How Children Seek Out Information from Technological and Human Informants

Judith H. Danovitch (j.danovitch@louisville.edu)
Department of Psychological & Brain Sciences, 317 Life Sciences, University of Louisville
Louisville, KY 40292 USA

Nicholaus S. Noles (n.noles@louisville.edu)
Department of Psychological & Brain Sciences, 317 Life Sciences, University of Louisville
Louisville, KY 40292 USA

Patrick Shafto (p.shafto@louisville.edu)
Department of Psychological & Brain Sciences, 317 Life Sciences, University of Louisville
Louisville, KY 40292 USA

Abstract

Members of the current generation of young children have been exposed to technological informants, primarily consisting of devices that search the Internet for information, nearly since birth. However, little is known about how young children explore information using these digital sources. To address this issue, 30 preschool children generated questions about unfamiliar animals that were to be answered by either a human or technological informant (i.e., an Internet search program). Children also completed a measure of biological and psychological attributions to different types of information sources. Overall, children generated similar numbers of questions for each informant, and a similar proportion of their questions were causal in nature. Children also attributed few biological and psychological characteristics to the Internet search program. This suggests that, despite understanding that technological devices share few biological and psychological properties with people, young children seek out information in similar ways from human and technological information sources.

Keywords: technology; information; questions

As human beings, we have a natural propensity to ask questions and seek out information about the world around us. If the answers to our questions are not readily observable, we look for answers from other sources. For the vast majority of human history, these sources have consisted primarily of other people (with the later addition of books, radio, and other media). Seeking out information sources often requires time and effort, and even then the answer they provide might be "I don't know."

However, in the past few decades, there has been a dramatic change in how people look for answers to their questions. With the advent of the Internet, questions that would have required consulting an expert, or a trip to the library, can now be answered within milliseconds by consulting an Internet search engine. In addition, devices such as smartphones have made it possible to quickly and easily access an enormous amount of information from nearly anywhere in the world. Yet, despite the fact that nearly 43% of the world's population now has access to the Internet (http://www.internetworldstats.com/stats.htm), little is known about how access to the Internet influences the development of information-seeking behaviors.

One issue that has been of interest to both popular commentators and researchers is whether Internet use has consequences for curiosity and exploration. Some commentators have argued that access to information via technology and the Internet is diminishing our cognitive capacity and intelligence (e.g., Bauerlein, 2008; Carr, 2010). These concerns extend to include effects on motivation to seek out information and acquire meaningful understanding (i.e., by providing a quick answer, technological informants might stifle exploration or skepticism). There is also emerging evidence that, at least among adults, obtaining information via the Internet may lead to overconfidence in one's own knowledge (Fisher, Goddu & Keil, 2015; Ward, 2013), potentially diminishing motivation to learn more. That said, there have been no studies examining how interactions with technological informants influence curiosity and exploration in children during a period when their epistemological concepts are still rapidly changing and they are becoming more aware of the limitations of their own knowledge (Mills & Keil, 2004).

The study described here examines how consulting a person or the Internet as an information source affects children's information-seeking behaviors. Children in many modern communities have been exposed to technological devices that can access the Internet nearly from birth, and they frequently observe adults using these devices to obtain information. Anecdotally, parents report that their young children ask them to look up information using Google or other search engines – although they do so even for questions that cannot be answered by information available via the Internet (e.g., "is there a pizza in the freezer?" Richler, 2015). Thus, comparing the questions children direct to human and technological sources can provide an insight into how children use technological sources to obtain information and their beliefs about the kinds of information that can be obtained from human or technological sources.

Although, to the best of our knowledge, there is no research looking at the questions children ask of technological informants, there is ample existing research examining the developmental trajectory of children's information-seeking via questions. By age 4, children are more likely to ask questions of more knowledgeable informants than less knowledgeable ones (e.g., Birch, Vauthier, & Bloom, 2008; Koenig, Clement, & Harris, 2004), and they are capable of directing their questions to individuals with appropriate background knowledge and expertise (Lutz & Keil, 2002). Thus, by preschool, children are adept at differentiating between different types of information sources.

In addition, by age 5, children are capable of formulating questions that will allow them to solve problems (Mills et al., 2010). As Greif and colleagues (2006) found, children tailor their questions to the topic at hand and seek out different kinds of information about unfamiliar animals versus artifacts. If, for the purposes of obtaining information, children treat the Internet search engine as having the same capabilities (e.g., ability to select the most relevant information) as a human, then we would expect children to show similar levels of curiosity (e.g., rates of question asking) when seeking out information from a person or an Internet search engine. However, if children view the Internet as having a greater or lesser capacity to obtain information or formulate answers, then their rate of information seeking should differ.

