# Measuring Trust in Children's Speech: Towards Responsible Robot-Supported Information Search

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## ABSTRACT

Children use conversational agents, such as Alexa or Siri, to search for information, but also tend to trust these agents which might influence their information assessment. It is challenging for children to assess the veracity of information retrieved from the internet and social media, possibly more so when they trust a voice agent excessively. In this project, I propose to design child-robot interactions to empower children to have a critical attitude by implementing real-time trust monitoring and robot behavioural interventions in cases of high trust. First, we need to be able to measure children's level of trust in the robot real-time during the interaction, to reason about when excessive trust may be occurring. Second, we need to study what behavioural interventions by the robot foster critical attitudes toward the provided information. By adapting the robot's behavior when excessive trust occurs, I aim to contribute to more responsible interactions between children and robots.

## CCS CONCEPTS

• **Human-centered computing** → **User studies**; • **Social and professional topics** → **Children**.

## KEYWORDS

children, human-robot-interaction, trust, speech

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## 1 INTRODUCTION

Children increasingly search online for information in their final years of primary school, from the age of eight [17]. However, it can be challenging for children to assess the quality of information [22]. Industry and academia are trying to help by developing tools (e.g., a separate search interface for children [16]) and agents (e.g., voice assistants for children [18]) that filter out inappropriate information, or help in formulating the search query. While these agents can help children by engaging in dialogue with them through conversation, they might also pose some risks in this context. Embodied agents, such as virtual assistants or robots, currently do not moderate the information to prevent them from conveying the wrong information to the children [5]. Together with the knowledge that children tend to build social bonds with robots and are prone to trust them [5, 9, 10], this could create hazardous situations.

Previous research has shown that children find it difficult to assess the credibility of an information source [22], and excessive trust can compromise the assessment even more. Filtering out the inappropriate or unreliable information could become counterproductive for children's development of their critical skills, since they will need these eventually when they encounter information that has not been filtered. This PhD project aims to create responsible interactions between children (10-12 years old) and robots in the context of search and information retrieval through conversations with a robot [3]. Children in this age group are in the last years of primary school and are figuring out how to independently search for information. I propose to create these responsible interactions by adapting the robot's behavior when excessive trust occurs. This implies that we need to address two challenges. First, we need to be able to measure children's level of trust in the robot real-time during the interaction, to decide when excessive trust is occurring. Since previous research indicates that speech contains information about trust [11, 21, 31], the child's speech will be used as a real-time behavioral measure of their trust in the robot. Second, we need to study what behaviors the robot should display to dampen children's trust in the robot. Hence, I pose the following research questions:

- How can children's speech during an interaction with an information-providing robot be used as a real-time behavioral measure of trust?
- How can the robot's behavior dampen trust during the interaction when excessive trust occurs?

In short, this PhD project aims to develop a responsible robot that supports children (10-12 years old) in their information search information by measuring excessive trust in the robot real-time and acting on it to empower children to have a critical attitude towards the provided information.

## 2 SENSE: SPEECH AS A REAL-TIME MEASURE

Trust in automation has been defined as 'the attitude that an agent will help achieve an individual's goals in a situation characterized by uncertainty and vulnerability' [20]. In our context of information-providing robots this can be interpreted as the attitude that the robot will help the child by providing correct information. Insufficient or excessive trust occur when the robot's capabilities do not match the user's expectations, which could lead to underuse or misuse of the robot. As previously stated, children are prone


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to trust a robot, often overtrusting due to anthropomorphization [9, 12]. One possible consequence of misuse in this context could be that excessive trust compromises the credibility assessment of information that is provided by a robot, since children could think the robot knows what's correct. Excessive trust would thus show an acceptance of the robot's information, regardless of its content.

### 2.1 Measuring trust in child-robot interaction

Measuring trust is not straightforward. Questionnaires, which are often used (e.g., [15, 25, 32]), are not always appropriate since they have an after-the-fact character, they are based on self-reporting, and children are known people-pleasers [4]. Active behavioral measures are also unsuitable due to the limitations they impose on the design of the interaction, since it must include behavior-provoking scenarios (e.g., the trust game [6]). The use of observational data could be a viable solution, since this can be used real-time and objectively. Previous research has already found some promising indicators of trust, such as the distance between the robot and the user [2], or whether user and robot use the same words [26]. However, little research looks into such measures for children.

