From Screen to Seen:

The Influence of Modality and Perceived Autonomy on Children's Trust in Chatbots via the HAII-TIME Model

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Introduction

A majority of children's learning is facilitated through their interactions with various sources of information. This may include seeking information from both living (e.g., humans) and non-living sources (e.g., books and computers). As children take in information from a particular source, they are engaging in the act of building trust - or not - with that source. This can be seen through the trust they develop with caregivers, teachers, or textbooks, among many other sources. Building trust - or not - comes with consequences. For example, children who display trust in their teacher may be perceived more positively by the teacher, leading to stronger student-teacher relationships and, in turn, better academic performance (Bernath & Feshbach, 1995; Imber, 1973). On the other hand, children who display mistrust may face more challenges in forming such relationships, potentially hindering their academic development. This process of building trust with a source extends to non-human sources as well and carries its own implications. For technological sources, such as the internet or smart speakers, children's trust may influence how they choose to engage with those technologies, for instance, relying heavily on the internet to learn, or treating Alexa, a smart speaker, as a conversational partner. These behaviors are especially concerning because children are increasingly immersed in digital environments. This raises questions about how their trust in various sources, both human and technological, shapes their understanding of the world and the way they learn.

Importantly, trust does not develop blindly or automatically. Children's trust in humans, texts, technology, and other sources can vary depending on a range of cognitive, social, and contextual factors. A substantial body of developmental psychology and educational research has examined how children come to view humans as reliable informants (Koenig & Harris, 2005; Koenig & Sabbagh, 2013), highlighting various epistemic and social cues that influence their

trust-based decisions (Tong et al., 2020). Yet, in today's digital age, where technology is not only ubiquitous but also increasingly interactive, questions arise about how children build trust in technological informants (Danovitch & Alzahabi, 2013; Einav et al., 2020; Wang et al., 2019). Is trust in AI-based (aritificial intelligence) sources constructed similarly to trust in human sources? Or do new cognitive and social processes emerge in response to these novel media? These questions are especially relevant given the rapid rise in children's engagement with digital devices. Data from recent years show that more than 98% of U.S. households with a child under 8 have internet access (Rideout & Robb, 2020), and children as young as four are already using smartphones, tablets, computers, and smart speakers (Eisen & Lillard, 2017). As a result, it is critical to explore how children interpret and respond to the information presented by emerging media platforms.

While previous research has helped clarify how children learn from traditional sources like parents, peers, and teachers (Corriveau et al., 2009; Koenig & Harris, 2005; Koenig & Sabbagh, 2013), less is known about how they learn from or place trust in AI and other emerging technologies. As children grow up surrounded by smart devices and AI systems differing in modality and features, it is also important to examine how they develop expectations, scripts, or relational models that guide their interactions with these tools (Gambino et al., 2020). To that end, this study aims to investigate how children come to trust AI, in the form of AI chatbots, as sources of information. By examining two dimensions of trust (epistemic trust and social trust), this study hopes to uncover developmental differences underscoring children's engagement with AI and will identify which characteristics and communicative modalities of AI are most influential for children. This work has meaningful implications for both theory and application, especially in informing the design of AI technologies that are developmentally appropriate and

educationally supportive. Therefore, this study will analyze children's trust evaluations toward AI chatbots, detailing below the technological and message features considered for manipulation, as well as the psychological mechanisms through which "trust" is conceptualized.

Literature Review

As mentioned, previous research has established how children learn from and trust other humans (Corriveau et al., 2009; Koenig & Harris, 2005). This research often compared children's evaluations of humans, modifying variables of accuracy, familiarity, and benevolence. Often times, children relied on epistemic (e.g., accuracy) and social cues (e.g., wanting to share) to make their judgments about who to trust. For example, children as young as 3 years old were able to display trust in a knowledgeable (accurate) speaker over an ignorant (inaccurate) one (Koenig & Harris, 2005). In this study specifically, children viewed two informants either accurately or inaccurately labeling a familiar object, like a ball (e.g., "That's a ball" vs. "That's a shoe"). After these familiarization trials, children then saw these two informants (accurate vs. inaccurate) provide conflicting labels for a series of novel objects (e.g., "That's a mido" vs. "That's a loma"). It was found that although both 3- and 4-year-old children were able to distinguish between accurate and inaccurate informants, only the 4-year-olds went on to accept the labels and functions provided by the accurate informant, suggesting that early on, children value sources who seem well-informed, but by age four, they are sensitive to informant accuracy as it shapes what they learn about new things. Similar work has replicated preferences for accurate, helpful, and prosocial informants, modifying levels of familiarity (i.e., children trust familiar teachers more than unfamiliar teachers, especially if they are previously accurate) (Corriveau et al., 2009) and benevolence (i.e., children assume that informants with positive traits are also knowledgable) (Lane et al., 2012).

