Can we Google That?: Children's Beliefs about the Capacities of Three Technological Devices

Lauren N. Girouard-Hallam (girouala@umich.edu)
Department of Psychology, University of Michigan
East Hall, 1004, 530 Church St, Ann Arbor, MI 48109, USA

Judith H. Danovitch (j.danovitch@louisville.edu)
Department of Psychological and Brain Sciences, University of Louisville
355 Life Sciences, Louisville, KY 40208, USA

Abstract

This study examines 205 4- to 12-year-old children's beliefs about the abilities of three technological informants (the internet as a whole, Google search, and Amazon's Alexa smart speaker) to answer questions about celebrity and non-celebrity people and near future and far future events. The results indicate that, with increasing age, children increasingly indicate that these sources can accurately answer questions about near future events and celebrities but not about non-celebrities or far future events. Although children increasingly indicate that these sources cannot tell them about everyday people, the oldest children in the sample believe that the internet is more likely to be able to tell you about non-celebrities than Alexa or a Google search. Children's understanding of the capacities of technology change with age and information type, perhaps reflecting changes in children's experiences online. Implications for children's learning and understanding of privacy are discussed.

Keywords: children; cognitive development; information seeking; internet; technology; smart speaker; search engine

Introduction

There is no source of information so vast as the internet. For example, ChatGPT, the popular online large language model and conversational chatbot accesses online text equivalent to three times what can be found in the Library of Congress (Gupta, 2023). The kinds of information found online are also wide ranging from video commentary on cultural phenomena to social media posts about a person's life to predictions for the next presidential election. The internet provides a home to much more than objective fact. It is therefore essential for children to develop a clear sense of what kinds of information can and cannot be found online, and when internet-based tools are useful agents for obtaining information.

Children's Trust and Online Information

Just as they do with human sources, children use cues like accuracy to decide when to trust technological informants like computers (Danovitch & Alzahabi, 2013) and webpages (Wang et al., 2022). However, children are not always able to determine when webpages are inaccurate (Einav et al., 2020) and may sometimes still trust a previously inaccurate online source (Guerrero et al., 2020). Most 6-10-year-old children say that the internet is an accurate source for information when directly asked, though this belief does decrease with age (Girouard-Hallam et al., 2023). Children in this age group also express a preference for the internet and internet-based devices, including search engines and smart speakers, over human informants (Girouard-Hallam & Danovitch, 2022a; Girouard-Hallam & Danovitch, 2022b; Wang et al., 2019), perhaps in part because skepticism and doubt in human informants increases in this age group as well (Mills, 2013). Children's trust in the internet and internet-based sources is therefore not unmitigated, but it is still high when compared to traditional informants like other people.

Although most research on children's beliefs about technology has focused on scientific or historical facts that do not change and are not personal in nature, some research has examined personal information about other people. Children under 7 struggle to recognize that internet-based smart speakers, such as Amazon's Alexa, are not useful for learning personal information about other people; however, by age 7, children recognize that personal information is easier to access through an interaction with another person as opposed to a smart speaker (Girouard-Hallam & Danovitch, 2022a). That said, the internet can provide personal information about other people – including celebrities, whose personal information is widely available and of relatively high interest to the public, and non-celebrities. Through their experience, children may easily grasp that celebrity information is accessible on the internet, but it may be more difficult for them to grasp that personal information about non-celebrities is also available to some extent. Understanding whether children recognize that the internet can provide personal information about non-celebrities has theoretical and practical implications. Theoretically, children's beliefs about personal information on the internet have implications for understanding whether children believe that non-human sources are valid resources for learning information about others. Practically, children's intuitions about personal information have implications for their privacy and safety online.

Starting at age 6, children recognize that internet-based devices like tablets are useful for current event information like the weather (Eisen & Lillard, 2016), and children increasingly prefer internet searches over consulting people for current event information with increasing age (Girouard-Hallam & Danovitch, 2022b). Similarly, children ages 7 to 10 believe that questions about future events are generally harder to answer correctly than questions about the past or present, but that Google can answer them better than a person

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can (Girouard-Hallam & Danovitch, 2022b). The current study extends this work by examining children's beliefs about the capacity of technological agents to answer questions about near future events and far future events. Near future events including weather forecasts, sports win/loss projections, and event schedules, are often the subject of internet searches and can be considered at least moderately reliable. In contrast, accurate information about far future events is not readily available online; although plenty of people might speculate about far future events on public facing websites or social media platforms, one would not expect these sources to necessarily predict far future events correctly. The current study explores whether children recognize this distinction by acknowledging that information about near future events obtained from internet-based technologies is more likely to be accurate than information about far future events.

