Social Robots to Encourage Play for Children with Disabilities: Learning Perceived Requirements and Barriers from Family Units

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ABSTRACT

We are currently conducting a study with children and their family units to learn the requirements for, concerns about, barriers to, and opinions on using social robots to facilitate play in children with physical disabilities. The motivation for this work is that children with disabilities often have fewer opportunities and lower playfulness, impacting their cognitive and social development. Simultaneously, social robots provide opportunities for supporting these children to engage in play. To work toward developing these robots, our goal in this work is to improve our understanding of the fundamental needs of the child and their family unit to allow us to be better positioned to develop such a social robot.

CCS CONCEPTS

• **Human-centered computing→Human Computer Interaction (HCI)**

KEYWORDS

child-robot interaction; human-robot interaction; participatory design; play and playthings; children with physical disabilities;

ACM Reference format:

Raquel Thiessen, Minoo Dabiri, Denise Y. Geiskkovitch, Jacquie Ripat, & James E. Young. 2023. Social Robots to Encourage Play for Children with Disabilities: Learning Perceived Requirements and Barriers from Family Units. In the Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (HRI '23 Companion), March 13-16, 2023, Stockholm, Sweden. ACM, New York, NY, USA, 5 pages. https://doi.org/10.1145/3568294.3580161.

1 INTRODUCTION

Play is a fundamental human right for children [1]. Through play, children develop their physical health, social skills, cognitive skills, and creativity [2], [3]. Learning new skills ultimately leads to increased self-efficacy and can help them develop the tools they need to solve future problems or challenges [2]. Most importantly, play is a fun and joyful part of childhood that all children should have the opportunity to enjoy. Despite the vital role of play in children's development and the joy it can bring them, time for play has decreased over time [4]. Children with physical disabilities often have even fewer play opportunities because they need to devote more time to their therapies and are impacted by their physical, social, and environmental barriers [5], [6].

We explore how we can use social robots to encourage and facilitate play for children with physical disabilities. Social robots have successfully engaged children in many applications, such as in education [7], [8] and rehabilitation settings [9], [10]. They can also have positive impacts on children's emotional well-being, such as mitigating anxiety and pain [11], [12]. In our work, we focus on a social robot that would help facilitate play at children's homes, schools, or therapy centers. Therefore, the social robot must be able to integrate into multiple aspects of the family's life and routine. Unfortunately, adapting social robots to domestic

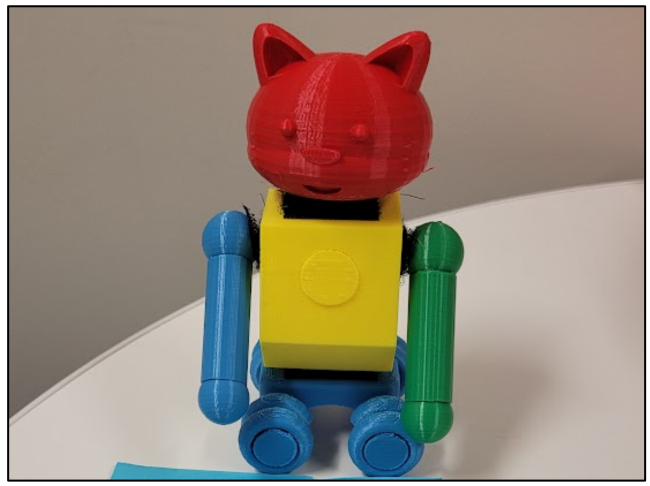

Figure 1. Robot prototype created by a child participant in our study, which they used to tell a story. We analyze this process to gain insight into the child's desires and concerns about a social robot.

HRI '23 Companion, March 13–16, 2023, Stockholm, Sweden

ACM ISBN 978-1-4503-9970-8/23/03…$15.00
https://doi.org/10.1145/3568294.3580161

environments has not yet been successful in the marketplace [13], highlighting the need for ongoing inquiry and exploration.