Furthermore, our study examines whether children direct different types of questions to a human or technological informant. Young children are highly motivated to seek out causal explanations, and they ask appropriate "how" and "why" questions in order to obtain these explanations (Frazier, Wellman, & Gelman, 2009). Nevertheless, they may view the Internet as a good source of detailed factual information, but not necessarily as a good source of causal explanations, which require additional synthesis and understanding to generate. To address this possibility, our study examines the proportion of questions children ask of each informant that seek out causal information.

Finally, we are interested in how children's information-seeking behaviors are related to the ways in which they conceptualize human and technological sources. Some insight into this issue can be gained from existing research examining how children conceptualize computers and their capabilities. For instance, although young children understand the biological and psychological differences between humans and computers (Scaife & van Duuren, 1995; Mikropoulos, Misailidi, & Bonoti, 2003), they may have difficulty understanding the extent of a computer's information storage capacity (Subrahmanyan, Gelman, & Lafosse, 2002). That said, because much of the existing research took place more than a decade ago, these studies did not make any mention of the Internet. The Internet provides access to a vast amount of information and search engines are much more interactive and selective than previous generations of technology, and even children with experience using the Internet seem to have difficulty understanding its structure and complexity until late elementary school (Yan, 2005, 2006, 2009). Thus, our current study not only provides an important update to previous work, but it also investigates whether children attribute pedagogical capacities to Internet search engines.

Method

Participants

Thirty children ranging from 4.36 to 5.89 years (M_{age} = 4.89, 16 males) participated at preschools and kindergartens in an urban area. The majority of the children were identified by their parents as Caucasian-American and non-Hispanic. Children were interviewed individually by an experimenter in a quiet area of their school.

Materials & Procedure

The procedure was loosely based on the paradigm developed by Greif and colleagues (2006), where children encounter unfamiliar animals and are encouraged to generate questions about each animal. Children interacted with two informants: a person and an Internet search engine. Because questions are typically presented to human and technological informants in different ways (e.g., verbal vs. typed on a keyboard) and this might affect children's behavior, the experimenter "interacted" with both informants via a laptop computer with a 15-inch screen. Information was submitted to both informants by typing.

The Internet search engine was represented using a window labeled "search" that contained a magnifying glass icon (see Figure 1a). The human informant was presented in a schematically similar manner in a window labeled "chat" (see Figure 1b). The graphic in this window was a silhouette of a person. Both windows featured an editable text area where the experimenter could type in a question with a question mark button to the right, which the experimenter hit to transmit the question to the informant.

Other materials included full color images of each of the four target animals (pangolin, colugo, echidna, and tarsier) printed on separate sheets of paper.

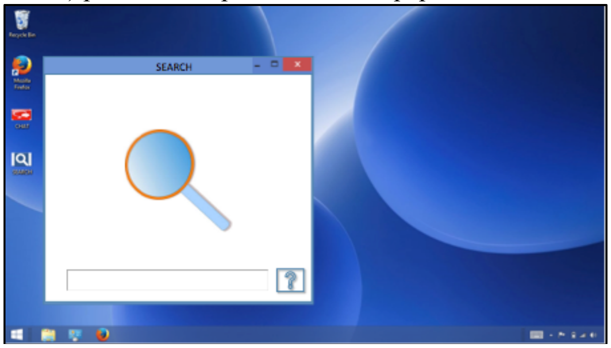

Figure 1a: Screenshot of desktop with search window open.

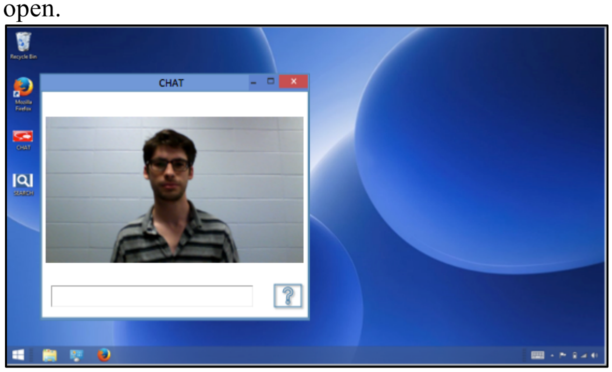

Figure 1b: Screenshot of desktop with chat window open. The video of the person used in the familiarization trials was replaced by a silhouette image in the question trials.