Children's Intuitions about Internet-Based Devices

The current study considers whether children's intuitions about internet-based information sources differ based on the type of technology being used. One of these sources is the internet itself, which serves as a kind of baseline for other internet-based devices. Previous studies probing children's intuitions about "the internet" shows that children's preference for obtaining information from the internet increases as children age, with children preferring the internet to other sources like peers or teachers by age 7 (e.g., Wang et al., 2019). However, recent research with 5- to 10-year-old children also suggests that children increasingly understand that information on the internet may be inaccurate (Einav et al., 2020; Girouard-Hallam et al., 2023; Tong et al., 2022). That said, this prior work treats "the internet" as a single entity without addressing the websites or devices are being used. Thus, children's intuitions may differ based on the familiarity and properties of the internet-based source that is providing information.

Google is the world's most visited website and processes billions of searches per day (Howarth, 2024). Children are often the primary users of internet search in their homes (Foss et al., 2012), and use search engines like Google for a variety of information and entertainment related searches (Ofcom, 2022; Rideout & Robb, 2020). However, children may have trouble formulating a search query (Druin et al., 2010; Duarte-Torres et al., 2014) or navigating search engine results appropriately (Duarte-Torres & Weber, 2011) and children can also have difficulty understanding the nature of Google search and how it works. Children as old as middle schoolers, for example, will depict Google as a group of people feeding answers to a question into a computer when asked to draw a representation of the Google search process (Kodama et al., 2015). Although children may struggle to conceptualize Google search, they tend to prefer to use Google search as an informant as opposed to asking a person to answering a question, particularly for events occurring in the past (Girouard-Hallam & Danovitch, 2022b). Children's familiarity and experience with Google may lead them to ascribe more capacity to Google than to the internet, which may be less familiar or more difficult to conceptualize.

Another category of internet-based search technology, which is becoming increasingly popular, is smart speakers like Amazon's Alexa. Nearly half of American homes with children ages 0-8 already have a smart speaker (Rideout & Robb, 2020) and, unlike Google search, using a smart speaker does not require a child to be able to read or write. Children as young as 4 can therefore ask smart speakers questions about a wide range of topics (Lovato et al., 2019). Smart speakers are appealing and exciting informants for children (Druga et al., 2017; Festerling & Siraj, 2020; Wojcik et al., 2022); particularly for very young children, who may even view them as social partners or "friends" (Hoffman et al., 2021). Children under age 6 are also more likely to say that a novel smart speaker could tell them information about another person than a friend of that person (Girouard-Hallam & Danovitch, 2022a). This combination of familiarity and interactivity may increase trust in their responses, such that younger children may be likely to believe that smart speakers can tell them about other people.

Current Study

The current study examines children's judgments about the capacity of three technological informants (the internet at large, Google, and Alexa) to answer questions about near future, far future, celebrity, and non-celebrity information. We hypothesize that, as participant age increases, children will increasingly indicate that all three technological informants can provide information about celebrities and near-future predictions. We anticipate that, with increasing age, children will increasingly indicate that the internet and internet-based devices can provide information about non-celebrities. However, we also hypothesize that children's judgments about non-celebrity information may vary based on the device, such that they believe that the internet is better able to provide this kind of information than a Google search or Alexa. Finally, we anticipate that, with increasing age, children will increasingly identify the ability to predict far future events as a limitation of the internet and internet-based devices.

Given that children's exposure to technology is nearly ubiquitous (Rideout & Robb, 2020), it is particularly important to examine age-related differences in children's intuitions about technology. Based on evidence that children's intuitions about the internet and internet-based devices change over development (e.g., Danovitch & Lane, 2020; Girouard-Hallam et al., 2023; Oranc & Ruggeri, 2021; Wang et al., 2019), the current study included a broad participant age range of 4- to 12-years. Children's understanding of the capacities and limitations of the internet and internet-based devices improves between ages 7 and 10 (Girouard-Hallam & Danovitch, 2022b; Girouard-Hallam et al., 2023) and their understanding of how the internet works continues to improve through age 12 (Brodsky et al., 2021; Yan 2005, 2006, 2009), but even older children can struggle to understand the intricacies of how tools like Google search

function (Kodama et al., 2015). Previous research has suggested that both children's experience and age are often related to differences in their intuitions about internet-based sources (Girouard-Hallam et al., 2021; Girouard-Hallam et al., 2023), so we also asked children about their previous experience using the three sources we tested, as well as their experience asking other people questions and using books to answer their questions.

