# “Hey Google is it OK if I eat you?” Initial Explorations in Child-Agent Interaction

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## Abstract
Autonomous technology is becoming more prevalent in our daily lives. We investigated how children perceive this technology by studying how 26 participants (3-10 years old) interact with Amazon Alexa, Google Home, Cozmo, and Julie Chatbot. We refer to them as “agents“ in the context of this paper. After playing with the agents, children answered questions about trust, intelligence, social entity, personality, and engagement. We identify four themes in child-agent interaction: perceived intelligence, identity attribution, playfulness and understanding. Our findings show how different modalities of interaction may change the way children perceive their intelligence in comparison to the agents’. We also propose a series of design considerations for future child-agent interaction around voice and prosody, interactive engagement and facilitating understanding.

## Author Keywords
Child-agent interaction; interaction modalities

## ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)]: Interaction Styles

## Introduction
Prior research in child-computer interaction explores the role of computers in shaping the way children think. In her

**Figure 1:** Alexa
Internet search, games, jokes, music
*Morphology:* Cylinder, LED ring, female voice
*Input:* voice
*Outputs:* voice and LEDs

**Figure 2:** Google home
Internet search, games, jokes, music
*Morphology:* Cylinder, LED ring, female voice
*Inputs:* voice, touch
*Outputs:* voice, LEDs

book ”Second Self”, Sherry Turkle describes them as intersectional objects that allow children to investigate ”matter, life, and mind”[7]. Similarly, emerging autonomous technologies invite children to think about what it means to be intelligent and conscious. These technologies are becoming increasingly prevalent in our daily lives. Yet, there is little research on how children perceive them. This paper presents the preliminary findings of a study on how children, ages 3 to 10, interact with modern autonomous agents. In our results, we analyze how and why children ascribe particular attributes to agents. We address how different modalities affect children's perception of their own intelligence.

## Related Work

In the fields of human-computer interaction (HCI), human-robot interaction (HRI), and applied developmental psychology, there is extensive research on how children perceive robotic and conversational agents. Tanaka found that children build relationships with these agents the same way that they build relationships with people [6]. Kahn found that they consider robots as ontologically different from other objects, including computers [3]. He also saw that age and prior experience with technology led to more thoughtful reasonings about robots' nature [3]. Turkle argues that the intelligence of computers encourages children to revise their ideas about animacy and thinking [7]. She observed that children attributed intent and emotion to objects that they could engage with socially and psychologically. Bernstein's study revealed that voice, movement, and physical appearance are other factors that children consider when deciding how to place agents [2].
To understand why children may attribute characteristics of living beings to inanimate objects, we must consider Theory of Mind development [3]. Those with a developed Theory of Mind can perceive the emotional and mental states of other beings. An analysis of 178 false-belief studies led to a model that showed that across cultures, Theory of Mind usually develops when a child is 3 to 5 years old [8].
This finding indicates that age is a significant factor in children‘s reasoning about technology. Through our work, we build on prior research by analyzing how children interact with and perceive modern agents. In our analysis, we consider developmental differences between children and functional differences between agents.

## Method

Participants were randomly divided into four groups, roughly 4-5 in each group, then groups were assigned to a station. We had four stations, one for each agent. Each station had enough devices for participants to interact alone or in pairs. At the stations researchers introduced the agent, then allowed participants to engage with it. After playing with the first agent for 15 minutes, participants rotated to the next station to interact with a second agent. Each session of structured play was followed by a questionnaire, in the form of a game, analyzing children's perception of the agent. We interviewed 5 children (3 boys and 2 girls), to further probe their reasoning. We selected children that played with different agents and displayed different interaction behavior. Between interviews, participants were allowed to free-play with the agents. This methodology is based on the prior research work of Turkle [7].

*Participants*

This study consisted of 26 participants. Of these participants, four were not able to complete the entire study due to lack of focus. The children were grouped according to their age range to gather data about how reasoning changes at different development stages. There were 12 (46.15%) children aged 3 or 4 years old classified as our younger children group. The older children group contained

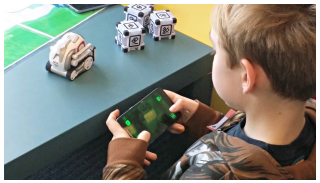

**Figure 3:** Cozmo
Games, autonomous exploration, object/face recognition
*Morphology:* robot (wheels, lift), garbled voice, block accessories
*Inputs:* visual information, distance, app
*Outputs:* sound, movement, LED eyes, block LEDs, app

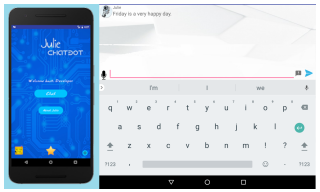


**Figure 4:** Julie
Conversations, jokes, and games
*Morphology:* Android app, tablet TTS voice
*Inputs:* text, voice
*Outputs:* text, voice

14 (53.85%) children between the ages of 6 and 10. Of the 26 participants, 16 offered information about previous technology experience. A total of 6 (37.5%) of the respondents had programmed before and 9 (56.25%) had interacted with similar agents (Google, Siri, Alexa, and Cortana) previously.