Procedure

At the beginning of the experimental session, the experimenter informed children that they 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 corresponding windows for each source.

Familiarization Trials Each session continued with 2 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. For the human informant, when the question mark button was pressed, it was replaced with video of an adult male who presented evidence by looking down (off screen) for approximately 5 seconds. He then looked back up as he presented his response by holding up an image printed on a sheet of paper. For the technological informant, when the button was pushed, the magnifying glass graphic disappeared and was replaced by a large rotating hourglass. After rotating for 5 seconds, the hourglass disappeared and 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 experimenter also pointed at each image and said its name (e.g., “rabbit”) after it appeared.

The first informant’s response remained on screen while the experimenter queried the other informant and that informant’s answer appeared on the screen. Thus, both responses were available at the end of each trial. Children were then asked to state the correct answer to each question. The order in which the informants were queried was counterbalanced so that half of the participants always saw the human informant answer the question first, and the other half always saw the technological informant answer first. Following the familiarization trials, the experimenter cleared both windows from the screen and participants were presented with the question trials.

Question Trials The experimenter introduced the first pair of question trials by telling the child that they would have a chance to learn more about some new animals by asking the person questions. She then opened the “chat” window only, which appeared in the center of the screen. Children were instructed to tell the experimenter their questions about the animal and the experimenter would type the questions. Children were told that they could ask as many questions as they wanted, and that they would receive the answers later.

The experimenter began each trial by placing a photo of an animal on the table in front of the child and asking: “Do you know what this is called?” If the child answered that they did not know, the experimenter continued by stating “It’s a [animal name]. What questions do you want to ask the person about the [animal]?” If the child named the animal incorrectly, the experimenter corrected them by introducing the animal’s name. Each time the child asked a question, the experimenter repeated the question while typing it into the window on the computer screen. The experimenter then submitted the question to the information source, and the child had the opportunity to ask another question. There was no limit on the number of questions children could generate. However, if the child paused for more than 10 seconds, the experimenter asked the child if s/he had any more questions about the animal. If the child did not generate additional questions, the trial ended.

Following the second trial, the experimenter cleared the screen and stated that now the child would be learning about animals from the computer program. She then followed the same procedure as with the first set of trials, entering the child's question in the "search" window instead.

The order in which the child encountered the informants (person or computer program first) and the order in which the animals were presented was counterbalanced between subjects.

Attribution Trials The goal of this task was to examine children's intuitions about the biological and psychological nature of human and technological entities. Children were instructed to answer yes or no to a series of questions about four target items presented as photos on cards: a person (represented by an image of the man in the chat window from the familiarization trials), a computer program (represented by an image of the search window from the familiarization trials), a book, and a bird. The book and the bird were included to provide comparison points with the human and technological sources. The experimenter introduced each object by stating "This is a [object name]" and then asked 7 questions in the form of "Can this one ____?" The questions addressed biological processes ("eat"), perception ("see things"), cognition ("think"), emotion ("feel happy"), social awareness ("tell how you feel"), intentionality ("want to help you") and pedagogical capacity ("teach you something").

Results

All children correctly identified the correct answers in the familiarization trials and no child was able to initially name the animals correctly, confirming that the animals were unfamiliar to all of the children.

Question Trials There were a total of 215 questions asked by 26 participants. (Four children did not ask questions of either informant.) For our initial analysis, we calculated the combined number of questions over the two trials asked of each informant. Preliminary analyses showed no gender differences nor effects of the order in which the informants or animals were introduced so these variables were excluded from further analysis. A paired samples t-test showed no difference between the number of questions children asked of the human (M = 4.07, SD = 3.45) and the computer program (M = 3.47, SD = 2.54), $t(29) = 1.57$, $p = .124$.

In order to examine potential differences in the content of the questions children directed to the human or technological informant, we calculated the proportion of questions each child asked of each source that used the terms "why" or "how." (The two "how" questions related to the animal's sleep and movement patterns, and were causal in nature.) We found that 38% of the questions directed to the human and 44% of the questions directed to the computer sought causal explanations, yielding no significant difference in the proportion of causal questions children asked of each informant, $t(24) = .998$, $p = .328$ (see Figure 2).