Method

Participants

Participants were 205 children (90 girls, 115 boys) ages 4 to 12, including 63 4-6-year-olds (M_{age} = 5.59), 74 7-9-year-olds (M_{age} = 8.52), and 68 10-12-year-olds (M_{age} = 11.44; overall M_{age} = 8.60, overall SD_{age} = 2.48). Fourteen additional participants were excluded due to inability to complete the inclusion task. Of these participants, 11 were 4 or 5 years old.

To determine sample size, we performed a two-tailed, one sample t-test a priori power analysis in G*Power (Faul et al., 2007) as a proxy for determining sample size for a multilevel model (see Muryama et al., 2022). We used an effect size value of d = .33 (based on Girouard-Hallam & Danovitch, 2022a). The minimum total required sample size for this study at power = .90 is 200.

Participants were recruited through social media advertisements and http://childrenhelpingscience.org. Approximately 67% of participants were identified by their parents as White, 9% as Black/African-American, 13% as Asian-American, 2% as Native American, 6% were identified as mixed race, and 3% of parents chose not to respond. Additionally, 7% of children were identified by a parent as Hispanic, 90% as non-Hispanic, and ethnicity information was not provided for 3% of participants.

Procedure

Study data were collected between 2021 and 2024. The study took place over a synchronous Zoom video-call led by an experimenter or at a preschool or in a laboratory in Louisville, Kentucky. The study procedure was approved by the University of Louisville's IRB (14.0053, "Children's Thinking and Learning").

Introduction to Informants and Identification Inclusion Task

Children were shown images and provided with descriptions of three popular technological agents: the Google search engine (i.e., "a program that searches the internet"), Amazon's Alexa (i.e., "a smart speaker that responds to a person's voice"), and the internet at large (i.e., "a kind of network; a group of interconnected computers"). They were also told about a popular print reference: the dictionary. After viewing an image of each informant and hearing its description, children viewed images of all four informants on the same screen. To ensure that children understood the differences between each of the informants, children were asked which of the informants matched each description. Only children who could correctly match the informants to their descriptions were included in the study.

Previous Experience Questions

To examine children's experience with each of the four informants, children were asked a series of yes/no response questions about whether they had used the internet, Google, Alexa, and books to answer questions. They were also asked if they used other people, like parents or teachers, to answer their questions.

Dictionary Questions

To check children's understanding of the proper uses of information sources, we also asked children about the dictionary's ability to answer questions about how a word was spelled and what someone ate for breakfast. Although this task was not used to exclude participants, children's responses to these items (particularly those of the youngest children in the sample) were intended to provide context into their general ability to evaluate information sources.

Informant Evaluation Task

Children were instructed to listen to questions posed by a person. After they heard the question, they were told that the person had used one of the three technological informants to answer the question and heard the answer provided by the informant. The ways in which the answer was acquired were paired to the informant type. Alexa simply "says" the answer, Google's "search results say" the answer, and the internet takes the user to a webpage that says the answer. Children were then asked whether the informant "could answer questions like this in real life" (yes/no response). They were also asked how certain they were of their yes/no response (very sure or a little sure). The question items corresponded to four categories: celebrities, non-celebrities, the near future, and the distant future (see Table 1 for examples). There were three items per category for 12 total items. Each informant was paired with one item from each category.

Results

Preliminary analyses did not reveal significant effects of order, gender, or testing location (in person vs. online), so these variables were excluded from further analysis.

Informant Endorsement

To address the impact of age, informant, and question type on children's judgments, we developed a cumulative link multilevel model (CLMM) using the clmm function in the ordinal package (Christensen, 2023) in R version 4.2.2 (R Core team, 2022). The fixed effects in the model were informant (Internet, Google, or Alexa) and question type (celebrity, non-celebrity, near future, far future), and child age (centered at its mean) was included as a continuous predictor. The model also included 2-way and 3-way interactions between informant, question type, and age, and random intercepts for child and item. Random intercepts were added one at a time to the base model (Informant x Question

Type x Age) until a model that was parsimonious and explained the most variance was reached. Odds ratios were also calculated in order to further examine the effects found in the model. The dependent variable was a four-point ordinal scale of children's response and response certainty, ranging from 1 = no, very sure, to 4 = yes, very sure. Each question category was rotated as the reference category to ensure that we captured all significant effects found in the model.

