year-olds	20	3.00**	1.95 (0.22)**	19	2.53 (0.84)**
Experiment 2					
3-year-olds	16	2.88 (0.34)**	1.25 (0.86)	8	2.13 (0.64)*
4-year-olds	19	2.89 (0.31)**	1.74 (0.45)**	15	2.60 (0.83)**
5-year-olds	16	3.00**	1.81 (0.40)**	13	2.92 (0.28)**

Note. Test trial scores only include participants who answered both explicit judgment questions correctly.
*Values significantly different from chance at the $p < .05$ level.
**Values significantly different from chance at the $p < .01$ level.

judgment questions incorrectly, and sixteen 3-year-olds (76%) and nineteen 4-year-olds (95%) answered both explicit judgment questions correctly. There was no significant difference in scores between 3-year-olds and 4-year-olds, $t(39) = 1.752$, $p = .088$ (see Table 1). (Levene's test indicated unequal variances, $F = 12.054$, $p < .001$, so degrees of freedom were adjusted from 39 to 26, $t[26] = 1.784$, $p = .086$). There were also no effects overall, or within each age group, for the question posed during the explicit judgment trials, suggesting that children performed equally well regardless of whether they were asked to identify the accurate or the inaccurate computer, all $t\text{s} \leq 0.124$, all $p\text{s} \geq .902$. Only children who answered both explicit judgment questions correctly were included in the data analysis for the test trials and preference question.

For the *test* trials, children received 1 point for each time they chose the object identified on the reliable computer, yielding a total score between 0 and 3. Overall, children's scores were well above chance responding, $M = 2.51$, $SD = 0.853$, $t(33) = 7.034$, $p < .001$. There was also no significant difference in scores between 3- and 4-year-olds, $t(33) = 0.090$, $p = .929$ (see Table 1) and no difference in scores between children who were asked to identify the accurate or the inaccurate computer during the explicit judgment trials, $t(33) = 0.370$, $p = 370$. Thus, children in both age groups used each computer's prior history of accuracy or inaccuracy to determine the names of the novel objects.

Despite relying on the previously accurate computer more often during the test trials, only 22 of 35 participants (63%) indicated a preference for using the reliable computer to find information, a proportion that did not differ from chance, $\chi^2(1, n = 35) = 2.314$, $p = .138$. There was no significant difference in preference for the reliable computer between the two age groups, as indicated by a chi-square test for independence with Yates Continuity Correction $(1, n = 35) = 1.196$, $p = .274$, phi $= .244$. However, 3-year-olds were exactly at chance (50%) in their choice of preferred computer, whereas 4-year-olds preferred the reliable computer 74% of the time, a rate that is above chance, $\chi^2(1, n = 19) = 4.263$, $p = .039$. It may seem surprising that the 3-year-olds did not show a preference for the reliable computer, especially because they all correctly identified the computers during the explicit judgment trials moments earlier. Perhaps the unreliable computer appealed to some of the younger children because of its novel responses or they were interested in using it to figure out why it was inaccurate. Alternatively, 3-year-olds may not have viewed the computer's accuracy as a persistent or stable trait, leading them to believe that each computer would be equally likely to provide them with correct answers in the future. Children's responses may also have been influenced by their beliefs about the source of the inaccurate computer's errors: If children believed the error was due to the human user's incompetence and they viewed themselves as more competent than him, then they may have concluded that the previously unreliable computer would provide accurate answers if they used it.

When prompted to explain why the inaccurate computer was wrong, the majority of participants said, ''I don't know,'' made irrelevant statements (''because red already answered''), reiterated information that had been provided (e.g., ''it kept getting things wrong''), or declined to respond. However, a few 3- and 4-year-olds generated explanations that implied computer error, such as ''the computer didn't have the right cable,'' ''maybe it ran out of batteries,'' and ''it wasn't hooked up right.'' Two additional children (both age 3) attributed the error to the human user's actions, stating that ''the person didn't know what button to push'' and ''he turned it on and off.'' Thus, although most children had difficulty explaining why the inaccurate computer was wrong, there is some evidence that preschool-aged children recognize at least two potential mechanisms that could underlie the computer's errors.