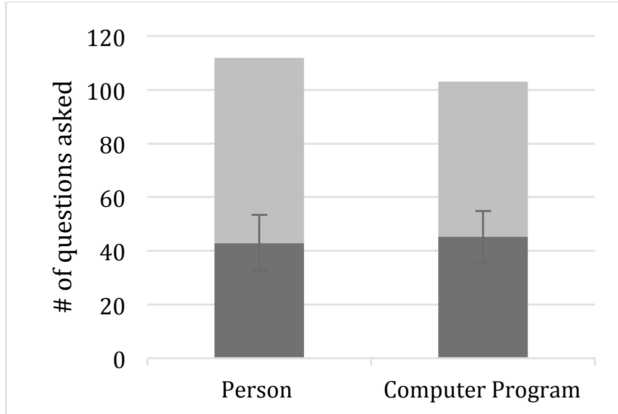

Figure 2. Total number of questions asked of each information source. Dark sections indicate proportion of questions that were causal in nature (i.e., "how" or "why" questions). Error bars indicate SE.

Attribution Trials Although four children did not ask questions, all 30 participants successfully completed the familiarization and attribution trials. Thus, we included every child tested in our analyses. For these trials, we calculated a score of 0-7 for the total number of characteristics children attributed to each object. We analyzed these data using a repeated-measures ANOVA with Object-type as a within-subjects factor. This test revealed a significant main effect of Object-type, $F(3,87) = 68.32$, $p < .001$, $\eta_p^2 = .703$. Bonferroni-corrected post-hoc analyses revealed that significantly more attributions were made to the human than to the bird, computer program, or book (ps $< .001$). The bird represented an intermediate level of attributions, which was significantly lower than the human, but still significantly greater than the computer program or book (ps $< .05$). The number of attributions to the computer program or book did not significantly differ, $p = 1.00$.

Although these differences are important, the attribution task included some characteristics that were not essential to our goal of evaluating human versus technological informants (e.g., questions about physical or perceptual capabilities – questions that primarily ensured that children were paying attention and knew how human and technological informants differ). Thus, we conducted a second analysis focused more narrowly on attributions about thinking and teaching by combining responses to the cognition and pedagogical capacity items to create a more focused composite score. We analyzed this data as we did the full set of attributions, again finding a significant main effect for Object-type $F(1,29) = 5.12$, $p < .05$, $\eta_p^2 = .15$. Post-hoc analyses revealed a pattern that differed slightly from our findings including all attributions. As in our initial analysis, significantly more attributions were made to the human *(M* = 1.87) than to the bird, computer program, or book, $p < .001$, but the bird, computer program, and book did not differ from each other (*M*s between .57 and .67).

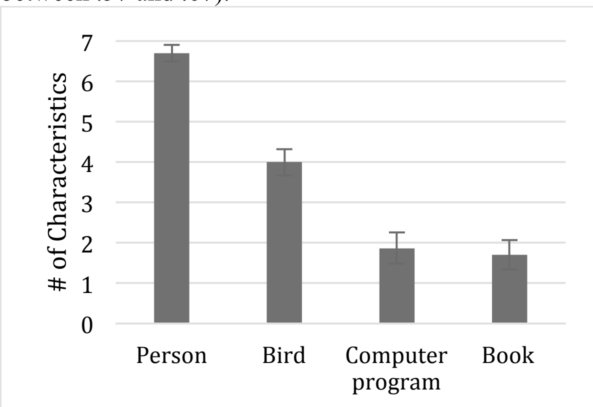

Figure 2. Mean number of characteristics attributed to each object in the attribution task. (Error bars indicate SE.)

Relationship between questions asked and attributions We performed a correlational analysis to investigate whether the content or number of children's questions were related to their attributions of biological and psychological characteristics to the computer program. We found no significant correlations between children's rate of asking questions of each informant or the proportion of causal questions asked and the number of characteristics attributed to the computer program. There was also no relationship between the number or nature of the questions asked and children's attribution of the capacity to think and teach to the computer program. Thus, children's questions appeared to be largely independent of the characteristics that children attributed to technological informants.

Discussion

We examined what kinds of information 4- and 5-year-old children seek from a human or a technological informant (i.e., an Internet search program), and how their information seeking behavior relates to their attributions of psychological and biological characteristics to technological informants. Our methods provided children with an opportunity to utilize one of their most powerful and natural learning mechanisms: asking questions. We presented children with unfamiliar animals, knowing that these effectively provoked questions in prior studies (e.g., Greif et al., 2006). Critically, we sought to evaluate whether children's questions to a human versus a technological informant varied in terms of volume and the proportion of causal questions. The contrast between these two information sources is important because children today learn from both sources, but unlike human sources, technological devices do not have the beliefs, intentions, and behavior patterns that underlie human pedagogical behaviors.