In recent years, research on children's trust in humans has extended to the non-human domain, looking at the role of text-based and technological sources. These studies have found similar patterns, such that children prefer books that were written by accurate authors (in the study, the authors were dolls) (Vanderbilt et al., 2018) and that as children start to read, they view text-based materials as reliable sources of information (Robinson et al., 2013). On the technological side, a hallmark study looked to compare children's trust in voice assistants to that of humans (Girouard-Hallam & Danovitch, 2022). In this study, children evaluated a human and voice assistant across different types of information. It was found that children's trust in each source varied on the type of question being asked. For example, results revealed that children preferred the human source when asking about personal information but preferred the voice assistant when asking about factual information. This study is one of many that begins to bridge selective trust research to the realm of media and technology. Further studies in this area can benefit the field by drawing on media psychology studies that directly modify elements of the technology (e.g., modality, presence, content, etc.) and analyzing psychological effects that occur for individuals (e.g., emotions, behaviors, etc.). Thus, building off of the robust literature dealing with children's trust in human and non-human sources, this study plans to contribute by taking a media-centered approach and investigating the effects of varied technological features on children's trust.

The guiding research question is as follows:

RQ: How does modality and perceived autonomy influence children's epistemic trust and social trust toward AI chatbots?

Psychological Effects

For perceived psychological effects, this study hopes to look at two variables that work together to comprise children's "trust," building off of the related literature in developmental and media psychology studies: epistemic trust and social trust.

DV #1 - Epistemic Trust

First, children's epistemic trust involves a willingness to accept new information as relevant, trustworthy, and worth incorporating into one's life (Li et al., 2023). In other words, this can be viewed as assigning credibility to information provided by a source (i.e., trusting what it says). This way of conceptualizing trust is often used as a measure in developmental psychology studies, also known as selective trust when dealing with multiple informants. Previous research related to this current study has looked at how children evaluated information from technological sources when accuracy was manipulated (Danovitch & Alzahabi, 2013). This work revealed that 3- to 5-year-olds had a preference for the previously accurate computer informant rather than the previously inaccurate one. This suggests that children's preferences are shaped by epistemic cues like accuracy. For purposes of this study, epistemic trust is being measured to analyze how different technological features (rather than source-type, as looked at in previous studies), influences children's evaluation of the AI chatbot. By modifying modality and autonomy, this may impact how children come to value - and trust - the information the chatbot provides. For example, children may trust the chatbot that is accompanied by a human figure more than the text-based chatbot, but the framing of autonomy may influence these differences.

Additionally, it is important to measure children's epistemic trust in relation to their interactions with AI chatbots because this may inform how children assign credbiltiy to AI-based sources. Furthermore, evaluations of epistemic trust has implications for children's learning,

suggesting how different types of AI chatbots (e.g., those with avatars vs. those with just text) may be leveraged to support educational designs and individualized learning.

DV #2 - Social Trust

The other component of trust this study will look at involves social trust, which can be described as having faith or confidence that people will do what they ought to do most of the time (Guo et al., 2022). For purposes of this study, this builds off of previous work that characterized child-robot relationships into two categories: closeness and trust (van Straten et al., 2020a). In this work, closeness was defined as connectedness or intimacy that could develop into a friendship, and trust was defined as the expectancy that another person/thing will keep their word or promise. Analyzing this measure can inform how children may form relationships with AI, and what factors influence that. For example, a chatbot with an accompanying human figure or a perceived autonomous chatbot may elicit more social trust from children, which has implications for how children interact and engage with AI. Preferring to interact with more social forms of AI may influence how children choose to learn in the future (e.g., greater trust towards information provided by AI).