EXPERIMENT 2

In Experiment 1, children relied on the computer with a history of accuracy to identify novel objects by name, suggesting that they show selective trust in technological informants similar to selective trust in humans. However, children rely on human informants to learn more than just object labels (e.g., to learn functions, Birch et al., 2008; Koenig & Harris, 2005; to answer questions about foods and toys, VanderBorght & Jaswal, 2009). Children are potentially more likely to have observed older children and adults using technological informants to find answers to specific factual questions (e.g., what time a store opens) than as a means of identifying unfamiliar objects. Hence, Experiment 2 utilizes more complex factual stimuli that may have higher ecological validity for interactions with technological informants. Because the increased complexity of the stimuli may involve a higher cognitive load, we included a group of 5-year-old participants as well.

Method

Participants

Fifty-one children participated in the study: sixteen 3-year-olds (*M* = 3;7; range = 3;1–4;0), nineteen 4-year-olds (*M* = 4;7; range = 4;1–4;11), and sixteen 5-year-olds (*M* = 5;5; range = 5;0–6;0). Approximately half of the children were girls. Children were drawn from the same population as in Experiment 1 and had similar demographic characteristics, and the experimental sessions were of approximately the same length as in Experiment 1.

Design and Procedure

The design and procedure were identical to those in Experiment 1, except that the actor in the video used the computers to obtain factual information instead of identifying objects. In the familiarization trials, the actor's queries were: 1) ''I want to know what color grass is'' (accurate computer displays a green square and inaccurate computer displays an orange square); 2) ''I want to know the shape of a wheel'' (accurate: circle; inaccurate: square); 3) ''I want to know what a rabbit likes to eat'' (accurate: carrot; inaccurate: shoe). Children then made an explicit judgment requiring them to identify the accurate or inaccurate computer, as in Experiment 1. In the test trials, the actor inquired about three unfamiliar facts: 1) ''where blickets live'' (responses: water or trees); 2) ''what the weather will be in Daxtown tomorrow'' (responses: sunny or raining); 3) ''what season is best for flurping'' (responses: winter or fall). Each computer displayed an image corresponding to the answer provided (e.g., a sun to represent sunny weather). Children also completed the second explicit judgment, preference, and explanation questions, presented exactly as in Experiment 1.

Results

Forty-eight children (94%) correctly identified all three answers in the familiarization trials, and the remaining 3 children (two 3-year-olds, one 4-year-old) identified two out of three items correctly (see Table 1). Scores for the explicit judgment trials and test trials were calculated as in Experiment 1. Overall, children identified the reliable computer at rates well above chance on the explicit judgment trials, $M = 1.61$, $SD = 0.635$, $t(50) = 6.837$, $p < .001$. A one-way analysis of variance (ANOVA) showed a significant effect of age, $F(2, 48) = 4.254$, $p = .020$. (Levene's test indicated unequal variances, $F = 11.55$, $p < .001$, but the Brown-Forsyth robust test of equality of means revealed a similar pattern of results, $F[2, 29.648] = 3.536$, $p = .027$). Post-hoc Tukey honestly significant difference (HSD) tests revealed that 3-year-olds' scores were significantly lower than 5-year olds' scores, $p = .028$. Likewise, 3-year-olds' scores were not different from chance, $t(15) = 1.168$, $p = .261$, but 4- and 5-year olds' scores were significantly above chance, all $t\text{s} \geq 7.099$, all $p\text{s} < .001$ (see Table 1). There were no effects overall, or within each age group, for the question posed during the explicit judgment trials, suggesting that children performed equally well regardless of whether they were asked to identify the accurate or the inaccurate computer, all $t\text{s} \leq .620$, all $p\text{s} \geq .538$. Compared with Experiment 1, the 3- and 4-year-olds did, however, answer fewer explicit judgment questions correctly in Experiment 2, a result that may reflect the increased complexity of the questions being answered during the trials. As in Experiment 1, only children who passed both explicit judgment trials ($n = 36$) were included in subsequent data analyses.

On the test trials, children chose the information provided by the reliable computer at rates well above chance, $M = 2.61$, $SD = 0.688$, $t(35) = 9.693$, $p < .001$. A one-way ANOVA demonstrated that children's trust in the reliable computer's responses increased with age, $F(2, 32) = 3.888$, $p = .030$, with post-hoc Tukey HSD tests revealing that this was driven by significantly higher scores among 5-year-olds relative to 3-year-olds, $p = .023$. All three age groups also had scores above chance, all $t\text{s} \geq 2.758$, all $p\text{s} \leq .028$. There was no relationship between the question children were asked during the explicit judgments and their performance on the test trials, $t(34) = 0.186$, $p = .853$.