### 2.2 Automatic measuring of trust in speech

One type of sensor data, which can be measured objectively and real-time, is speech. Previous work associates speech with a user's trust towards conversational partners [11, 21, 23, 26, 31]. For instance, the words people use have been previously associated with their trust in the other. High trust is associated with lexical mimicry, meaning users start using the same words during interaction [26]. Timing can also reflect trust. A user's duration of their response can be used as predictor of trust by an agent (in combination with their demographics and their pitch) [11]. Furthermore, trust can be reflected in turn-taking [23]. Finally, how people talk can reflect trust. For example, trust is reflected in the amount of emphasis the user uses [31], how fast a user is talking and the intensity of their voice [21]. While it looks promising to use speech as a measure of trust, research on this topic remains scarce and the question remains whether the results from earlier studies transfer to the information-seeking context in child-robot interaction.

### 2.3 Toward an experimental manipulation of trust

To study speech as a measure of trust, a manipulation is needed to create distinct trust levels. In a within-subject study with a trustworthy robot and an untrustworthy robot, we studied the relationship between children's trust in an information-providing robot and children's acceptance of the information provided by the robot during their spoken interaction (a paper describing this study in detail is in the making). The trustworthiness of the robot, a Furhat robot [1], was manipulated based on previous research (e.g., the robot's capability, its displayed emotions, and previous accuracy [14, 19, 28]). Children (10-12 years old, $N = 30$) played a quiz where the robot helped the child by suggesting an answer. Children's trust in the robot was subjectively measured using the interpersonal scale for child-robot interaction by Van Straten et al. [29] to compare conditions. Due to the pandemic this was done via video call, where the robot, researcher and child could talk to each other. Results showed that the manipulation was effective in creating two distinct conditions. Whether perceived trust is reflected in the speech is currently being investigated. 349 minutes of speech containing dialog between a child and robot was recorded. This is currently being transcribed and annotated. The analysis focuses on three parts: acoustic features (e.g., pitch), interaction features (e.g., interruptions) and dialog features (e.g., speech acts).

[1] furhatrobotics.com

## 3 ACT: DAMPENING TRUST TO EMPOWER

When trust can be measured real-time through speech, the robot can act on this to influence trust. While current research is mostly focused on building trust [9, 12, 24], our aim is to find ways to dampen trust when necessary, since children already tend to trust robots [9, 12, 30]. Especially in contexts with a risk factor (e.g., misinformation, physical danger), it is necessary to look at how we can dampen trust, as proposed by Aroyo et al. [1].

### 3.1 Possible robot behaviors to dampen trust

One solution could be for the robot to make intentional mistakes that are obvious to the child, which has shown to lower trust in the robot [14]. Other researchers have proposed disfluencies or filled pauses as cues of uncertainty to instill distrust [7, 10]. A lack of trust can be instilled by showing less confidence, which is often the result of appearing uncertain [8]. The perception of this is known as the feeling-of-another's-knowing (FOAK). This FOAK is based on the display of confidence [7]. When the agent would show a lack of confidence, the user's FOAK goes down, and with it, a user's trust in the agent. Although it might seem counter-intuitive for a robot to intentionally display uncertainty when it might not be uncertain, in our context this could be used as an empowering intervention to lower trust and support children in their critical thinking skills.

### 3.2 Future work towards dampening trust

In the next steps, I will study behaviors that the robot could use to dampen trust when excessive trust is noticed. One avenue to consider is increasing audiovisual uncertainty cues in the interaction, such as disfluencies and filled pauses in speech or facial expressions associated with doubt [7, 10, 27]. Another avenue could be the use of prosodic entrainment (i.e. tendency to assimilate behaviors of each other), since this has been linked to trustworthiness of conversational agents [13]. I will study whether children notice these cues and whether they alter their trust in the robot accordingly.

Through the described studies two major challenges are tackled. First, a behavioral real-time measure of trust is realized by studying speech cues. Second, future work will focus on how trust can be dampened in child-robot interaction to create a more responsible interaction. When this is implemented in a sense-think-act loop, children should be empowered to have a critical attitude towards the information the robot provides.

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