Table 1: Informant Evaluation Task Question Categories and Item Examples

Question Category	Example
Celebrity	Alex wants to know where famous actress Emma Stone was born, so he uses Google search to answer his question. Google's search results say that the famous actress Emma Stone was born in Wisconsin.
Non-Celebrity	Marian wants to know when her friend's birthday is, so she asks Alexa for the answer. Alexa says that her friend's birthday is February 16, 1993.
Near Future	Grace wants to know what the weather will be like on Sunday, so she uses Google search to answer her question. Google's search results say that there's a good chance it will rain on Sunday.
Far Future	Wyatt wants to know which movie will win the big award at the awards show in ten years, so he uses the internet to answer his question. A webpage about movies says that the movie "Life in Paris" will win the big award in ten years.

Note. The informant paired with each item varied across orders such that every informant was paired with each of the items in at least one order. These examples showcase one potential item-informant pairing.

The analysis revealed main effects of question type and age that were subsumed by a two-way interaction between age and question type (see Table 2 for odds ratios and p values for all significant effects and interactions by reference category). Younger children more frequently stated that the technological informants could not tell them about predictable future events or celebrities than older children did. Older children also stated that the informants could not tell them about non-celebrities or far future events more frequently than younger children did. Additionally, the analysis revealed a three-way interaction between Age, Informant, and Question Type where older children were more likely to say that the internet could help people answer questions about non-celebrity people than a Google Search or Alexa.

Table 2: Cumulative Link Multilevel Model Significant Results Across Reference Categories

Significant Effect	*OR*	*B*	*p*
Far Future			
Simple Main Effect (SME): Age	0.57	-0.057	< .001
SME Question Type: Celebrity	26.64	3.28	< .001
SME Question Type: Near Future	12.39	2.52	< .001
Interaction Age*Question Type: Near Future	2.08	0.73	< .001
Interaction Age*Question Type: Celebrity	2.41	0.88	< .001
Interaction Age*Question Type: Non-Celebrity	1.41	0.35	< .001
Interaction: Age*Informant Alexa vs. Internet* Question Type: Non-Celebrity	.75	-0.029	0.023
Near Future			
SME: Age	1.18	0.16	0.011
SME Question Type: Non-Celebrity	0.13	-2.02	< .001
Interaction Age*Question type: Non-Celebrity	0.68	-0.38	< .001
Celebrity Information			
SME: Age	1.36	0.31	< .001
SME: Question Type Non-Celebrity	0.06	2.79	< .001
Interaction Age*Question type: Non-Celebrity	0.59	0.53	< .001
Interaction Informant (Google vs. Internet) *Question type Non-Celebrity	0.53	0.64	0.046
Interaction: Age*Informant (Google vs. Internet)* Question type: Non-Celebrity	0.76	0.27	0.034
Interaction: Age*Informant (Alexa vs. Internet)* Question type: Non-Celebrity	0.74	0.31	0.015
Non-celebrity Information			
SME: Age	0.80	-0.22	< .001
SME: Informant: Alexa	0.61	-0.49	0.017
Interaction Age*Informant: (Alexa vs. Internet)	0.76	-0.27	0.002