Thirty-two out of 36 participants (88%) indicated a preference for using the reliable computer to find information on their own, $\chi^2(1, n = 36) = 21.778$, $p < .001$. A Kruskal-Wallis Test revealed a significant increase in preference for the accurate computer across the three age groups, $\chi^2(2, n = 36) = 7.355, p = .025$. Although only a slight majority of 3-year-olds (63%) preferred the reliable computer, 93% of 4-year-olds and 100% of 5-year-olds did so. Thus, by age 4, children indicated that only the reliable computer should be used to find information.

Most children did not generate an informative explanation when prompted to explain why the inaccurate computer was providing inaccurate answers. However, as in Experiment 1, a few 4-and 5-year-olds attributed the errors to the computer (e.g., ‘‘the wire was hooked up to the wrong place,’’ ‘‘the Internet told it the wrong thing’’) or to an error on the part of the human user (e.g., ‘‘because he wasn’t thinking about it’’). Thus, as with identifying objects, some children attribute the computer’s factual errors to the machine itself and others to the person using it. Interestingly, although one might expect children to infer that the adult in the videos was not very intelligent or competent because he was searching for answers to simple questions, children did not appear more likely to generate explanations attributing the computer’s errors to the human user in Experiment 2 than they were in Experiment 1.

EXPERIMENT 3

Experiments 1 and 2 demonstrate that preschool-aged children show selective trust in computer informants based on a prior history of accuracy. Moreover, they do so even when the task requires them to transfer information from a video to a real object (see Allen & Scofield, 2010) and when the information is relatively complex and involves unfamiliar entities and locations. However, children’s responses to the preference and explanation questions raise the possibility that the youngest participants did not necessarily view the computer’s accuracy or inaccuracy as a stable trait that could be used to predict the computer’s future behavior. That is, they may believe that the computer’s accuracy level can change from one moment to the next, or that its accuracy depends on other variables, such as who is using it. One way to address this possibility is to examine how children explain the inaccurate computer’s errors. Although some children made clear references to errors originating with either the human user or the computer in Experiments 1 and 2, the majority of children did not clearly refer to the human or the computer in their explanations and many simply said, ‘‘I don’t know.’’

To address these questions, Experiment 3 focuses on children’s preferences for each computer and how they explain the inaccurate computer’s mistakes. To minimize the possibility that younger children would forget which computer had previously been accurate or that the test trials involving novel objects would confuse them (e.g., if they did not consistently choose the accurate computer’s responses during those trials), Experiment 3 omitted the test trials and measured children’s preferences immediately after the first explicit judgment. The preference question was also rephrased to focus on finding a picture rather than ‘‘looking something up.’’ In addition, Experiment 3 addressed the possibility that children’s responses to the preference question were skewed by their personal preferences (e.g., choosing the red computer because it is their favorite color) by asking them both which computer they would want to use and which computer a knowledgeable adult (their teacher) should use to find information. Finally, to clarify children’s attributions about the source of the computer’s error, Experiment 3 employed a forced-choice explanation question where children had to choose whether the error was a result of a computer malfunction or the human user’s actions.

Participants

Fifty-three children participated: sixteen 3-year-olds ($M = 3;5$; range = 3;1–3;10), twenty 4-year-olds ($M = 4;5$; range = 4;0–4;10), and seventeen 5-year-olds ($M = 5;6$; range = 5;0–6;0). Approximately half of the children were girls. Children were drawn from the same population and had similar demographic characteristics as the children in Experiments 1 and 2. Each experimental session took place in a similar environment as in the previous experiments and lasted approximately 7 minutes.

Design and Procedure

Using the video stimuli and procedure from Experiment 1, children completed the familiarization trials and the first explicit judgment. (The test trials and the second explicit judgment were omitted.) Children then answered a more specific version of the original preference question: ‘‘If you came to my house and wanted to find a picture of something, which computer would you like to use?’’ Afterward, children were asked a forced-choice question about the source of the inaccurate computer’s error: ‘‘The [inaccurate computer’s color] computer kept getting things wrong. Why do you think it was getting things wrong? Was it because the person didn’t ask the question the right way or because the computer didn’t know?’’ As an additional measure of preference, children were also asked: ‘‘If your teacher needs to find a picture of something, which computer should she use?’’

