PERSPECTIVES ON THE USE OF SOCIAL ROBOTICS IN OCCUPATIONAL THERAPY INTERVENTIONS

A Thesis submitted to the faculty at Stanbridge University in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy.

by

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Certification of Approval

I certify that I have read *Perspectives on the Use of Robotics in Occupational Therapy Interventions* by Sarah Lebada, Lyneth Mercado, Erin Patterson, and Sara Yusi, and in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy at Stanbridge University.

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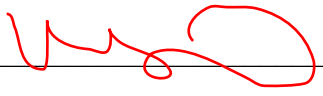

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Abstract

Currently, the use of a social robot has been identified as a feasible aid to assist with managing and improving autism spectrum disorder (ASD) symptoms. However, there are significant gaps that are necessary to address in order to define its true applicability in its future use in occupational therapy as well as incorporating the subjective viewpoints from parents and occupational therapy practitioners (OTP). It is important to understand the viewpoints from the key stakeholders, such as the OTPs and parents, because they have the most knowledge on their client's or child's interest and abilities and can provide applicable insight as to how effective a social robot can be. Potentially, they can contribute to what skills a social robot can provide; what challenges may arise when implementing an intervention or activity with a social robot; and what benefits, such as improvement in motor skills or creativity, can a social robot contribute to. In this study, we aim to examine the OTPs' and parents' perspectives on the effectiveness of social robotics in therapy sessions. Through a mixed method study, we surveyed 5 OTPs and 1 parent of a child with ASD and found that there was an overall positive view on the use of QTrobot from both groups. However, there was also a clear hesitancy on the use of QTrobot for children with ASD due to participants having concerns in maintaining attention and engagement and in lacking a human touch. With this study, we hope to add a layer of understanding on the acceptance of the use of social robotics in ASD interventions by parents and OTPs to further establish and guide effective collaboration between the two.

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Perspectives on the Use of Robotics in Occupational Therapy Interventions

Autism spectrum disorder (ASD) is characterized by “persistent impairment in reciprocal social communication and social interaction” and “restricted repetitive patterns of behavior, interests, or activities" (American Psychiatric Association, 2013, p. 53). Because there is no cure for ASD, there is an ongoing focus on early interventions to improve the functioning of individuals with ASD, as ASD can be detected or diagnosed as early as 12 months (Kouroupa et al., 2022). For instance, the use of a social robot has been noted as a feasible aid to assist with managing and improving ASD symptoms (Marino et al., 2020). Researchers have also developed multiple interventions and created studies to understand the role of social robotics in the development of cognitive, emotional, and social ability and in improving participation in daily living and social situations in children with ASD (Kouroupa et al., 2022). The current literature on social robotics also focuses on the benefits and effectiveness for children with ASD. One article investigated how different features of the robot improved social communication skills in children with ASD (Marino et al., 2020), whereas another study focused on improving emotional expression (Costecu et al., 2015). To our knowledge, research has primarily focused on an objective viewpoint of how a social robot would improve different domains of development such as social and emotional; communication and interaction; motor skills; and sensory development (Alabdulkareem et al., 2022). Although there is an increasing amount of research explaining and evaluating the benefits of a social robot for children with ASD, we have yet to understand the benefits of using a social robot from the stakeholder’s subjective point of view.

Statement of Problem

For our study, we define 'subjective' as the viewpoint of individuals who will be purchasing and incorporating the use of a social robot. For instance, we want to evaluate if parents or occupational therapy practitioners (OTPs) were to see a video of a social robot and its features, would they utilize a social robot at home or at interventions (Alabdulkareem et al., 2022). In other words, would parents and OTPs find social robotics useful for their children or their clients? Although there are studies that have shown that there are benefits of using social robotics, it is important to address the key stakeholders' subjective opinion of the social robot to understand the true value of a social robot. To ensure positive and long-lasting changes in the development of children with ASD, it is important to work alongside these groups as they have immediate access to the child's progression. Through this study, we will evaluate the perspectives of both OTPs and parents to gain a deeper understanding of their perceptions towards social robots. We also hope to increase conversations about using social robots in occupational therapy (OT) and create a passageway for developers and researchers to understand what is important for parents and OTPs and create a better method of application of social robotics within the profession. More importantly, in accordance with revised "Occupational Therapy Education Research Agenda," clients want an effective intervention in improving their condition, and practitioners want to be able to provide that *just right* intervention (American Occupational Therapy Association [AOTA], 2018). However, in order to do so, innovative interventions need to be defined, described, and tested (AOTA, 2018). In our study, we aim to define and describe the perspectives of both parents and OTPs in order to contribute to the distinct value of occupational therapy,

which is client-centered care, and to understand the true value of using a social robot in therapeutic interventions.