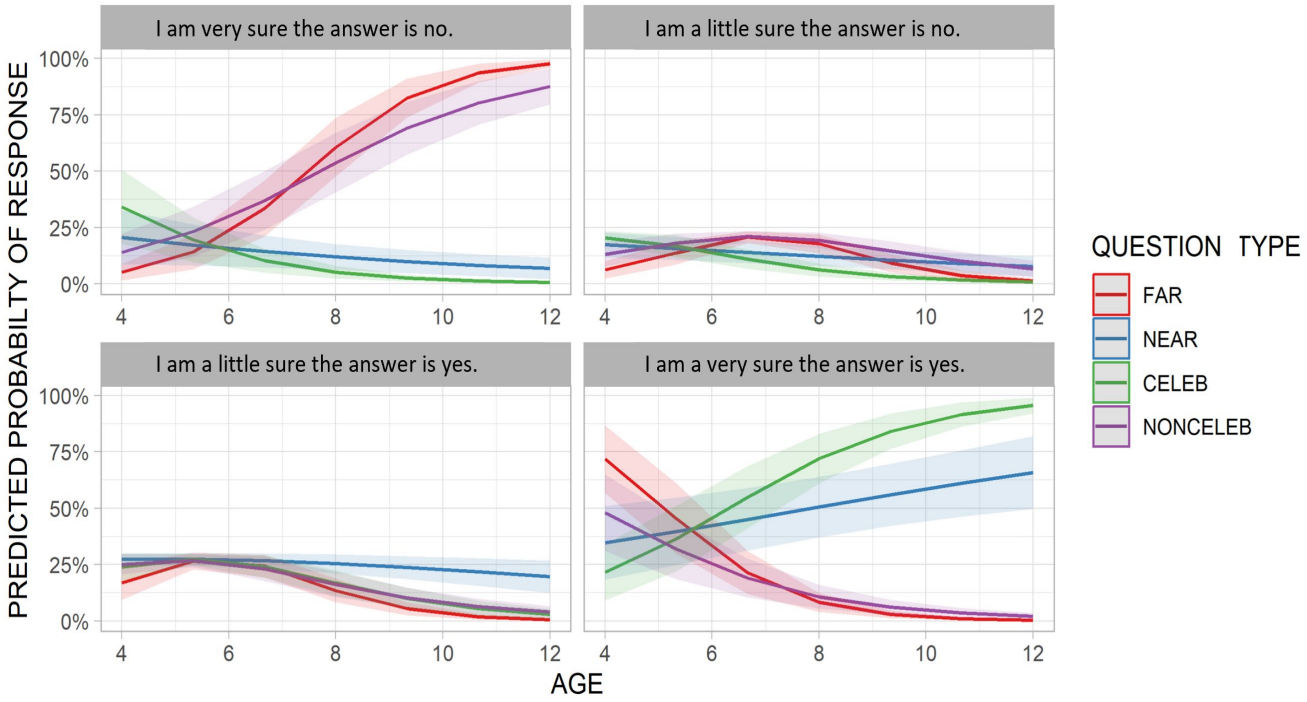

Figure 1: Predicted probability of each endorsement type for the two-way interaction of Question Type and Age (with confidence intervals).

In general, children usually expressed that they were certain of their yes or no answer. Interestingly, children were least sure of their answer in the near future condition; this category had a consistent 25% predicted probability of the children in the sample saying that yes, the informant could answer the question, but that they were only a little sure of this (see Figure 1). Although children's beliefs that a technological informant can answer questions about the near future increase with age, these beliefs do not show the same dramatic increase as questions about celebrities.

Similarly, children's belief that an informant can answer the questions about non-celebrities and far future events dramatically decrease with age. Even though children under age 6 were generally divided on informants' ability to answer the target questions, they still maintained that they were confident in their responses.

Dictionary Questions

Eighty-five percent of children indicated that a dictionary could provide the spelling of words. Of the 15% of children that did not say the dictionary could provide the spelling of words, 64% were under age 6. Additionally, only 5% of children said that the dictionary could provide information about what people ate for breakfast. Of the 5% of children that thought that the dictionary could tell you what someone ate for breakfast, 73% were under age 6.

Previous Experience

Children most frequently stated that they consulted other people, such as parents or teachers, to answer their questions (88%). By contrast, children least frequently stated that they used books to answer questions (54%). For the technological informants, 75% of children said they used Google to answer their questions, 66% said they used the internet, and 64% said they used Alexa. A series of logistic regressions further revealed an increase in the likelihood that a child would say that they use Google, the Internet, other people, and books to answer their questions with increasing age (ps < .001). Use of Alexa was not related to age, suggesting that younger and older children are able to use Alexa, perhaps because it relies on verbal rather than written queries, to answer their questions at similar rates.

Discussion

The current study explored children's intuitions about the internet, Amazon's Alexa, and the Google search engine's ability to answer questions about near and far future events and celebrity and non-celebrity people. In general, children's belief in all three informants' capacities to answer questions about near future events and celebrities increased with age, and their belief that these devices could not answer questions about non-celebrities and far future events decreased with age. There was one notable exception to this general pattern where the oldest children in the sample believed that the internet was more able to provide information about non-celebrities than Alexa or Google, while they indicated that celebrity information was accessible on all three platforms.