Theoretical Framework: HAII-TIME

A commonly used framework in previous studies is the Computers are Social Actors (CASA) paradigm. The basic idea of CASA was that social rules and dynamics that guide human-human interaction also apply to human-computer interaction (Nass et al., 1996), and this perspective is based on the assumption that people have automatic and mindless responses to machines.

However, some scholars argue that changes are happening in individuals themselves, as well as in technology and human-computer interactions; there should be a more mindful version

of the CASA paradigm (Gambino et al., 2020). People are becoming increasingly familiar with how media agents work, computers are designed more human-like, and personalized interaction between humans and media agents has begun to emerge on an increasingly regular basis. The difference even exists between different age groups, where Japanese elders have a completely different perception of robot caregivers based on their past experiences, compared to younger generations (Wang et al., 2017). Therefore, the psychological mechanism should also be discussed based on the traits of individuals and technologies.

The HAII-TIME model was thereby proposed as a more advanced version of CASA. Particularly, the focus of the theoretical framework turned from human-machine interaction in general to Human-AI Interaction (HAII), which indicated a greater emphasis on the socialness of interaction (Sundar, 2020). According to the cue route, simply identifying AI as a source could trigger stereotypes and affect their perception. Action route, on the other hand, speaks more to the process of collaboration, as interaction, social exchange, agency, and mutual augmentation could all influence users' engagement and trust. The following diagram shows how the two routes are developed:

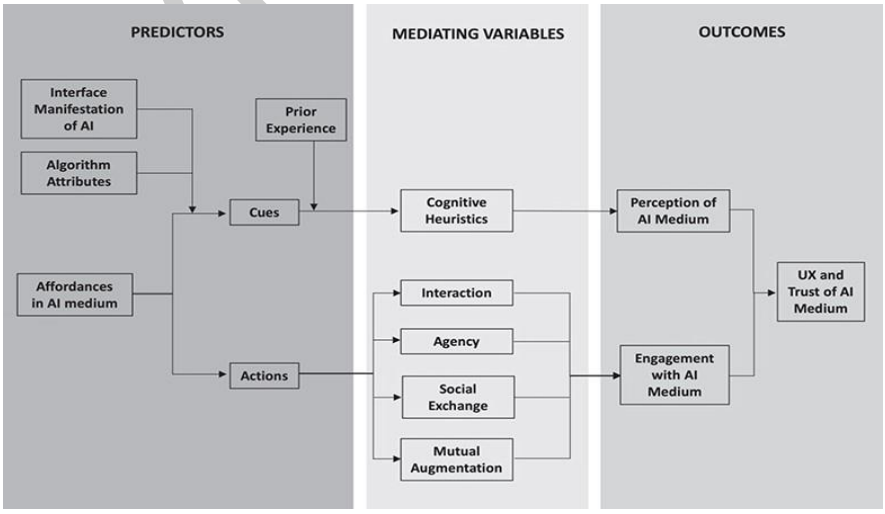

Figure 1. Cue Route (Top) and Action Route (Bottom) in HAII-TIME Model (Sundar, 2020)

Informed by the variables in the cue route and the action route, technology features for the current study were proposed.

Technology Features

Based on HAII-TIME model, the attribution and socialness features could have an impact on users' trust in AI medium. Therefore, modality and autonomy were proposed as factors influencing children's trust.

IV #1 - Modality

People subconsciously attribute more human-like characteristics to agents with a higher level of social presence, which could enhance trustworthiness (Gao et al., 2025). Specifically, anthropomorphic features, including visual or linguistic cues in terms of appearance, could enhance users' perceived social presence (Nowak & Rauh, 2008; Zhang & Patrick Rau, 2023), which is closely related to trust. Therefore, modality was proposed to manipulate the level of visual anthropomorphism.

When interacting with robots with higher levels of social presence, children who rated the robot as more socially present developed a stronger rapport, and this effect remained stable throughout the interaction, which was different from adults' patterns due to varied expectations (Chen et al., 2023). This speaks to the influence of machine heuristics, and aligns with the formation of stereotypes during human development.