Literature Review

Current Research

As OTPs work with children with ASD, they seek to enhance their treatment interventions by incorporating new interventions that are client centered (AOTA, 2020). Given the heterogeneity of ASD, there is a need to search for intervention approaches that are adaptable and catered towards a child's individual needs (Kouroupa et al., 2022). For instance, one child with ASD may present mild difficulties, such as having problems with initiating social interactions, having atypical responses to peers, and having an inflexible behavior (Billing et al., 2020). Whereas, another child with ASD may present with severe difficulties, such as having very limited levels of initiation, having no interest in social overtures from peers, having severe difficulties in both verbal and nonverbal communication, and having restrictive and/or repetitive behaviors that impacts functioning in all spheres of living (Billing et al., 2020). Because the severity and the symptoms of ASD can vary in each child, it is important to create a client-centered intervention that caters to the symptoms that each child displays, and because social robotics includes features that are customizable, social robots provide an opportunity for practitioners to aid children with ASD. For instance, robots have the ability of imitation, eye-contact, joint attention, behavioral response, and repetitive and stereotyped behavior that can be difficult for human therapists to do without exhaustion (Kouroupa et al., 2022). Research has identified two areas of improvement in robot assisted therapy: social and emotional skills, and motor skills. Various robot devices, such as KASPAR (Kinesics

and Synchronization in Personal Assistant Robotics) and a humanoid robot named NAO, have been tested. For children with ASD, there have been significant improvements in a child's ability to socialize, self-regulate, and perform motor skills after interacting with a robot during therapy sessions (Alabdulkareem et al., 2022).

Social Robots

Currently, there is an increasing number of studies that focus on the use of a social robot in therapy. Common social robots used were the KASPAR and NAO robots. The KASPAR robotic device has been used in therapeutic settings for pediatric populations, including children with ASD. KASPAR has human-like characteristics that promote interaction with children, such as moveable hands, torso, and arms (Huijnen et al., 2018). KASPAR also includes speech and sound abilities. Having these human-like qualities is significant in therapeutic interventions as it has a more natural way of interaction, socialization, and play. The robot's ability to move its hands while talking, in addition to demonstrating emotions through words and emotional expressions creates a more natural way of interaction that can be more receptive to a child with ASD. This is significant because children with ASD may have impaired social skills. Children may be able to learn these skills with the example of a robot and its' features. With all of these unique characteristics, KASPAR has been an asset when used in an intervention with a child with ASD (Huijnen et al., 2018).

The NAO humanoid social robot, created by SoftBank Robotics, was developed to interact naturally with humans (Balmik et al., 2023). This is achieved through its physical features and abilities that are similar to a human, such as stature and appearance. According to Marino et al. (2020), NAO is child-sized social robot, who can be utilized

as a co-therapist because of its ability to take turns, direct one's attention, deliver cues when needed, and reinforce behaviors in a natural way. This study also revealed that after direct contact and interaction with NAO, researchers found that there were significant increases in one's socio-emotional understanding skills. Participants within the study demonstrated high interest when with the robot and also an increase in sustained attention and motivation (Marino et al., 2020). Furthermore, in a study by Butchart et al. (2021), researchers suggest that the NAO robot is an acceptable complement to rehabilitation therapies for children with ASD. Parents, children, and therapists found perceived therapeutic value through NAO's potential to improve engagement in rehabilitation and assistance in the delivery of rehabilitation programs. Overall, the NAO robot has been shown to be an effective tool for accommodating the different learning styles of children with ASD.

Strengths of Current Research

Practical Aspects of Methodology

Current research regarding the use of robotics in therapy has shown various strengths that can be beneficial for our study. Within qualitative studies, we have seen that researchers have allowed for in-depth perspectives of their participants. For instance, in a study by Silvera-Tawil et al. (2022), researchers found that adults with ASD, teachers, and school therapists were enthusiastic about the use of a social robot to support student learning. Researchers found that participants were enthusiastic about the humanoid features as it would be likely relatable for students. This creates a better understanding of what the participants think about the use of robotics. This was done by

the development of an organized and structured set of questions in hopes of collecting feedback (Silvera-Tawil et al., 2022).

According to Kitt et al. (2021), unstructured interactions with the social robot has led to an increase in the child's positive affect. Their study examined the interactions of the social robot without a specific agenda, as opposed to having a detailed outline of the intervention was more beneficial to the child (Kitt et al., 2021). The positive outcomes from Kitt et al. showed emotional support to a child's mental health, especially in a stressful situation. As a group, we discovered that existing research has indicated there are preconceived ideas that robotic devices are unnatural and maybe even unusual. Conti et al. (2017) reported that people may have negative views on the use of robots because people view them as "dangerous machines." However, studies have shown that spontaneous, unstructured interactions from a social robot are effective in children's learning (Kitt et al., 2021).