The oldest children in the sample may have had the most nuanced views on information about non-celebrities because of their exposure to social media. Recent polling indicates

that 48% of children ages 8-12 have interacted with a social media platform, while 76% of children ages 13-18 have done so (Rideout et al., 2022). The oldest children in this sample were nearly 13, and it may be that their exposure to social media has helped them observe that information about non-celebrity people can be found through social media apps and webpages, but that it is harder to find this information via a Google search and likely harder still to coax Alexa into imparting this information. Future research could examine adolescent and adult samples to gain insights into how early perceptions about what kind of information can reliably be obtained online, including non-celebrity information, persist or change over development, as experience with social media (Rideout et al., 2022) and understanding of the internet (Yan, 2009) continue to improve.

Research on children's understanding of social media has largely centered on their self-image and mental health (see Richards et al., 2015 for review), or beliefs about community or social norms (e.g., De Ridder, 2017; Hynes & Wilson, 2016; Marino et al., 2020;) rather than about the kinds of information they believe are accessible online. Our findings suggest that, despite a general increase in skepticism about the internet's ability to access information about non-celebrities online, with age, children become more aware that information about everyday people can be accessible via the internet. However, even the oldest children in our sample believed that it is much harder to find information about non-celebrities than about celebrities. The reality is that the ease of finding information about people depends greatly on the kind of information. For example, it is difficult to find celebrities' personal phone numbers or home addresses online, but this kind of information is often accessible about non-celebrities. Paradoxically, information about the details of celebrities' lives and day to day activities can be quite traceable online, but this type of information is sometimes more difficult to find for non-celebrities. Future research should therefore consider how children's experience with social media and celebrities impacts children's awareness of the different types of personal information that can be accessed on the internet and via internet-based devices.

Our finding that the youngest children in the sample more frequently stated that information about non-celebrities could be found online than older children did may also reflect that younger children may view technological sources as omniscient or nearly omniscient (Girouard-Hallam & Danovitch, 2022b) or that they are biased towards yes responses when asked yes or no questions (Okanda & Itakura, 2010). However, children over age 6 appear to believe that personal information about non-celebrities is not accessible online. Given that at least some personal information about non-celebrities can often be found online, it would be worthwhile for parents and educators to consider teaching early elementary school age children about safety and privacy online, and the kinds of information that can be accessible to others.

In general, children's doubt and skepticism in human informants increases with age (Mills, 2013), and their executive function and decision making improves (Hermes et al., 2018), thereby impacting the cues they use to trust various sources. With technological informants, children are increasingly confident in technology's ability to provide accurate testimony and answer questions about scientific and historical facts (e.g., Danovitch & Lane, 2020; Girouard-Hallam & Danovitch, 2022a; Wang et al., 2019). The results of the current study suggest that this confidence extends to certain domains outside of scientific or historical information (e.g., celebrities' personal information). However, children were not as confident in their responses about near future events as they were about other categories. Even the oldest children in our sample were uncertain about their responses in this category. Near future events are relatively predictable, but there is no guarantee that even a very reasonable prediction will be correct. Although children recognize that technological sources can answer some questions about future events (and may even do so better than a human could, Girouard-Hallam & Danovitch, 2022b), they seem to also recognize that even an informant they view as reliable for other kinds of information may not be able to answer a question about the near future correctly. Children's understanding of timelines containing future events (Hudson & Mayhew, 2011; Zhang & Hudson, 2018) and the predictability of future events improves with age (Tillman et al., 2018). This improved understanding of time may contribute to children's increasing uncertainty about whether the internet and related devices can correctly predict near future events, even though they realize that it would be impossible for these sources to predict far future events.

There were some potential limitations to the current study. First, most children were white, from middle to upper class households in the United States. Additionally, some children participated via a Zoom call, which by its very nature suggests that children are exposed to the internet and internet-based devices. It is perhaps unsurprising then that most children were quite experienced with technological devices, and it would be interesting to repeat the same tasks with less experienced and more diverse samples.

Taken together, the results of this study demonstrate that children's intuitions about the capacities and limitations of several popular technological informants change between ages 4 and 12. As participant age increased, children's confidence in the ability of technological agents to provide answers to near future questions increased, as did their understanding that technology cannot be used to answer questions about far future events. Older children were also more likely to believe that internet-based technology could answer questions about celebrities, but not about non-celebrities, highlighting the importance of teaching children about the relationship between privacy and public-facing social media profiles. As internet-based technology continues to evolve and children can increasingly access it on their own, it remains critical to understand what kinds of information children believe is online, and therefore what kinds of questions they use internet-based sources to answer.

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