We try to address this adoption issue by engaging the stakeholders before we start designing or building a robot. Thus we employ co-design [14], [15] and participatory design [16] techniques, prioritizing the children's perspective and input from the family about pertinent issues including safety, privacy, home environment, and family dynamics. Through this study, we hope to gain a clearer picture of the social and domestic environment that a social robot to encourage play for children with physical disabilities would need to fit in.

2 BACKGROUND

Social robots have been built and investigated to gauge their effectiveness in supporting children and encouraging them to play. In these explorations, social robots have been shown to effectively motivate and engage [7], [8] children, improve children's social behaviors [10], and bond with and have a positive relationship with children [17]. This research highlights the benefits and potential of social robots for facilitating play with children with physical disabilities.

Previous research has explored the use of social robots for children with physical disabilities. In the IROMEC project, researchers collaborated with professionals to create a social robot for children with physical disabilities and those with autism spectrum disorder [18]–[21], but struggled to fit the requirements of both groups of children because of the groups conflicting needs. Studies have also tested the effect of commercially available robots for children with disabilities in their therapies. One study used the publicly available ZORA robot with children with physical disabilities [9], [22] and found many positive effects. However, they also had many technical challenges with the robot, including the lack of scenarios and the professional's inability to customize the robots for their sessions. We build on previous work, focusing instead on learning from children with physical disabilities and their families to understand the practical and social landscape the robot needs to fit within.

3 PROPOSED METHODOLOGY

We designed a study to help us learn about the needs, desires, fears, and constraints that children and their families perceive around using a social robot, by directly engaging with these stakeholders. Currently, we are conducting this study at SSCY (Specialized Services for Children & Youth) aiming to work with 10-15 children and their families.

3.2 Collaborative Design

Collaborative design methods such as participatory design or co-design approaches, aim to shift the power dynamic giving participants the control to influence the technologies used in their world [14], [15]. The purpose of collaborative design methods is to get direct ideas and feedback from the primary stakeholders about improvements, general needs, or innovations. Co-design methods have been used with children to design robots for many different purposes such as supporting mental health [23], boosting creativity [24], and robots for inclusive play [25]. One study worked with children and their parents to explore design requirements for a robot to help with pain management [26]. Before their session, they introduced the children to several robots and allowed them to spend time interacting with them. Similarly, we have a phase in our study to help ground the stakeholders with what is technically feasible for a social robot. We also used similar methods and activities as previous research co-designing robots with children.

Our approach to learning from them is through co-design and participatory design activities followed by semi-structured interviews. With their perspectives, we will extract their *primary concerns, desires, and use cases* to brainstorm and better inform how we can design and develop novel social robots to help facilitate play in the future and the requirements of doing so.

3.3 Method

Our study is being performed over 1-1.5-hour sessions with children aged 4-14 and their family units. To make their participation in the study as convenient as possible, we try to schedule them while they are already at the center for another appointment. We also give them the option to disclose the child's disability in our demographics form but do not require them to do so nor conduct any confirmation of their disability, given the sensitivity of the information. Each session is performed with just one family at a time. For the session, we have two primary phases: *social robot exposure and elicitation*, where the elicitation phase consists of two subphases: *reflection and creation.* Throughout all phases of our study, we intermittently ask the children and their families semi-structured interview questions to help us understand their thoughts and perspectives throughout the session.

Figure 2. Nao [27]**, Aibo** [28]**, SnuggleBot** [29]**, Pepper** [30]

3.4 Study Phases and Tasks

Social Robot Exposure Phase. To help ground the stakeholder's ideas with what is technically feasible, we start by briefly showing them currently available social robots. With this information, the stakeholders will be primed to understand known possibilities and benefits, better positioning them to make judgments regarding a social robot intervention and provide more realistic desires, opportunities, and use cases. For this phase, we used a Nao [27], Aibo [28], SnuggleBot [29], and a Pepper [30] robot (*Figure 2*).