Another strength represented is the recruitment of participants. It is important to include the appropriate populations for the purposes of our study. The recruitment of participants were chosen through purposive selection, which included their demographics, their age, and a diagnosis of ASD (Amirova et al., 2022). Other studies have also recruited teachers and therapists who were involved in autism-specific service provides (Silvera-Tawil et al., 2022). Gathering participants who have experience with working with children with autism is valuable, as they are familiar with the needs of this population. Seeking perspectives of other individuals with unrelated experiences would not suffice for our study.

Social and Emotional Skill Improvement

Children diagnosed with ASD may have difficulty with social and emotional skills. The use of robotics can improve a child's ability to socialize and regulate emotions. It has shown to promote interaction between the robot and the child. This can be seen in children who may be nonverbal or may need further support in social situations. After interacting with the robot, children have shown to be more comfortable with the robot (Marino et al., 2020). According to Costescu et al. (2015), engaging with the robot leads to a better performance regarding cognitive abilities. They have also reported that robot assisted therapy has also been used to educate children about the different emotions with facial expressions of the robot. This assists with improving the child's emotional skills.

Motor Skill Improvement

Robotic interventions in therapy have also shown to improve a child's motor skills, another common theme that was identified. This includes improvement in a child's mobility of their body, such as fine motor skills. Research has indicated positive impacts, showing that children with ASD have improved motor imitation with the use of a social robot (Kouroupa et al., 2022). It has also demonstrated functional improvement of the upper extremity of motor improvements and lower extremity improvements with gait training practices (Howard, 2013).

Weaknesses of Current Research

Though there are indications that robot assisted therapy is an effective tool for children with ASD, hesitations arise when using it in therapeutic interventions. This may be due to the wide range of population characteristics (Costescu et al., 2015) or a smaller

sample size that occurred in past studies (Marino et al., 2020). These are both weaknesses because they impact the generalizability of the study to the population. Studies also found concerns about the costs, the fragility of the robot, the amount of time required for training, as well as general technical issues that may impact lessons (Silvera-Tawil et al., 2022).

Statement of Purpose, Hypothesis, and Research Questions

The purpose of our mixed-methods study was to evaluate the perspectives of OTPs and parents on the use of a social robot for children with ASD in hopes to understand the benefits and effectiveness of a social robot in comparison to traditional, in-person therapy interventions. We also expected to further establish and guide effective collaboration between the two groups, parents and OTPs, and to provide information to developers and researchers on what parents and OTPs find beneficial in social robots in order to help advance the clinical value of social robots. Our specific research question was: how do parents and OTPs perceive the potential use, benefits, and effectiveness of a social robot for children with ASD in comparison to traditional, in-person therapy? Through our data collection, we also question:

- What programs of a social robot did parents and OTPs find beneficial?
- What programs of a social robot did parents and OTPs not find beneficial?
- Is there a similarity or dissimilarity in survey responses between parents and OTPs?
- Is using a social robot in therapy interventions a viable tool for parents and OTPs?

Overall, we can assert that the utilization of robots in therapy interventions shows promise for supporting children and practitioners. As mentioned, there are various strengths and positive impacts social robots have on improving a child with ASD's social skills, language and communication, and gross motor skills (Marino et al., 2020; Costescu et al., 2015). Due to this, we hypothesize that both parents and OTPs will have a positive outlook on the use of social robots in therapeutic interventions. We also believe that both parents and OTPs will identify that using a social robot is a viable option for children with ASD.

Theoretical Framework

A common approach to working alongside children diagnosed with ASD is the use of behavioral theories. The use of a social robot, such as QTrobot, has a psychosocial aspect that focuses on one's behavior; it helps increase language and communication skills, improves attention in the areas of focusing, social skills, memory, and academics (Billing et al., 2020). It also facilitates the remediation of unwanted behaviors. Social robots can assist in a structured intervention by being consistent and assisting with reinforcements. For example, social robots can continuously repeat the same reaction, action, or verbal cues to really emphasize on a certain topic or lesson.