In addition to the color and location of the accurate and inaccurate computers, the computer that the child was asked to identify (accurate or inaccurate) in the explicit judgment trial and the order of the response choices in the forced-choice explanation question were balanced across participants.

Results

All children correctly identified all three items in the familiarization trials and answered the explicit judgment question correctly. Forty-three out of 53 participants (81%) indicated a preference for using the reliable computer to find information on their own, a proportion that was significantly above chance, $\chi^2(1, n = 53) = 20.547$, $p < .001$. Whereas both 4- and 5-year-olds preferred the reliable computer at very high rates (only one 4-year-old and one 5-year-old preferred the unreliable computer), 3-year olds were at chance, with exactly 50% of the sample selecting each computer.

For the forced-choice explanation question, preliminary analyses showed an effect of order, $t(51) = 2.289$, $p = .026$, where children were more likely to select the explanation that was presented last. However, this effect appears to have been driven by the 3-year-olds’ responses (12 out of 16 of whom followed this pattern), and when 3-year-olds were excluded from the analysis, there was no longer any significant effect of order, $t(35) = 1.357$, $p = .177$. Three-year-olds also responded exactly at chance to this question, $\chi^2(1, n = 16) = 0$, $p < 1.00$, suggesting that they did not have clear intuitions about the source of the computer error. Four- and 5-year-olds showed an overall preference for the explanation that the ‘‘computer didn’t know,’’ with children choosing this explanation approximately 73% of the time, a rate significantly above chance, $\chi^2(1, n = 37) = 7.81, p = .005$. Furthermore, a Mann-Whitney U Test revealed no difference between the distributions of responses among the two older age groups, $U = 162.500$, $p = .821$, suggesting that children begin endorsing a consistent explanation for the computer's error at age 4 and that the explanation they prefer—that the error lies in the computer, rather than the human user—remains consistent through age 5.

When asked which of the two computers their teacher should use, 45 children chose the accurate computer, a proportion that was significantly above chance, $\chi^2(1, n = 53) = 25.830$, $p < .001$. A Kruskal-Wallis Test showed no differences between age groups, $\chi^2(2, n = 53) = 2.306, p = .316$, and even 3-year-olds selected the accurate computer at rates above chance, $\chi^2(1, n = 16) = 4.000, p = .046$. This stands in contrast to the 3-year-olds' chance responses to the personal preference question, suggesting that they found it easier to acknowledge that the accurate computer would be a better choice for an adult perhaps because their decision was less influenced by personal biases (e.g., choosing their favorite color). Taken together, these results suggest that young children perceive the computer's reliability as a persisting trait, although 3-year-olds' ability to do so may be more fragile and their personal preferences may be influenced by irrelevant factors.

DISCUSSION

Children aged 3, 4, and 5 years old showed differential trust in computers based on each computer's prior history of accuracy or inaccuracy, relying on the previously accurate computer's responses more often to identify novel objects by name and to answer questions about unfamiliar facts. Our results also suggest that, at least by age 4, children view a computer's status as a reliable or unreliable information source as stable and predictive of future responses even though computers are not social agents. Thus, although the mechanisms underlying selective trust in informants may have evolved for evaluating people, young children appear to extend at least some of these mechanisms to evaluations of technological informants as well.

The fact that children show differential trust in technological informants implies that children's trust in humans does not necessarily depend on social cues. That said, social cues may be helpful and enable children to evaluate humans more quickly or easily than computers. It remains an open question to what extent social cues play a role in children's selective trust in people above and beyond a domain-general heuristic of tracking prior accuracy. One way to address this question is to compare children's selective trust in technological informants with selective trust in human informants using a within-subjects design. Although we did not examine this question in the current study, it is important to note that our tasks may have been quite challenging compared with similar studies using human informants (e.g., Koenig et al., 2004), yet children still performed well on the test trials. In Experiment 1, children not only had to decide which word referent they trusted, but they also had to transfer their knowledge from a two-dimensional image on the computer screen to a three-dimensional object on the table in front of them. Although children as young as 2 years old are capable of transferring knowledge learned on video to live situations (Allen & Scofield, 2010), children may have performed even better if this transfer had not been required. Likewise, despite differences in color and size between the laptop that was used to present the videos and the computers in the videos, some children may have found it confusing to watch a video of a person interacting with computers on a computer screen. A live version of our task where children interact with computers or Web sites directly would address this possibility. That said, children's strong performance in Experiments 1 and 2 suggests that young children are as good, if not better, at evaluating technological informants as they are at evaluating human informants based on prior accuracy. This may also reflect a priority among children for accuracy over other factors, such as conventionality, when judging informants (see Scofield, Gilpin, Pierucci, & Morgan, 2013).

