Children's Trust in Technological and Human Informants

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Abstract

Children understand early in development that different people know different things, and they are adept at using this information to select appropriate sources of information (Lutz & Keil, 2002). However, in the current digital age, information may be gathered from both humans and technological sources that select and present information as humans do. Using methods designed to study epistemic trust in human informants (e.g., Koenig, Clement, & Harris, 2004), the current study investigates children's and adults' selective trust in a technological and human informant. Children (ages 4 and 5) and adults were presented with queries designed to probe their willingness to seek out and accept information from human versus technological informants. The results demonstrate that 4-year-olds prefer to seek information from a human informant, but by age 5, children show an increasing preference for the technological informant. The relationship between children's trust and their experience with technology is also discussed.

Keywords: epistemic trust; technology; information

A mere generation ago, an individual wondering why the sky is blue or who invented the typewriter would find that the boundaries of their intellectual world did not extend far beyond the local library or the best guess of a community member. Today, we interact with a world wide web of information that represents a new level of interactivity, ease of access, and volume to information searches. Less than 10 years after the web was created, the majority of American adults had accessed the Internet at least once (Pew Research Project, 2000) and today over 42% of the earth's population has access to the Internet.[1] This level of information access raises important questions about how technology affects learning and understanding, particularly among children raised in this information-rich, highly technological environment. To date, there have been no studies examining how children's interactions with technological informants converge with or diverge from interactions with human informants, particularly early in development when children's epistemological concepts are still rapidly changing.

The study described below examines children's epistemological judgments about a human and a technological informant. For our purposes, a technological informant is a device or program that selects information from a very large knowledge base, such as the World Wide Web, and presents it to a user. One common example of this is a search engine, such as Google, that answers questions or provides links in response to a specific query. Thus, much like human informants, technological informants act as a selection mechanism for information. However, what makes technological informants unique from humans is that they are mechanical devices that presumably lack beliefs and intentions. Thus, the information a technological informant provides is not selected with the goal of facilitating learning, but rather it is likely to be driven by algorithms based on location, sponsorship, website popularity, etc.

The existing literature on young children's understanding of search engines and the Internet is extremely limited, or largely anecdotal; however, the literature on children's understanding of computers provides a starting point for considering how children may view technological informants. By age 5, children understand the basic biological and psychological differences between humans and computers, such as the fact that computers are not alive and do not experience emotions (Scaife & van Duuren, 1995; Mikropoulos, Misailidi, & Bonoti, 2003). However, not until later in elementary school do children understand what computers can do (e.g., store information; Subrahmanyan, Gelman, & Lafosse, 2002) and what kinds of questions they can and cannot answer (Danovitch & Keil, 2008). Although these experimental results are informative, the computers referenced in these studies were not described as providing access to the Internet and it is unclear whether participants were familiar with the Internet. By accessing the Internet,

[1] http://www.internetworldstats.com/stats.htm

technological informants can draw from a vast amount of information and they are much more interactive than previous generations of technology, yet even children with extensive experience using the Internet fail to appreciate its structure and complexity (Yan, 2005, 2006, 2009). These findings provoke an important question: If children do not understand the nature of the Internet, then how do they evaluate the information provided by technological informants that primarily draw information from Internet sources? Do they conceptualize them as they do human informants, granting them the properties of psychological agents, or do they view them as non-agents, as they might a non-interactive, non-human information source, such as a book?

Recent advances in understanding the development of children's social cognitive skills inform our approach. For the vast majority of human history, the main way to obtain information that could not be directly observed has been to consult other people, who would then select evidence for you. Given that children acquire much of their information about the world from others, it is not surprising that young children quickly develop relatively sophisticated means of judging potential informants and the information that they provide. Children as young as age 3 consider individuals' prior accuracy when determining who to consult or whose testimony to believe (e.g., Koenig, Clement & Harris, 2004; Birch, Vauthier, & Bloom, 2008). Children also take into account factors such as familiarity (Corriveau & Harris, 2009), group membership (Elashi & Mills, 2014), and access to relevant information (Nurmsoo & Robinson, 2009) when determining whom to trust. Although the vast majority of epistemic trust research has involved comparisons between human sources, recent work has shown that children apply some principles of epistemic trust to non-human informants, such as animated characters encountered in the media (Danovitch & Mills, 2014) and computers with differing rates of prior accuracy (Danovitch & Alzahabi, 2013).