In this study, we will be utilizing the Model of Human Occupation as our guiding framework, as this theory contributes to positive and lifelong learning for children with ASD. In the theory of the Model of Human Occupation, occupational performance is driven by volition and consists of three elements: the interest of the client, personal causation, and values (Taylor, 2016). In other words, this model considers what the client is interested in, their ability to do, and what the client finds important to them (Taylor,

2016). Based on this model, children with ASD who have difficulties in engaging in occupations and in communication are at a state of disorder. In other words, children with ASD may refuse to engage in important occupations, such as play, due to their condition. In a child's development, play is a critical factor (AOTA, 2020). Play is an important occupation for children because it provides them with opportunities to not only develop social and communication skills but to motivate them to engage in occupations that are important (AOTA, 2020). Furthermore, the social environment for children with ASD needs to be considered because environmental factors can either prevent or encourage participation in meaningful occupations (AOTA, 2020). For children with ASD, the support and relationships of OTPs and parents play a pivotal role in the care of children with ASD (Jacobs et al., 2020). It has been noted that understanding ASD starts with considering the perspectives of individuals, such as parents and practitioners, who have immediate access to the child's progression (Jacobs et al., 2020). Overall, in our study, we are considering the children with ASD and their interests and environmental factors, such as the parents and practitioners, to understand the most effective method of application for a social robot to support children in achieving the desired occupation.

Methodology

Our study used a mixed-methods design and the survey consisted of 2-4 demographic questions (two for OTPs and four for parents), 10 Likert-scale questions, and six open-ended questions. These survey questions were designed by the research team after investigating and gaining insight from the literature review. Butchart et al. (2021) reported utilizing semi-structured interviews because they "allowed rich descriptions and understanding of participant experience" (p. 165). Our aim with this

survey was to have a better understanding of perceptions of the QTrobot in a setting where a child with ASD can improve their motor and social skills. The survey questions included were for the purpose of gathering both positive and negative perceptions and allowed the participant to voice their opinions. We chose to host our survey and video intervention over online platforms in order to recruit a large number of participants while minimizing their time commitment. Lastly, we found that using Google Forms was appropriate for this study because it allowed the participants to withdraw at any time. The Likert scale questions for both the parent and OTP groups are outlined in Appendix A.

Recruitment of Participants

Participants were recruited using the online platform Facebook, and by posting a flier in local community bulletin boards. After researching Facebook for groups that would qualify based on our inclusion and exclusion criteria, we found two Facebook groups for parents of children with ASD and three Facebook groups for OTPs. Then, the research team created a Facebook account and requested permission from the groups to post onto the groups' feed. After gaining permission from each group, the research team created a post with our fliers and a recruitment post to add to the groups' feed. The same flier was also posted on community bulletin boards throughout three local public libraries.

We also recruited study participants by contacting Stanbridge University alumni and pertinent Stanbridge Masters of Science, Occupational Therapy (MSOT) faculty. In order to do so, we submitted a site agreement form and submitted a media request for a mass email to contact Stanbridge MSOT alumni and pertinent Stanbridge MSOT faculty for potential study participation. If the participants chose to participate in our study and

agreed to the consent form, they were given access to the survey and the video-viewing intervention that they could complete.

Inclusion and Exclusion Criteria

In order to participate in our study, both parents and OTPs had to fulfill the following criteria. In order to participate as a parent, (1) their child must be between the ages of 3-16 years old with a clinical diagnosis of ASD based on the *Diagnostic and Statistical Manual of Mental Disorders,* 5th edition (*DSM-5*); (2) their child must currently be in or have previously received OT; (3) the participant must have access to an electronic device, such as a cell phone, laptop, or tablet, to access and complete the survey; and (4) the participant must sign and agree to the informed consent form prior to taking the survey and viewing the video intervention.

In order for an OTP to participate in the study, the participant (1) must be a licensed occupational therapist or certified occupational therapist assistant; (2) must have provided OT services to a child aged 3-16 years with a clinical diagnosis of ASD based on the *DSM-5* within the past year; (3) must have access to an electronic device, such as cell phone, laptop, or tablet, to access and complete the survey; and (4) must have signed and agreed to the informed consent form prior to taking the survey and viewing the video intervention.

Parents were excluded from this study if (1) they are not able to read and write in English; (2) if they are under 18 years of age; or (3) if the child has had previous experience with any form of a social robot. OTPs were excluded from our study if (1) they are a current occupational therapy student or any other allied health professionals; (2) they had less than 1 year as a licensed and/or registered OTP or certified occupational

therapist assistant; or (3) they are not able to read and write in English. These exclusion criteria were considered due to our study being on a platform where literacy and comprehension is required and to ensure that there is no more than minimal risks for our participants.

To ensure that all responses included are from participants who fulfill the criteria, the research team monitored the responses as they were coming in and focused on the answers based off the demographic questions asked in the survey to make sure that the participants who completed the survey were eligible.

Ethical Considerations

Our study did not collect any identifying data from participants, such as name, age, or gender. The reason why the research team used a Google Form was to provide an accessible online survey platform with minimal risk. The first section of the survey was an informed consent document with the option to accept or decline. To minimize the risk of our study, the research team's consent forms included the following statement: "the purpose of this study is to gain perspective of social robotics only and is not intended to provide direct intervention to study participants, their clients, or their children."