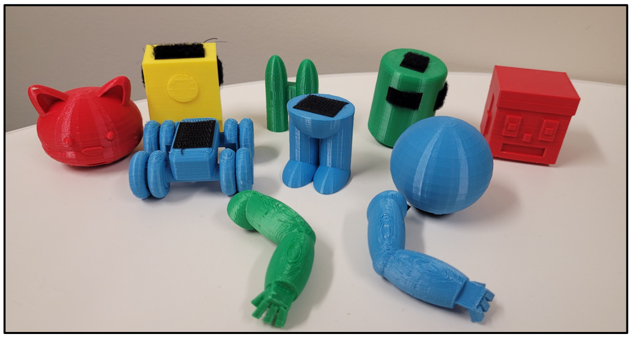

Figure 3. Sample pieces of our 3D printed toolkit.

Elicitation Phase. This phase focuses on engaging the stakeholders to collect data that we can use to help understand our research questions. This phase has two subphases *reflection and creation.* The elicitation is done through activities inspired by co-design and participatory design methods. The choice and sequence of the activities is adapted per session to guide the participants through our research questions and potentially be modified based on the child's abilities. Throughout this phase, we prompt the child and other family members to get additional information on their design decisions, general thoughts, and feedback.

Reflection. In the reflection subphase, we aim to get insight into what the family unit thinks about robots through a brief verbal reflection of the demo robots they saw. This phase also enables us to help them start the brainstorming process before we ask them to design their robot.

Creation. In the creation subphase, we aim to understand the kind of robot the children believe would help encourage a child such as themselves to play. Our goal in this subphase is to understand how they imagine themselves or another child playing with the robot, any fears they might have, their perception of a robot's limitations, and the role of the robot in their play in different parts of their life. Using their described robot design, we ask the guardians about any concerns they might have with the robot interacting with their children or of it being in their home and any perceived barriers to integrating such a robot. Following, we encourage the family to draw, act out, or verbally tell stories about their robot. However, if this does not work well for them, we alternatively describe scenarios of them with their robot and ask what they thought about them.

For this subphase the children are given the option to build a physical robot prototype using a 3D printer toolkit we designed or draw their robot (*figure 3*). Since our study has young children with varying mobility issues, we designed a toolkit that would be quick and easy to use but would still allow them to be creative if they do not like to draw or have trouble doing so. Our toolkit design was inspired by Robo2Box [31] and following studies [26], that used toolkits designed to elicit children's design requirements. An example of a prototype built with this set can be seen in *Figure 1.*

3.5 Analysis

We record only the audio of our sessions and take photographs of all generated materials in the study activities. The recordings and photographs allow us to focus on the session and let the child keep what they produced if they desired. We will analyze the data using an open coding process to derive analytic themes and groupings. We are interested in how the children and families believed we could use a robot to engage children and encourage them to play. We will discuss the resulting themes from our coding process and refine them using affinity diagrams to identify the key points. With these points, we hope to have a set of recommendations and design considerations that future researchers can use to design and build a social robot to facilitate play for children with physical disabilities.

4 CONCLUSION

We build on previous work trying to leverage social robots for facilitating play by working with children with physical disabilities to ensure that we can meet families' real-life social and pragmatic needs and constraints. Our goal is to contribute to the HRI research field by providing insights we learned from our study to help guide future designs of social robots for children with physical disabilities to facilitate play for play's sake. Furthermore, we hope to further reflect on our process and specific methods, and the related challenges we faced working with this demographic, to support future work in this area.

ACKNOWLEDGEMENTS

We would like to thank the Winnipeg, Manitoba Center for Specialized Services for Children & Youth (SSCY) and the Winnipeg Regional Health Authority (WRHA) for their extensive support of this project and research. This research was funded by Natural Sciences and Engineering Research Council of Canada (NSERC) and the NSERC Discovery Grants Program.

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