*Agents*
The children interacted with four different agents: Amazon's Echo Dot "Alexa" (Figure 1), Google Home (Figure 2), Anki's Cozmo (Figure 3), and Julie Chatbot (Figure 4). These agents were chosen for their commercial prevalence and playful physical or conversational characteristics. Alexa is a customizable, voice-controlled digital assistant. Google Home is also a voice-controlled device, for home automation. Cozmo is an autonomous robot toy. Finally, Julie is a conversational chatbot.

*The Monster game: interactive questionnaire*
After interacting with an agent, participants completed a ten item questionnaire in the form of a monster game. The game was adapted from the work of Park et.al, and was used to keep younger children engaged [4]. In the game, two monsters would share a belief about an agent then children placed a sticker closer to the monster they most agreed with. We vetted the usability of this method and the clarity of the questions in a pilot test. The questions queried how children felt about the agent in terms of trust, intelligence, identity attribution, personality, and engagement and were adapted from a larger questionnaire found in the work of Bartneck[1].

## Findings
Overall, most participants agreed that the agents are friendly (Figures 5,6) and trustworthy (Figures 7,8). The younger children (3-4 years old) experienced difficulty

| | | **Agents** | | | |
|---|---|---|---|---|---|
| *Age* | *Response* | *Alexa* | *Google* | *Cozmo* | *Julie* |
| Younger | Smarter | 20% | 0% | 40% | 60% |
| | Neutral | 20% | 100% | 0% | 40% |
| | Not as smart | 60% | 0% | 60% | 0% |
| Older | Smarter | 100% | 43% | 20% | |
| | Neutral | 0% | 57% | 40% | |
| | Not as smart | 0% | 0% | 40% | |

**Table 1:** How children perceive agent's intelligence compared to theirs. Note: Only one session of interaction and questionnaire data with Julie was collected, the group was restless after interaction

interacting with the conversational and chat agents. They enjoyed very much playing with the Cozmo. The older children (6-10 years old) enjoyed interacting with all the agents, although they had their favorites based on the different modalities of interaction. Responses varied depending on the agent and age of the participant. These are discussed below as: perceived intelligence, identity attributions, playfulness, and understanding.

*"She probably already is as smart as me" - perceived intelligence*
Younger participants had mixed responses, but many older participants said that the agents are smarter than them. The older participants often related the agent's intelligence to its access to information.

For example, Violet[1] (7 years old) played with Alexa and Google Home during structured playtime, then Julie and Cozmo during free play. She systematically analyzed the

[1] Participants names are changed

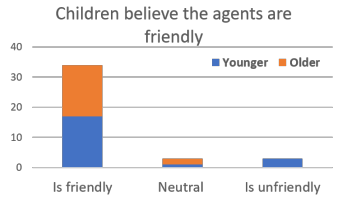


**Figure 5:** How children perceive friendliness of agents by age

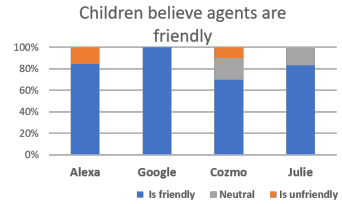


**Figure 6:** How children perceive friendliness by agent

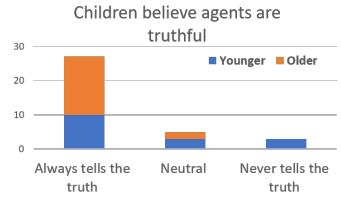


**Figure 7:** How children perceive truthfulness of agents by age


**Figure 8:** How children perceive the truthfulness of each agent

intelligence of the agents by comparing their answers in regards to a topic she knew a lot about: sloths.“Alexa she knows nothing about sloths, I asked her something about sloths but she didn‘t answer... but Google did answer so I think that‘s a little bit smarter because he knows a little more". Mia(9.5 years old) played with Julie and Google Home during the structured play, then tried all the other agents during free play. She used a similar strategy of referring to the things she knows when trying to probe the intelligence of the agent: “[Google Home] probably already is as smart as me because we had a few questions back and forth about things that I already know“.