When results came in, the research team made sure to only talk about results in a secure room with no outside members listening. Results were kept in a drive that was only available to the research team and the principal investigator. In case of a breach of confidentiality, the research team implemented a backup plan. The backup plan was to report the incident to the Stanbridge University Institutional Review Board and take all the necessary steps to keep our study ethical. There were no vulnerable populations used in this study.

In order to adhere to the ethical guidelines of AOTA (2020), we wanted to provide a study that was a safe environment. Including an informed consent is not just a requirement for the Institutional Review Board, but allowed the research team to let the participants know all the necessary information regarding the study. In the informed consent, the research team included their emails as well as the principal investigator's email for any additional questions. Lastly, the participants were able to skip any questions that they were uncomfortable with.

The research team took necessary steps to obtain consent of usage for QTrobot, since Stanbridge University is the owner of this specific QTrobot. A site agreement form was also obtained from Stanbridge University and was signed by the Vice President of the university as seen in Appendix B. This site agreement in addition to the approval from the Institutional Review Board, the research team was able to start collecting data. The video of QTrobot and the survey was created by the research team, crediting the research team with the copyright.

Instruments

This study gathered perspectives from OTPs and parents on the use of a social robot, QTrobot. QTrobot was developed by LuxAI S.A. (https://luxai.com/) in 2018 and was purposefully designed to be a child-sized robot and mimic child-like reactions. LuxAI S.A. has provided previous studies that have been done with QTrobot with significant results in improving children's gaze in terms of attention and the engagement in children with ASD (LuxAI, 2022). The robot has an LCD screen for its face which allows it to show animated expressions. The creators at LuxAI S.A. did not want to create a face that was a touch screen to minimize children touching the actual robot. Some of

these expressions can also be translated through the movement of QTrobot's shoulders moving up and down. With the ability for the robot to move its arms, it can also demonstrate motor skills such as, putting their hands on their head, blowing a kiss, and waving hello/goodbye. To encourage positive reinforcement when the child performs the correct task, QTrobot also has the ability to move their neck to mimic a nod.

QTrobot is controlled by the use of two tablets, one for the child (which we will refer to as the learner tablet) and then one for the educator (which we will refer to as the educator tablet). The educator tablet allows the educator to choose which lesson the child will be performing, as well as control what the robot says and does. The educator may choose from the following lesson topics: (1) "All About Clothing Curriculum" where QTrobot teaches the child to be independent in getting dressed by learning the names of clothing items, dressing sequence, and their proper placement on the body; (2) "Emotional Ability Training Curriculum" where QTrobot teaches emotional identification, such as happy, sad, anger, and surprised, and the ability to interact with others in society, for example getting angry when another child takes their toys away; and (3) "Early Stage Development Curriculum" where QTrobot demonstrates motor skills, such as raising the hands to the head and clapping their hands. During these lessons, the child will be tested with a question from QTrobot. The student's answer will be recorded using the tablets. QTrobot will either praise the student for the correct answer or will provide cues for correction. Cues vary from fading incorrect answers and highlighting the correct answers, showing the correct answer twice on the tablet, verbally saying the correct answer, or repeating the question.

Data Collection

Data was collected by the survey created through Google Forms by the research team. This was the platform chosen by the research team due to the convenience of an online platform and the research team collectively thought Google Forms was the easiest to navigate and use to collect data. The survey included a video clip that lasted 9-10 minutes of QTrobot performing the lessons stated above, followed by a set of Likert scale and open-ended questions. The same survey was taken by all participants, with the exception of demographic-specific questions. The research team decided to keep the survey consistent in order to create reliability and validity of the survey. The research team drew on common language from surveys appearing in our literature review as a basis for designing our own survey questions. The video clips of QTrobot showcased all the different features of the robot as well as how the robot is controlled. Data was also collected over the span of one month.

Intervention

Each potential participant accessed the research study and corresponding consent form, via a web link or the QR code located on the recruitment flier. Prior to the beginning of the survey, potential participants were required to read and agree with the consent form presented. Next, the participants watched a video that lasted about 9-10 minutes and then when finished, continued to the demographic questions. The demographic questions for parents were aimed at collecting the following data: the child's age, the child's gender, and if there were any past experiences with robot-assisted therapy. Similarly, the demographic questions for OTPs were aimed at collecting: if they were currently practicing and licensed as an OTP; if they have experienced robot-assisted

therapy in the past. To further understand the participants viewpoints, the research team wanted to know their experience with a social robot.

As the survey continued, both participants who were in the parent group and the OTP group answered 10 Likert scale questions, ranging from 1-strongly disagree to 5-strongly-agree. To gather more information and allow the participant to speak their voice, the survey also included six open-ended questions.