Here we examine children's epistemic trust in technological and human informants. Our design is based on established methods for measuring epistemic trust (e.g., Koenig, Clement, & Harris, 2004), where participants must choose between two people that vary on some dimensions (including familiarity, knowledge, etc.) in order to learn a piece of novel information. Based on prior findings that 4-year-olds hold a fragile view of the differences between people and computers and the function of computers, and our assumption that 5-year-olds have more exposure to and experience using technology, we expected to find developmental differences where older children would show greater trust in a technological informant than their younger counterparts.

Method

Participants

Twenty 4-year-olds ranging from 3.99 to 4.96 (M_{age} = 4.34, 12 males) and 20 5-year-olds ranging from 5.03 to 6.03 (M_{age} = 5.48, 12 male) participated at preschools or a university laboratory in an urban area. The majority of the children's parents (n = 28) also completed a brief survey about their child's experience with and access to technological devices. The majority of the children were identified by their parents as Caucasian-American and non-Hispanic. Twenty-one undergraduates (M_{age} = 23, 5 male) at an urban university also participated. Adults were tested individually in a university lab following the same procedures as the children.

Materials & Procedure

For this experiment, we elaborated on the standard selective trust paradigm developed by Koenig and colleagues (e.g., Koenig, Clement, & Harris, 2004). In order to control for the differences in how questions are typically presented to human and technological informants (verbal vs. typed on a keyboard) and the medium in which answers are provided (e.g., humans speak but computers provide printed responses), we used presentation software to display information from both informants in windows on a laptop computer with a 15 inch screen. The windows were the same size and they featured editable text boxes with adjacent question mark buttons (see Figure 1).

Figure 1: Screenshot of desktop with editable windows featuring the human and technological informant.

The technological informant was represented using a "search" window containing a magnifying glass icon. The experimenter typed questions into a blank box underneath the icon, and when the button was pushed, the icon disappeared and was replaced by a large rotating hourglass. After rotating for 5 seconds, the hourglass was replaced by an image representing the program's response to the query (e.g., an image of a rabbit in response to the query "what animal eats

carrots?"). The human informant was presented in a schematically similar manner in a window labeled "chat." The icon in this window was the silhouette of a person, and when a question was entered and the question mark button was pressed, it was replaced with video of an adult male. The man initially looked down (off screen) for approximately 5 seconds before looking back up as he presented his response by holding up an image printed on a sheet of paper. For each set of responses, the images were approximately the same size on the screen, and the hourglass spun in the search window for exactly as long as it took the actor to lift his image, so that the timing was equivalent between informants.

Other materials included line drawings and digital images that the informants presented as their answers to queries. Colored line drawings of familiar animals (e.g., rabbits, cows, etc.) were used during familiarization trials. Digital images or colored line drawings were used as needed to represent the options presented in endorse trials.

Procedure

At the beginning of the experimental session, the experimenter informed each participant that he or she would be learning about animals from two different sources and explained that one source was "a computer program that can look for answers to questions on the Internet" and the other source was "a live video chat with a person who lives in another city." During the introduction, the experimenter opened and displayed the windows corresponding to each source.

Familiarization Trials Each session continued with 4 familiarization trials that involved questions about information familiar to young children (e.g., what animal says moo?). The experimenter read each question aloud as she typed the question into each informant's text box and each informant gave an answer in turn. The first informant's response remained on screen while the other informant presented a response so that both responses would be available at the end of each trial. Children were then asked to state the correct answer to each question. In order to establish that both informants were accurate but fallible, each informant responded to 75% of the familiarization questions accurately (i.e., each was wrong on one item that the other answered correctly). The order in which the informants were queried was counterbalanced so that half of the participants always saw the human informant answer first, and the other half always saw the technological informant answer first. Following the familiarization trials, participants were presented with three *ask* trials followed by three *endorse* trials.

Ask Trials The three ask trials consisted of questions about unfamiliar animals that most children would not be able to answer (e.g., where do pangolins sleep?). The experimenter read each question, and then asked the participant "where should I go for an answer?" These trials were designed to probe participants' preference for seeking out information from the human versus the technological informant.