Due to its direct influence on whether the chatbot is human-like, the appearance of chatbots, especially humanoid avatars, has been brought to attention. Gong (2008) showed that visual representations have a positive effect on perceptions of trustworthiness, and Gao et al. (2025) looked at the coordination effect of visual and voice cues on improving people's trust.

However, these visual representations mainly referred to human figures, with limited concentration on the effects of avatars. However, some chatbots have already incorporated human avatars in their design, and a typical example is Doubao, developed by ByteDance. As humanoid avatars have been studied in the context of interpersonal communication (Nowak & Rauh, 2008), it's likely that they also have an influence on human-AI interaction, since socialness is involved in the process. Therefore, looking at whether the humanoid avatar appearance of chatbots affects children's trust is crucial in the study.

Another modality feature worth considering is text. Rapp et al. (2021) argued that the conversation between users and text-based chatbots was ambiguous, since the chatbots were recognized as non-humans. However, other studies suggested a more intimate relationship in text-based mediated communication (Derks et al, 2008). With fewer visually and vocally compelling cues, more intimate conversations were allowed. Whether text-based chatbots have a positive or negative impact on users' trust is still under discussion, but according to Sundar (2020), less anthropomorphic qualities would lead to greater socialness.

Based on the implications of two modality features, as well as the mediating role of social presence, the following hypothesis is proposed:

H1: Children exposed to chatbots with both appearance and text have a higher level of social trust than children exposed to text-based chatbots.

IV #2 - Autonomy

The concept of autonomy encompasses the degree to which the decision-making process during interaction is free from the control of any other agent (Barber et al., 2000). The idea of autonomy also relates to whether children perceive robots as "social beings", but more importantly, it affects whether children perceive robots as "moral others" that they can engage

and build relationships with (van Straten et al., 2022). Therefore, it has important implications for how children assign both social and epistemic trust, as well as for understanding the process of building partnerships with chatbots.

Reviews within the literature of robot autonomy have been mixed, with some studies showing that when children were informed a robot was teleoperated, it did not influence their perceptions of its humanness (Turkle et al., 2006), while other studies found that children regarded a robot as less intelligent after hearing it had been remotely controlled (Tozadore et al., 2017). However, little research has been done to examine the relationship between perceived autonomy and trust.

Despite the limited research, previous studies show that children's attitudes might differ by whether they think the robot could act according to developed scripts, with a higher possibility of having positive social relationships when autonomy is attributed. When interacting with a robot dog, children believe the robot to have higher emotional and physical sentience, with those who owned a dog being more prosocial toward the autonomous robot (Chernyak & Gary, 2016). A study on toddlers also revealed that when autonomous robots were programmed in a predictable manner, children might change their attitudes from treating them as toys to treating them as their peers (Tanaka et al., 2007).

Building on the literature, H2 and H3 are proposed as follows:

H2: Children exposed to autonomous chatbots have a higher level of epistemic and social trust than children exposed to chatbots described as being controlled.

H3: Children exposed to chatbots with appearance and autonomy have higher levels of epistemic and social trust than children in the other conditions.

Moderators

According to HAII-TIME model, prior experience in using AI could guide the arousal of heuristics. For example, when people originally have a positive attitude and trust towards machines, the idea of "automation bias" is more likely to be triggered. From a developmental point of view, children's heuristic approach might change as they grow up, and this change is closely related to their established stereotypes (Kahn et al., 2012; Chen et al., 2023). Therefore, age and previous experiences are proposed as moderators.

H4: Children's previous knowledge on AI have a negative influence on their trust towards chatbots.

H5: Older children will demonstrate less trust towards chatbots than younger children.