Data Analysis

After receiving survey responses, the research team then analyzed the data. For our quantitative data, such as our Likert-scale questions, they were analyzed using statistical analysis. The statistical analysis methods that the research team used was computing inferential and descriptive statistics by creating charts and graphs as seen in Tables 1 and 2. In order to ensure inter-rater reliability, the research team split into two pairs and reviewed the open-ended responses to identify common themes of the data. Each pair identified common themes provided in the open-responses and compared the results of the other pair. If there was a discrepancy with the results due to different interpretations, the research team reviewed the data again as one. However, if there were still discrepancies remaining our principal investigator would help resolve the discrepancies. These final thematic results were then analyzed with our research questions in mind.

Results

The final count of participants for our survey is six participants: five OTPs and one parent participant as shown in Figure 1. Overall, based on the surveys of the open-ended questions, the research team identified the following common themes throughout

the responses of the OTPs and the parent: “Attention,” “Engagement,” “Lacks Human Touch,” “Potential Issues in Billing Services,” “Appearances,” and “Robotics Contribution vs. Human Contributions.” Figure 3 represents how many times each theme was brought up by the participants. It is an accurate depiction of whether themes were repeated.

Attention

Both the OTP and the parent groups identified that the child’s attention span may be too short to sit through sessions. A clear depiction of the negative and positive viewpoints of attention are shown in Figure 2. An OTP stated: “Autistic kids are often gestalt language processors, and I’m not sure these types of prompts and language would make sense to some of these kids. These lessons also are not neurodiversity affirming. Would love instead to see some affirming uses with the robot!” Additionally, the parent identified that some children may display sensory seeking behaviors which can interfere with their attention to the robot. The parent also included that due to the children's short attention span, they are more likely to be distracted and want to play with the robot as a toy.

Engagement

Engagement with the robot was another common theme that was addressed. OTPs expressed that children will have little engagement, saying: “Little engagement, or loss of interest after initially meeting the robot.” The OTPs included that incorporating neurodivergent affirming activities would be helpful to increase their engagement and participation with QTrobot. Another response from the practitioners included: “Depending on the age of the child some of the words/concepts might be beyond their receptive language skills and a task would be incorrect or not completed because they

simply didn't understand what was being asked of them." In other words, because QTrobot is preprogrammed to explain different tasks, it can be difficult to a child who does not understand the words being spoken. This can ultimately impact their engagement because it would be difficult to assess whether they are not paying attention or simply not understanding what is being asked of them.

Lacks Human Touch

Regarding the QTrobot, there was a response from the OTPs of it lacking human touch. The OTPs also pointed out that the QTrobot in the video displayed having slow movements. One of the OTPs stated: "the fact that robots don't have the human touch or social aspect." The parent response included that because children tend to express verbal thoughts and questions, the social robot may not be able to expand its discussions with the child. Conversations and interactions between the robot and the child may be impacted because of miscommunication or misinterpretation of controlled prompts. However, the parent preferred the robot's verbal response. The parent stated: "I really liked the verbal 'Yahoo!!' moments when the answers were correct. Some children do better when verbal reinforcement is more energetic rather than calm and monotone. Also, when it would move its arms."

Potential Issues in Billing for Services

Being that the robot is not a common approach to therapy sessions, some OTPs found that the use of social robots can lead to potential issues in billing for therapy services. The practitioners reported that there may be issues with insurance and reimbursement policies. This raises the issue of how OTPs may be able to justify the use

of a social robot. A participant stated there may be challenges to "provide skilled services as the clinician."

Appearance

The QTrobot was reported to be toy-like and enticing, from the parent perspective. The OTPs group reported about its positive physical features, such as, the social robot's facial expressions, its voice, its friendliness, and its cute demeanor. The parent participant mentioned: "the facial expressions might make a child want to practice copying them."

Robot Contributions vs. Human Contributions

The final theme we identified is how QTrobot can contribute to therapeutic interventions in ways that a human therapist cannot. OTPs reported that the QTrobot was "forgiving" and provided positive feedback in a calm demeanor. Furthermore, the parent mentioned that QTrobot is able to provide clear and easily understood prompts that can easily be interpreted for children with ASD. An OTP recognized that "this offers a different approach" when talking about the implementation of QTrobot in interventions. There were also mentions of the utilization of the social robot as a safe space for children with social anxiety. An OTP mentioned that it provided more opportunities for socialization because it can be controlled through QTrobot's programming. However, an OTP did mention that this controlled environment that QTrobot is able to provide may be a disadvantage due to the interactions being similar to applied behavior analysis therapy and its focus on "neurotypical social skills" rather than focusing on the child as an individualized human first.