Endorse Trials In each of three endorse trials, the experimenter read a question about a novel animal (e.g., What do blickets have on their bodies?). She then submitted it to each informant by typing into the text box in each window and each informant presented a different, conflicting answer (e.g., fur or feathers). Participants were then asked to endorse one answer. The purpose of these questions was to examine participants' selective trust in information received from the human and technological informants. The answer presented by each informant was counterbalanced across participants.

Technology Questionnaire Parents of child participants completed a brief questionnaire with 4 sections. In the first section, parents indicated how often their child had observed adults (including the parent) interacting with different types of websites or apps on a device that could access the Internet. Responses ranged from "never" (0 points) to "every day" (4 points). Parents provided ratings for 5 specific types of websites or apps: educational sites, games, sites for looking at pictures or videos (e.g. Youtube), sites for looking up information (e.g., Google), and sites for video conferencing with another person (e.g., Skype). In section two, parents used the same scale to rate how often their child had personally used each type of website or app, for the same 5 categories. In section three, parents were provided with a list of 12 technological devices, including computers with Internet access, smartphones, and tablets (e.g., iPad), and were asked to indicate which ones were present in their home. In section four, parents were asked to indicate the age at which their child first heard a book being read to them, first experienced "screen time" (watching TV, movies, or other screen based media), first actively interacted with a technological device, and first experienced a video conference with another person.

Results

In order to establish that participants were paying attention to the informants and were sufficiently knowledgeable to detect errors in the evidence presented by each informant, we examined children's and adult's accuracy on the familiarization trials. Adults

were perfect (M=100%) on this task, and children's accuracy (M_{4yo} = 96%; M_{5yo} = 98%) did not significantly differ from adult accuracy. Thus, participants were sufficiently attentive to encode the accuracy of each informant.

For ask and endorse trials, we coded preferences for the technological informant as a "1" and human informant as a "0," and we averaged these responses in order to generate a composite scores ranging from 0 (privileging the human informant) to 1 (privileging the technological informant). A repeated-measures ANOVA with Age as a between-subjects factor and Trial-type as a within-subjects factor revealed a significant main effect for Age, $F(2,57) = 23.2$, $p < .001$, $\eta_p^2 = .45$, as well as a significant Age x Trial-type interaction, $F(2,57) = 9.0$, $p < .001$, $\eta_p^2 = .24$. The main effect of Age was embedded in the Age x Trial-type interaction, which we further explored with post-hoc Bonferroni-corrected analyses. These analyses revealed that, when presented with ask questions, adults preferred to ask technological informants significantly more often than children (M = .95), ps < .001, but 4-year-olds (M = .28) did not significantly differ from 5-year-olds (M = .45, see Figure 2). Endorse trials revealed a slightly different pattern, where adults (M = .67) and 5-year-olds (M = .68) endorsed technological informants at rates significantly higher than 4-year-olds (M = .40), ps < .05, yet the responses provided by adults and 5-year-olds did not significantly differ from each other.

When we examined these results across Trial-type by Age, a different pattern emerged for each age group. There was no significant difference in 4-year-olds' informant preferences across ask and endorse trials. Five-year-olds responded differently to each trial type. On ask trials, they showed no preference for asking either informant, but their preferences shifted significantly towards trusting the technological informant for endorse trials, $p < .05$. Adults exhibited yet another pattern, revealing a strong preference for the technological informant on ask trials, but a significantly reduced preference for it on endorse trials, $p < .01$.

Ask and endorse questions probe potentially different intuitions, and thus it is interesting that participants' responses differ. To facilitate interpretation, it is also important to identify where response patterns differ from chance levels. We evaluated response patterns by Age and Trial-type using one-sample t-tests to compare scores to chance responding (chance = .5).

On ask trials, 4-year-olds preferred to ask human informants (M = .28) at a rate significantly greater than chance, $p < .01$. However, 5-year-olds did not show a significant preference for either informant (M = .45), and adults overwhelmingly preferred to ask the technological informant (M = .95), $p < .001$. It is important to note that these group means were representative of individual responses patterns within each age group. For example, most individual adults and 4-year-olds showed a pattern of preference for technological and human informants, respectively, and five-year-olds' mixed responses were truly variable and did not reflect a bimodal distribution where children were split between strongly favoring the technological informant or the human. On the endorse trials, 4-year-olds exhibited no significant tendency to endorse either informant (M = .40), while 5-year-olds (M = .68) and adults (M = .67), were significantly more likely to endorse answers they received from the technological informant, ps < .05.