Our data reveal that children's question-asking behaviors were similar in quality and quantity for both humans and computers. Children asked many questions, and the proportion of causal questions asked did not vary between the two informants. One interpretation of these data is that children were more focused on the subject of their questions (i.e., the unfamiliar animals) than on the nature of the information source. They may also view both information sources as equally capable of answering both causal and non-causal questions about animals, although perhaps children would have made a greater distinction between information sources if the questions were in another domain, such as moral reasoning (see Danovitch & Keil, 2008). Another potential interpretation is that children of this age did not understand the differences between the informants and therefore did not tailor their questions to them; however, their responses on the attribution task suggest that this is not the case.

In the attribution task, we measured children's intuitions about the biological and psychological characteristics of human and technological informants. Despite treating human and technological information sources very similarly in terms of their question-asking behaviors, children's attributions of characteristics to human and technological sources were quite different. Although children asked the same kinds of questions of the person and the Internet search engine when allowed to do so, they did not explicitly state that the Internet search engine had characteristics that would allow it to be an effective teacher (such as the capacity for thought, intention, and pedagogy). Thus, children's explicit understanding of computers as a non-pedagogical entity appeared to have no meaningful relationship to their question-asking behaviors. That said, relatively few children in our sample attributed pedagogical characteristics to the computer program. This stands in contrast to the adult intuition that computer programs, and particularly Internet search engines, can be effective means of obtaining information and learning new concepts (Zickuhr, 2010). Thus, additional research is needed to investigate whether the pattern of responses we observed persists over development, or whether it is unique to young children who have relatively limited experience using technology to find information on their own.

These findings also raise important questions for future research regarding the broader consequences of obtaining information from technological informants. Why do children ask similar questions of information sources that are teachers and non-teachers? Do children co-opt question-asking behaviors that are usually targeted at pedagogical sources, or do they treat technological informants differently from other information sources? It would also be informative to examine how children reconcile their implicit behavior toward technological informants (e.g., asking them questions of the same nature that they ask of humans) and their explicit beliefs about technology, and whether this changes over the course of development.

In conclusion, our current findings represent an important first step toward understanding how growing up surrounded by information technology affects children's curiosity and exploration of information. As the devices that search the Internet become more readily available and children encounter them at younger ages, it is essential that we understand children's assumptions about the capacities and limitations of technological informants and use this understanding to inform the ways in which children interact with and learn from technology.

Acknowledgements

This research was supported in part by funding from the National Science Foundation, CAREER grant DRL-1149116 to PS. Thank you to Jacob Messmer, Kayla Renner, and Gretchen Santana for their assistance with data collection. We would also like to thank the staff, children, and parents at St. Paul School and Keneseth Israel Preschool in Louisville, KY.

References

Bauerlein, M. (2008). *The Dumbest Generation: How the digital age stupefies young Americans and jeopardizes our future (or, don't trust anyone under 30)*. New York, NY: Penguin.

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.

Carr, N. (2010). *The shallows: What the Internet is doing to our brains*. New York, NY: W.W. Norton.

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

Fisher, M., Goddu, M. K., & Keil, F. C. (2015). Searching for explanations: How the Internet inflates estimates of internal knowledge. *Journal of Experimental Psychology: General.*

Frazier, B. N., Gelman, S. A., & Wellman, H. M. (2009). Preschoolers' search for explanatory information within adult–child conversation. *Child Development*, *80*(6), 1592-1611.

Greif, M. L., Nelson, D. G. K., Keil, F. C., & Gutierrez, F. (2006). What do children want to know about animals and artifacts? Domain-specific requests for information. *Psychological Science*, *17*(6), 455-459.

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.

Mills, C. M., Legare, C. H., Bills, M., & Mejias, C. (2010). Preschoolers use questions as a tool to acquire knowledge from different sources. *Journal of Cognition and Development*, *11*(4), 533-560.

Mills, C. M., & Keil, F. C. (2004). Knowing the limits of one's understanding: The development of an awareness of an illusion of explanatory depth. *Journal of Experimental Child Psychology*, *87*(1), 1-32.

Richler, J. (2015) What children think of the Internet and Why it Matters. Retrieved from: http://parenting.blogs.nytimes.com//2015/02/16/what-children-think-of-the-internet-and-why-it-matters/

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.

Ward, A. F. (2013) *One with the cloud: Why people mistake the Internet's knowledge for their own* (Unpublished doctoral dissertation). Harvard University, Cambridge, MA.

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.

Zickuhr, K. (2010). *Generations 2010.* Retrieved from Pew Internet Research website: http://www.pewinternet.org/files/old-media/Files/Reports/2010/PIP_Generations_and_Tech10.pd