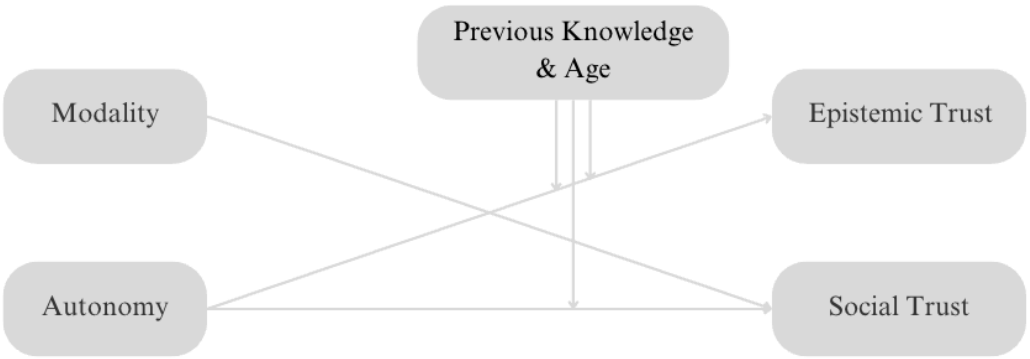

Figure 2. Conceptual Model

Method

Design

The study will employ a 2 (modality: text vs. text + appearance) × 2 (autonomy: autonomous vs. controlled) between-subjects design to examine how different chatbot features influence children's trust. Participants will be randomly assigned to one of four conditions: (1) a text-only autonomous chatbot, (2) a text-only controlled chatbot, (3) a text + appearance

autonomous chatbot, or (4) a text + appearance controlled chatbot. The text-only chatbot will only generate text as its responses, and the text + appearance chatbot will showcase text alongside a human avatar. In the autonomous conditions, the chatbot will be described as "responding on its own," while in the controlled conditions, it will be described as "being controlled by someone or something else."

Participants

A total of 120 children aged 6 to 10 will be recruited to participate in the study. This age range was selected because children as young as 6 years old are able to engage with textual stimuli. Research shows that new readers start to trust what they read on their own (Corriveau et al., 2014), suggesting that 6 years old is a suitable age to ensure that participants can engage with the textual responses provided by the chatbots. On the other hand, going up to 10 years old is reasonable because older children (8- to 10-year-olds) start to have more experience with technology and the internet, which may uniquely shape their perceptions of AI (Oranç & Ruggeri, 2021). Overall, this age range helps to uncover any developmental shifts and individual differences that may influence how children come to trust differing AI chatbots as sources of information.

Participants will be recruited through several channels, including partnerships with the Living Laboratory at the Museum of Science in Boston, MA, local park testing, elementary school partnerships, and virtual participation through the "Children Helping Science" platform.

Procedure

Children will be tested individually, either in-person or over Zoom. In-person visits, such as those conducted in the lab or within the community, will take place during a single session, lasting approximately 10 to 15 minutes. Children will sit next to the experimenter either at a

table or on the ground, both looking at the experimenter's computer screen. The interaction will be audio recorded for later coding purposes.

Virtual appointments, such as those occurring via Zoom, will consist of the experimenter sitting in a quiet room while participants join the Zoom session from their homes. The virtual visit will last for approximately 10 to 15 minutes. Both the participant and experimenter will be required to keep their audio and video on for the duration of the visit, and after gaining permission, the meeting will be recorded for later coding purposes. Despite the two methods of participation, the procedure will be the same across in-person and virtual appointments.

The study will follow a three-phase procedure designed to assess children's trust in chatbots across varying conditions of modality and autonomy. In the first phase, the experimenter will introduce each child to a chatbot tailored to their assigned condition. An example of this interaction for the text-only autonomous chatbot would be, "This is Chatbot A. When we ask Chatbot A a question, it will respond by generating some text. I also wanted to let you know that Chatbot A is completely responding to our questions on it's own! Now, let's start asking it some questions."

Next, during the main trial phase, the experimenter and child will interact with the chatbot with a set of pre-piloted, novel questions to avoid familiarity bias. The experimenter will enter the questions while the child observes the chatbot's response, to account for typing ability across participants and to prevent any manipulation of the computer/slide show from the child. All chatbot responses and animations will be pre-programmed and standardized to control for variability.

Last, after viewing the chatbot answer a series of questions, children will answer follow-up questions assessing their levels of trust in the chatbot. Epistemic trust will be measured by

asking whether the child believed the chatbot's responses was correct and how confident they were in that judgment using a 5-point Likert scale. Social trust will be assessed using adapted items from validated measures of closeness, trust, and perceived social support (van Straten et al., 2020b). This structured methodology will allow for a controlled examination of how different chatbot characteristics influence children's cognitive and social trust.

Results

All proposed hypotheses are supported via statistical tests (ANOVA, multiple regression).

