Investigating Looking Behaviors with a Humanoid Robot

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ABSTRACT

Several research studies have shown that children with autism spectrum disorders (ASD) often display impairments in their ability to engage in many social behaviors that are crucial for the development of social-emotional competence, empathy, and expressive language. Because most children with autism show strong preferences for nonsocial information such as objects and machines (Adamson, Deckner, & Bakeman, 2010; Tapus et al., 2012), researchers have explored using humanoid robots to help children with autism develop skills for social interaction (Tapus et al., 2012). In this study, we used data from 55 typically developing toddlers (*M* = 33 months) who participated in a 10-minute semi-structured play session with a humanoid robot, the NAO V4 (Aldebaran Robotics). The NAO robot was pre-programmed to advance through seven structured social interactions, such as Simon Says, I Spy, a tai chi routine, and a dance to "If You're Happy and You Know It." Using this data, we examined children's engagement with the robot, specifically their looking preferences during the interaction phases with the NAO.

BACKGROUND

Infants' and toddlers' ability to coordinate their attention with another person on an object of mutual interest (coordinated joint engagement) is a crucial milestone in the development of social behaviors, empathy, symbolic thought, and expressive language (Adamson, Bakeman, Suma, & Robins, 2017; Meltzoff, Brooks, Shon, & Rao, 2010). A number of research studies have shown that children with autism spectrum disorders (ASD) often display impairments in their ability to engage in joint attention. For example, they make less eye contact (American Psychiatric Association, 2013) and engage less frequently in social interactions with others (Adamson, Bakeman, Suma, & Robins, 2017).

Because most children with autism show strong preferences for nonsocial information such as objects and machines (Adamson, Deckner, & Bakeman, 2010), researchers have explored using humanoid robots to help children with autism develop skills for social interaction (Tapus et al., 2012). Pierno, Mari, Lusher, and Castiello (2008) discovered that typically developing children exhibited facilitation effects while imitating a human model, but not while imitating a robot arm, while children with autism demonstrated the reverse - facilitation effects by the robotic arm but not the human model. This finding suggests that individuals with autism might benefit from interventions that utilize robots to help improve their social-emotional competence. Yet, the questions remain whether the use of robotics can improve children's eye contact, and whether these effects are observed at a younger age, when social engagement behaviors first emerge.

OBJECTIVES

- Establish a normative range of looking behaviors in a typically developing sample of toddlers.
- Assess the efficacy of the robot's programmed interactions for evaluating children's social engagement, especially in regard to repeating this study with children with ASD.

METHODS

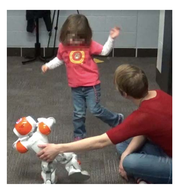
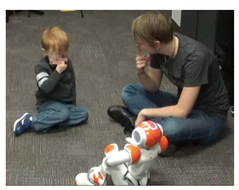
Data on toddlers' social engagement was collected throughout 2016 and 2017 in Dr. Jed Elison's Lab in the Institute of Child Development at the University of Minnesota. We used the data from 55 typically developing toddlers (M = 33 months of age) who were video-recorded during a 10-minute semi-structured play session with a humanoid robot, the NAO V4 (Aldebaran Robotics), in a 21' x 11' study room. All participating children met the NAO for the first time within the experimental setup. The toddlers' caregivers were present during the session and were asked to respond naturally to bids from their children but to otherwise remain unengaged. The NAO humanoid robot, controlled by an experimenter who was also present in the observation room, advanced through seven structured social interactions with the children. Types of interactions included imitation games, such as Simon Says and dancing to "If You're Happy and You Know It" and reciprocal play, such as I Spy.

Using the video recordings from each participant's test session and a video coding software (Ref Datavyu), we transcribed each participant's looking behaviors during the first 30 seconds of each of the robot's interactions. For the first interaction, "hello," we transcribed participants' looking behaviors for the entire test phase. Participants' looking behaviors were coded as looks to the robot or looks to a social agent (e.g. parent or experimenter).

Figure 1

Test Phase Descriptions

hello	The first interaction. NAO turns on for the first time and introduces itself. NAO asks the child to copy its actions. (Ex. "I touch my nose. Can you touch your nose?")
happy dance	NAO dances to "If You're Happy and You Know It" and invites the child to follow along.
spy & spy2	NAO initiates a simplified game of I Spy with the child. NAO turns its head and appears to be looking around the room. (Ex. "Can you look around with me? Do you see a table?")
bb dance	NAO dances to "Bye Bye Bye" by *NSYNC and invites the child to follow along.
simon	NAO initiates a simplified game of Simon Says. NAO asks the child to copy its actions, similar to the *hello* phase. (Ex. "I look over there. Can you look over there?")
tai chi	NAO dances slowly to instrumental music, including a few tai chi moves. NAO invites the child to follow along.

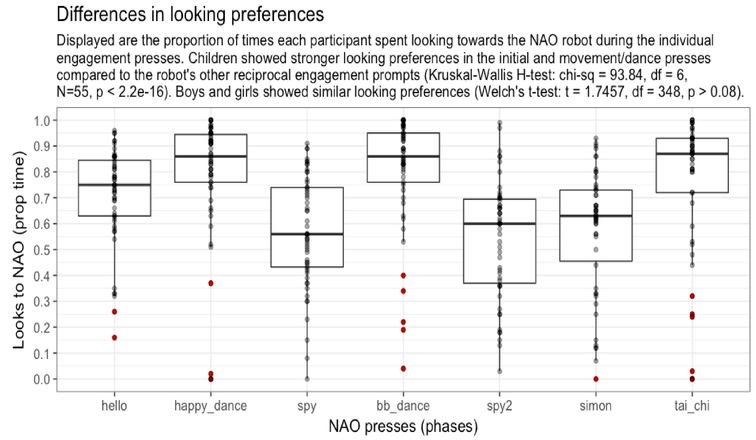
- The NAO V4 (left) performs tai_chi (middle) and plays Simon Says (right) with participants.

RESULTS

- Children looked at the NAO robot for a significantly greater proportion of time than they looked at any of the social agents (*M*= 68.1% vs. *M*=10.8%).
- Children spent a greater proportion of time looking at the robot during the *hello* test phase and dancing test phases compared to the other test phases (Figure 2).
- The proportion of time children spent looking to a social agent also differed according to test phase. Children spent more time looking at a social agent during test phases *spy, spy2,* and *simon.*
- We found no significant sex or age differences.

RESULTS

Figure 2



CONCLUSIONS

- Children showed more interest in the NAO robot than the social agents present.
- It is hard to know whether more variability in looking behaviors during test phases *spy* and *spy2* demonstrates that children were less engaged during these test phases, or if children spent less time looking at the robot because it was giving them directions to search for other objects in the room.
- It is also possible that the children were more interested in passively observing the robot during a performance than engaging with the robot in reciprocal interactions.
- When examining looking behaviors of children with ASD in the future, the robot's dances might help assess children's interest and ability to make eye contact, while I Spy might assess children's ability to engage in reciprocal interactions.

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