The fact that even the youngest children in our study relied on the accurate computer's responses more often during the test trials may reflect an appreciation among young children that a machine's past performance is more likely to be predictive of future performance than a person's past performance, at least when dealing with factual information. Although a computer's performance may be affected by physical factors (e.g., a cable being misconnected, as some children hypothesized), children may view computers as less sensitive to environmental influences on accuracy (e.g., a person can mishear a question in a noisy room). (Note that adults may have the opposite view based on observations of the negative consequences that even minute input errors can have on a computer's performance. Adults may also appreciate the fact that people can ignore environmental distractions or interruptions if necessary.) Furthermore, children may be more likely to think that computers' capabilities and knowledge are less likely to change in a short period of time in contrast to people who can quickly learn new things. Computers may also be viewed as less transient in nature compared with people: They are not subject to changes in mood and they do not play tricks or joke. Because children understand that computers do not have the same properties as people (Mikropoulos et al., 2003), perhaps not having to consider these potential influences on accuracy makes it easier for children to track which computer was reliable in the past and infer that the same computer is likely to be reliable again. Similarly, if children realize that computers do not have emotions, their choices about computers may be less subject to social pressures that bias their choice of human informants, such as a desire to interact with a different person each time or to give a person who was previously incorrect another chance to answer a question correctly.

Computers are not the only nonsocial information source children encounter, and our current findings raise important questions about how children evaluate other nonsocial sources with varying levels of animacy, such as books and robots. For instance, children can apply information obtained from books to real-world exemplars (Ganea, Ma, & DeLoache, 2011), suggesting that they trust the information that books provide. However, it is unclear if children evaluate nonsocial, minimally interactive sources like books in the same way as sources with more animate characteristics, such as computers or robots. Given the shifting emphasis from traditional printed sources to technological sources, this represents an important direction for future studies and one that could also help address to what extent children viewed the computers in our current study as social agents.

It would also be informative to examine the degree to which children's selective trust in technological informants is influenced by prior experience using computers and by literacy levels. Our participants came from a middle-class, suburban community where they were likely to have been exposed to computers both at home and at school, and their familiarity with technological informants may have influenced their judgments. Perhaps children with very limited experience with technological informants would show different patterns of responses. Similarly, as children age, they are likely to gain more experience observing adults using technological informants to find answers and interacting with technological informants on their own (Common Sense Media, 2011), and this may influence their evaluations of an inaccurate computer source. For example, once children realize that information accessed via the Web has human sources, they may distrust particular Web sites or search engines, rather than the computer itself. Older children are also likely to have stronger pre-reading skills, such as an appreciation that printed words convey information (Robinson, Einav, & Fox, 2013). Although the computers in our videos provided responses in terms of pictures only, understanding the function of printed words—what children commonly observe on adults' computer screens—may help children comprehend that technological devices convey information (as opposed to solely being a means of playing games or communicating). In general, we predict that children's ability to evaluate the reliability of technological informants is associated with how well they understand what kind of information technological informants can provide, and where that information originates.

As children mature, they must be able to handle a diverse range of situations requiring selective trust, ranging from choosing between people to choosing between Web sites, to successfully find answers and solve problems. The findings presented here suggest that even when potential informants are devices that do not share many characteristics with people, young children already possess a means of evaluating them. Children exhibit selective trust in both human and nonhuman sources of information, suggesting that selective trust may be a domain-general heuristic in the sense that it applies not only to social entities, but also to nonsocial ones. This idea offers a contrast to prior work suggesting that children draw conclusions about informants by focusing on uniquely human characteristics such as mental states (e.g., Birch et al., 2008). The fact that children consider factors such as prior access to information when choosing who to trust suggests that children do not view human informants merely as ‘‘information containers'' that are always either right or wrong, yet the current data suggest that children can apply the same criteria they use to evaluate informants to nonhuman sources, such as computers. Thus, children's extension of selective trust to nonhuman informants demonstrates that mechanisms evolved in the context of social interaction can be valuable for understanding nonhumans as well.

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