	Autonomous	**Controlled**
Text	Moderate epistemic trust Moderate social trust	Low epistemic trust Low social trust
Appearance + Text	High epistemic trust High social trust	Moderate epistemic trust High social trust

Discussion

This study aims to provide a better understanding of how and why children grant trust to chatbots. Findings suggest that attribution and socialness play an important role in children-AI interaction, which reiterates the psychological mechanism of HAII-TIME. Overall, children showed a positive "stereotype" towards chatbots, such that chatbots with more anthropomorphic features in avatar design and a greater amount of autonomy would trigger a higher level of social presence, which would enhance children's trust. Additionally, when the chatbot interaction was attributed to human control instead of autonomous functions, children exhibited a negative attitude by reporting lower levels of social and epistemic trust.

From a developmental perspective, as older children and children with more experience in AI establish more "stereotypes" towards machines, likely, their negative machine heuristics are more easily triggered. Therefore, they are less willing to attribute trustworthiness toward chatbots.

Theoretical and Practical Implications

Beyond previous studies, the implementation of HAII-TIME model provides more insights into the psychological process of children during their interaction with AI. Affordance features, namely modality and autonomy, were often studied separately and focused on effects, but this study connects the dots by revealing why children would attribute trust to humans and non-humans in a similar manner, and why their perception of machines is different from adults. As children grow up and accumulate negative machine heuristics, their negative perceptions grow stronger than their "mindless" reactions towards machines with human-like features and predictable reactions. The observations support the criticism towards CASA, because the mindful reactions were confirmed.

The findings also serve as a guide to designing educational and companion AI aimed at children. Different from generative AI like ChatGPT, educational chatbots should be designed with more modality features to increase it's anthropomorphism, and they should be framed as autonomous. Here, a certain level of ambiguity is worth noticing: While the reactions of chatbot were manipulated by data and algorithms, they could also perform in a predictable manner that aligns with children's social script. Therefore, it's essential to reflect upon ways to attribute algorithms to children, given their varied responses to controlled and autonomous machines.

Limitations and Future Work

Several methodological limitations should be considered when interpreting the findings of this study. First, the limited sample size (N = 120) may restrict the generalizability of the results and reduce the power to detect subtle effects, particularly interactions between modality and autonomy. Second, concerns around the reliability and validity of the method raise questions about whether children truly perceived the pre-programmed chatbot as an actual chatbot. If children were skeptical about the chatbot's authenticity or sensed it was pre-programmed, this could influence their trust responses, particularly in the autonomous conditions. Finally, the study faced ambiguity in choosing the type of visual representation for the chatbot - specifically, whether to use a human-like avatar or a more robotic humanoid figure. This decision may influence children's perceptions of realism and trust, as prior research suggests that appearance cues play a critical role in shaping social and epistemic judgments about artificial agents. Future studies should consider pretesting avatar designs to ensure consistency and ecological validity.

Future studies could consider including more modality features as well as their collaboration. For example, whether voice alone can lead to anthropomorphism in light of inconsistent empirical findings (Haresamudram et al., 2024), and the alignment among visual and voice cues could improve people's trust (Gao et al., 2025; Gong & Nass, 2007). Also, comparisons could be made between different UX designs to investigate the best way of attributing machine interactions to the system.

Conclusion

In conclusion, this study reveals how children develop trust in chatbots by examining the psychological mechanisms underlying their interactions with AI. The findings emphasize the importance of modality and autonomy as affordance features that shape children's perceptions of epistemic and socail trust. Specifically, chatbots perceived as autonomous and designed with

anthropomorphic features elicited greater trust, while those attributed to human control afforded lower levels of trust. These results support the HAII-TIME model and challenge the idea of mindless interaction with machines, instead highlighting children's mindful evaluations of AI agents. From both theoretical and practical perspectives, the study offers valuable insights for the design of child-oriented educational technologies, suggesting that trust can be enhanced through strategic framing and multimodal design. However, limitations in sample size, perceived authenticity, and avatar design signal the need for further research. Future work should explore the interplay of additional modality features and test how design elements can optimally convey autonomy to young users, ensuring trustworthy and developmentally appropriate AI interactions.

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