Discussion

With reference to the revised "Occupational Therapy Education Research Agenda," clients want the most effective interventions for their performance difficulties, and OTPs want to provide them with these interventions (AOTA, 2018). However, for practitioners to provide the most effective interventions, occupational therapy interventions must be defined, described, and tested, so that practitioners know what is effective for each client. Our results found that the use of a social robot, QTrobot, can be a promising tool to use for occupational therapy interventions for children with ASD.

After collecting data for four weeks, the research team analyzed both quantitative and qualitative data. We found that both groups had positive perspectives towards QTrobot's appearance and "friendly" nature. Both groups identified that QTrobot's features, such as its animated face and voice and friendly demeanor, were positive aspects of the robot and can contribute to motivating the child to imitate or to play with QTrobot in therapeutic sessions. Both groups agree that after watching the video, the most memorable component of QTrobot is the usage of verbal positive reinforcement and how QTrobot provides forgiveness for an incorrect response. Furthermore, from the results of the Likert questions, the parent generally had positive feelings of the use of QTrobot in therapeutic settings. On the other hand, the OTPs had mixed perspectives. Particularly, there were both positive and negative perspectives on whether QTrobot would be worth being used in sessions and for children with ASD.

Although there are a lot of similarities between the both groups, the differences are observed through the open-ended questions. One OTP observed and raised an issue with the screen-like face of QTrobot, that it will result in more "screen time" for the child

resulting in other social or development issues. Another issue raised by another OTP participant is the longevity of the robot. On the same question, the parent participant was focused more on the child becoming distracted when working with the robot. We believe that the OTP participants will focus more on the structure of the robot as they will be more experienced in the usage of the robot as opposed to the parent will be more focused on the interaction between the robot and the child/client.

Attention

Both OTPs and parent participants recognized the potential challenge in maintaining children's attention during therapy sessions with QTrobot. According to one OTP participant, sensory-seeking behavior highly interferes with children's attention, as it is a hindrance to the ability to focus on the robot. These findings and insights highlight the importance of incorporating neurodivergent-affirming activities, which are activities that provide a supportive and inclusive environment for individuals who are neurodivergent (Dallman et al., 2022), and helps to enhance attention and optimize the effectiveness of a therapeutic intervention. Though the survey responses reported that children with ASD may have difficulty sustaining attention, research has stated otherwise. A previous study researched the use of the NAO robot in education and care of children with developmental disabilities. After the robot demonstrated its different features of motion and gestures, it was reported that not all participants were necessarily interacting with it, however, they followed the robot and had “great attention” (Conti et al., 2017). This indicates that the right type and amount of demonstration of a robot can determine how much attention is given in the moment.

Both OTPs and parent participants recognized the potential challenge in maintaining children's attention during therapy sessions with QTrobot. According to one OTP participant, sensory-seeking behavior highly interferes with children's attention, as it is a hindrance to the ability to focus on the robot. These findings and insights highlight the importance of incorporating neurodivergent-affirming activities, which provide a supportive and inclusive environment for individuals who are neurodivergent (Dallman et al., 2022). These activities might help to enhance attention and optimize the effectiveness of a therapeutic intervention. Though the survey responses reported that children with ASD may have difficulty sustaining attention, research has stated otherwise. A previous study researched the use of the NAO robot in education and care of children with developmental disabilities (Conti et al., 2017). After the robot demonstrated its different features of motion and gestures, it was reported that not all participants were necessarily interacting with it, however, they followed the robot and had “great attention” (Conti et al., 2017). This indicates that the type and amount of demonstration by a robot can determine how much attention it is given in the moment.

The data analysis found that children may lack interest after meeting robots hence a potential for little engagement in therapy. Butchart et al. (2021) reported that parents noticed minimal engagement of conversation between the child and the robot. However, parents noted this is due to their child’s ability to interact in conversation, rather than an issue directly with the experience of the robot. Though the findings of this study show that the OTP group and parent believe children may have minimal engagement overall, this report may be due to the lack of a direct view of an interaction with a child and a social robot. With that being said, OTP concern is that this limited engagement among

children can play a significant role in hindering the active participation of children in the sessions. Therefore, for future considerations, therapists should tailor therapy sessions' activities to individual children's abilities and interests to foster skill development and interactive sessions.

Lacks Human Touch

Both OTPs and parents identified the need of the “human touch” in order to make therapeutic sessions with QTrobot more effective. OTPs expressed concern about the QTrobot’s inability to provide the same level of human interaction and adaptability associated with human therapists. Additionally, children might face language-related challenges as the robot is unable to engage in meaningful conversation with a child. This insight highlights the need to balance human therapists' use with technology such as QTrobot in therapeutic interventions. Similarly, in a systematic review by Pennisi et al. (2016), researchers questioned if a robot could replace a human therapist, and they found that a human agent is necessary to guide the robot to perform therapeutic sessions. Furthermore, they expressed that it is likely that having only a robot during therapeutic interventions may increase the difficulties to generalize learned skills.