*“ What are you?" - identity attribution and playfulness*

We observed probing behavior, where the participants were trying to understand the agent. Younger children tried to understand the agents like a person, “[Alexa], what is your favorite color“, “Hey Alexa, how old are you“. Older children tested what the agent would do when asked to perform actions that humans do, “Can you open doors?" “[Cozmo] can you jump?" They also asked the agents how they worked, “Do you have a phone inside you?" and how they defined themselves, “What are you?" The children used gender interchangeably when talking about the agents. Gary and Larry referred to Cozmo as both “he“ and “she“. “I don’t really know which one it is“ - Gary. “It’s a boy...maybe because of the name but then again you could use a boy name for a girl and and girl name for a boy“ - Larry. Later, they concluded that Cozmo “is a bob-cat with eyes“.

Multiple agents of the same type were provided during the playtest which led the participants to believe that different Alexas could give different answers , “She doesn’t know the answer, ask the other Alexa“.They would repeatedly also ask the same question to a device to see if it would change its answer.

As they became familiar with the agents we observed children playfully testing their limits. A 6 year old girl asked several agents “Is it OK if I eat you?". Other children offered the agents food and asked if they could see the objects in front of them, “Alexa what kind of nut am I holding?"

*“Sorry I don‘t understand that question“ - understanding*

We observed that the majority of participants experienced various challenges getting the agents to understand their questions. Several children tried to increase the level of their voice or make more pauses in their questions, things that may help people understand them. However, it did not always lead to better recognition with the agents.

Often, when the agents would not understand them, children would try to reword their question or make it more specific. Throughout the playtest, we observed shifts in children‘s strategies, under the encouragement of the facilitators and parents or by observing strategies that worked for other children.

Despite these challenges, participants became fluent in voice interaction quickly and even tried to talk with the agents that didn‘t have this ability (e.g Cozmo).

## Discussion

Building on prior work and based on the observations from this study, we propose the following considerations for child-agent interaction design: voice and prosody, interactive engagement, and facilitating understanding.

*Voice and prosody*

Voice and tone made a difference in how friendly participants thought the agent was (Figure 6). When asked about differences between the agents Mia replied, “I liked Julie more because she was more like a normal person, she had more feelings. Google Home was like ‘I know everything‘...Felt like she [Julie] actually understood what I was saying to her“.

Her favorite interaction with the agents was the following exchange she had with Julie, “She said ‘I‘m working on it‘’...I said ‘What do you mean you‘re working on it ? ‘ She said ‘I don‘t speak Chinese‘[laughs] I wrote back ‘I‘m not speaking Chinese‘ and she said ‘It sounded like it‘. That is an interaction I would have with a normal human“. Mia‘s perception of this interaction could be a result of the “mirroring effect“, where the agent‘s unexpected response is perceived as a sense of humor, a reflection of Mia‘s own style of communication. Through this interaction and previous experiments ran by Disney Research, we see an opportunity for future agents to imitate the communication style of children and create a prosodic synchrony in the conversations in order to build rapport [5].

*Interactive engagement*
Gary and Larry said they liked interacting with Cozmo the most “because she could actually move and all the other ones that we did she couldn‘t move“. Also because Cozmo had expressions, “he has feelings, he can do this with his little shaft and he can move his eyes like a person, confused eyes, angry eyes, happy eyes...Everybody else like they didn‘t have eyes, they didn‘t have arms, they didn‘t have a head, it was just like a flat cylinder“. This testimony reveals how mobile and responsive agents appeal to children and how the form factor plays a significant role in the interaction. Through its eyes and movements, Cozmo was able to effectively communicate emotion, and so the children believed that Cozmo had feelings and intelligence. Many participants, who tried to engage in dialogue with the agents, were limited by the fact that the agents weren’t able to ask clarifying questions. While the children were attracted to the voice and expressions of the agents at first, they lost interest when the agent could not understand their questions. We recognize the potential for designing a voice interface that could engage in conversations with the children by referring to their previous questions, by asking more clarifying questions and by expressing various reactions to children inputs.

*Facilitating understanding*
During the play-test the facilitators, parents, and peers helped the children rephrase or refine their questions. We wonder how some of this facilitation could be embedded in the design of the agent’s mode of interaction. If the agent could let the children know why they cannot answer the question and differentiate between not understanding the question and not having access to a specific information, this would help the users decide how to change their question, either by rephrasing it, or by being more specific. Another issue we recognized was that sometimes the amount of information provided to the participants was overwhelming. The agent’s answers could be scaffolded to provide information gradually. This would enable the children to decide how much they want to know about a specific topic and get more engaged by having a conversation with the agent.

## Conclusion
This research raises the following question: if these agents are becoming embedded in our lives, how could they influence children’s perception of intelligence and the way they make sense of the world? During our study the participants believed that they could teach the agents, and they could learn from them. This leads us to imagine novel ways in which the agents could become learning companions. In future work, we hope to design interactions where children are able to tinker with and program the agents and thus expand their perception of their own intelligence and different ways to develop it.

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