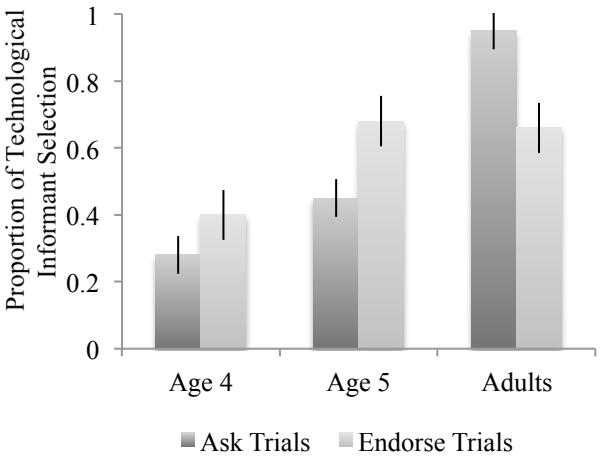

Figure 2: Proportion of trials where participants selected the technological informant. Values range from 0 (always selecting the human informant) to 1 (always selecting the technological informant). Error bars are standard error.

With respect to the technology questionnaire, of the 28 children who had a parent complete the questionnaire, all reported that their child interacted with technological devices at least a few times per month. All children also had at least 3 types of technological devices present in their home (M = 7.61). Notably, 89 percent of children observed adults searching for information on the Internet at least a few times per month and 32% of the children observed this behavior at least a few times per week. In addition, 75% of children had experience observing adults video conferencing and 61% had personally engaged in video conferencing at least once. Parents reported that their children had first experienced screen time at a mean age of 13 months old (range = 0 months to 2 years) and interacted with technology at a mean age of 22 months old (range = 6 months to 3 years, 5 months old).

Discussion

We presented 4- and 5-year-old children and adults with opportunities to express their preferences for a human versus a technological informant in two situations: when deciding which informant to consult in order to answer a question, and when deciding which informant's information to endorse. Two interesting patterns emerged. First, preferences for seeking information from the technological informant increased with age, beginning with a strong preference for the human informant at age four that transitioned into no preference by age five, and then a strong preference for the technological informant among adults. It is notable that responses were fairly consistent among individuals in each age group. This overall pattern suggests that a dramatic shift in preferences for technological informants between childhood and adulthood. Second, 4-year-olds endorsed answers provided by technological and human informants equally, yet 5-year-olds and adults endorsed statements by the technological informant significantly more often. This suggests that the sharp increase in the endorsement of technological informants between ages 4 and 5 is maintained into adulthood.

One factor that may have influenced children's responses was their actual experience using technological informants. According to their parents, most of the children in our sample had exposure to technological devices and most of them had observed adults using a technological device to obtain information. In addition, the children's exposure to technology had typically begun by their second birthday. What is interesting, though, is that despite having been exposed to technology early in life, young children did not show a strong preference for the technological informant; in fact, at age 4, they often trusted the person over the Internet search engine. In contrast, by age 5, children began to shift their trust towards the technological informant.

One potential explanation for this shift is that it is linked to children's growing awareness that print can be used to convey information. Recent findings demonstrate that as children learn how to read, they begin to prioritize printed information over oral testimony (Eyden, Robinson, Einav & Jaswal, 2013; Robinson, Einav, & Fox, 2013). Because technological devices that access the Internet typically provide text-based information, children may need to understand the value of text in order to appreciate the value of technological informants. Another possibility is that at age 5 children become more attuned to the range of information that can be accessed by the technological informant and the fact that human knowledge is more limited (Danovitch & Keil, 2008). Children may also solidify their awareness that technological devices are not intentional agents and that, consequently, technological devices are not subject to the influences that could undermine a human agent's reliability (e.g., an intention to deceive). Thus, children may begin to believe that information obtained from the Internet is more likely to be accurate. Future research is necessary to explore these possibilities.

Our current findings suggest that, when given the choice between obtaining information from an Internet search engine or a person, children exhibit a strong bias in favor of human informants early in development. Over time, children's trust in information provided by an Internet search engine grows, but their desire to seek out information from a technologically driven information source lags behind their reliance on the information that the source provides. This is a provocative narrative, but in order to test it effectively more information is needed about children's exposure to technology, and how these experiences shape their understanding of technological informants as targets of epistemic trust.

Our findings also raise questions about the broader consequences of obtaining information from technological informants. For instance, it remains unclear to what extent we treat technological informants as we do human informants, using the information that they present to us to shape our knowledge and inductions. If we treat technological informants as we would human teachers, is it problematic that we make pedagogical assumptions about them that are unfounded? For example, a teacher presents information to learners designed to aid learning and to highlight key concepts, but technological informants (e.g., search engines) employ algorithms that lack the intentions and beliefs that are inherent in human-to-human pedagogical experiences. As the Internet becomes a more ubiquitous part of our lives and we consult it more frequently to find answers to our questions, it is critical to explore the assumptions we make about technological informants, and investigate the consequences that these assumptions may have for our understanding. Given children's increasingly early exposure to technological informants, it is also essential that we understand their early intuitions about the capacities and limitations of technological devices in terms of obtaining information. Our study represents an important first step in evaluating how we learn from and relate to technological information sources in the modern digital age, and the timescale over which this relationship develops.

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References

Birch, S. A., Vauthier, S. A., & Bloom, P. (2008). Three- and four-year-olds spontaneously use others' past performance to guide their learning. *Cognition*, *107*, 1018–1034.

Corriveau, K. H., & Harris, P. L. (2009). Choosing your informant: Weighing familiarity and recent accuracy. *Developmental Science*, *12*, 426–437.

Danovitch, J. H., & Alzahabi, R. (2013). Children show selective trust in technological informants. *Journal of Cognition and Development, 14,* 499-513.

Danovitch, J. H., & Keil, F. (2008). Young Humeans: the role of emotions in children's evaluation of moral reasoning abilities. *Developmental Science, 11*(1), 33-39.

Danovitch, J. H., & Mills, C. M. (2014). How familiar characters influence children's judgments about information and products. *Journal of Experimental Child Psychology, 128,* 1-20.

Elashi, F. B., & Mills, C. M. (2014). Do children trust based on group membership or prior accuracy? The role of novel group membership in children's trust decisions. *Journal of Experimental Child Psychology*, *128*, 88-104.

Einav, S., Robinson, E. J., & Fox, A. (2013). Take it as read: Origins of trust in knowledge gained from print. *Journal of Experimental Child Psychology, 114(2),* 262-274.

Eyden, J. Robinson, E. J., Einav, S., & Jaswal, V. K. (2013). The power of print: Children's trust in unexpected printed suggestions. *Journal of Experimental Child Psychology, 16(3),* 593-608.

Koenig, M. A., Clément, F., & Harris, P. L. (2004). Trust in testimony: Children's use of true and false statements. *Psychological Science, 15,* 694–698.

Lutz, D. J., & Keil, F. C. (2002). Early understanding of the division of cognitive labor. *Child Development, 73,* 1073–1084.

Mikropoulos, T. A., Misailidi, P., & Bonoti, F. (2003). Attributing human properties to computer artifacts: developmental changes in children's understanding of the animate-inanimate distinction. *Psychology: The Journal of the Hellenic Psychological Society, 10*, 53-64.

Nurmsoo, E., & Robinson, E. J. (2009). Identifying unreliable informants: Do children excuse past inaccuracy? *Developmental Science, 12*, 41-47.

Pew Research Project. (2000). *Internet adoption*. Retrieved from http://pewinternet.org/Trend-Data/Internet-Adoption.aspx.

Scaife, M., & Van Duuren, M.A. (1995). Do computers have brains? What children believe about intelligent artifacts. *British Journal of Developmental Psychology*, **13**, 367–377.

Subrahmanyam, K., Gelman, R., & Lafosse, A. (2002). Animate and other separably moveable things. In G. Humphreys (Ed.), *Category-specificity in Brain and Mind* (pp. 341–371). London: Psychology Press.

Yan, Z., (2005). Age differences in children's understanding of the complexity of the Internet. *Journal of Applied Developmental Psychology, 26,* 385-396.

Yan, Z., (2006). What influences children's and adolescents' understanding of the complexity of the internet? *Developmental Psychology, 42,* 418-428.

Yan, Z., (2009). Limited knowledge and limited resources: Children's and adolescents' understanding of the internet. *Journal of Applied Developmental Psychology, 30,* 103-115.