Potential Issues in Billing for Service

Another theme mentioned by the OTPs was that the use of a social robot is underutilized as a therapist in sessions, as their use in therapy can lead to potential issues of billing. In other words, navigating reimbursement and insurance issues becomes difficult as using social robots is still an uncommon practice. Our findings highlights the need for OTPs to explore and clarify the usage of billing procedures when social robots are used to provide therapeutic services. During our literature review, we did not identify

any study that mentions potential issues in billing for services with a social robot. However, this may be due to the use of a social robot in OT services being a relatively novel idea. This theme, however, is important to address since these questions and concerns may arise when incorporating social robotics in occupational therapy.

Appearance

From the parent's perspective, the social robot was perceived as a toy-like and enticing item. The QTrobot was physically appealing as its animated friendliness, voice, face, and overall cute demeanor enhanced its acceptability among children. As a result, its potential engagement with children with ASD is enhanced. The appearance and nature of the robot may therefore motivate and create a positive environment for therapeutic intervention. In a study by Coeckelbergh et al. (2016), researchers found that some parents were worried about a social robot being too human-like and preferred robots that were animal-shaped because the respondents were worried that the child would perceive the robot as a friend and may become too attached. By contrast, in our study we found that OTPs perceived that QTrobots' human-like appearance and features, such as its face and voice, was a positive aspect of QTrobot.

Robot Contributions vs. Human Contributions

Lastly, OTPs and parents mentioned ways in which QTrobot can contribute to therapeutic interventions that a human therapist cannot. OTPs and the parent participant mentioned that QTrobot's unchanging and calm demeanor and ability to provide clear, understandable, and controlled interactions were positive features. In fact, in a study by Huijen et al. (2018), they mentioned a strength of a social robot was its ability to be personalized towards the child's individual needs and its ability to engage in a controlled

and consistent manner. Furthermore, they explained that a social robot is able to perform and interact in the same exact manner for an endless amount of time without fluctuations. Humans, on the other hand, are unable to do this because humans will vary in tone, volume, pitch, and expressions regardless if the same words or activities are being repeated.

Limitations

As a group we have identified limitations that occurred throughout our study. First, our research team experienced scheduling difficulties as well as limited time to access QTrobot. This restriction made it difficult to fully understand and incorporate all features of the robot. Easier access to the robot would have also allowed for the research team to prepare the study quicker. Second, in our survey, we chose to limit the amount of features and programs that was shown, so that the time consumption of the survey remained reasonable for participants. As a result, the video of QTrobot was 9-10 minutes long. This presented as a limitation because it did not provide the viewer of all that QTrobot has to offer. We chose specific features that we believe are common interventions that can be utilized in occupational therapy. This was done so that we were able to generalize our conclusions towards occupational therapy interventions. This may have limited our open-ended responses because of the heterogeneity of children with ASD, and it may be possible that the features chosen may have not been beneficial towards their child. Another limitation of our study was the time commitment required for participants to complete the survey. We received feedback from a potential participant that the survey was too long and had difficulty taking it. Other limitations arise with the platform which was used for the survey, Google Forms. It cannot be said that all

participants knew for certain how to navigate it and were familiar with how to answer and input their responses. We also found that while all participants completed the survey, not all participants answered every question. Future considerations for this would be to include simple directions and questions in the survey, so that it is easy to navigate and comprehend. Moreover, using a survey has its own limitations in a study. Although we include open-ended questions, there still was an open opportunity for lack of depth in the explanation of why a participant chose to answer the way they did. Furthermore, we were unaware of who took the surveys and could not guarantee that what the participants stated is true. These limitations are important to consider to develop an in-depth analysis of our potential data and to be able to generalize the conclusions towards our target population. Lastly, a limitation we identified was the small number of participants. This could be due to using only one platform, such as Facebook, to recruit participants. This is a limitation because our results may not represent the true perspectives of both populations. Other studies may want to consider multiple methods of participant recruitment to ensure the most exposure for recruitment.

Conclusion

The research team defined, described, and obtained the perspective of both parents and OTPs. Given that children with ASD experience difficulty developing social and emotional skills, the existence of objective evidence in favor of the use of social robots during therapy sessions for children necessitates a review of the subjective stance, particularly perception of stakeholders, such as parents and OTPs, towards the knowledge gap. OTPs are one of the key healthcare professionals that work with children with ASD; therefore, it is imperative that the OTPs are aware of the study's potential implications.

Based on the need to establish a subjective view of key stakeholders towards the use of social robots in therapy, our study aimed to evaluate the perceptions of occupational therapy stakeholders and parents on the use of robotics in pediatric ASD interventions.

Our study was based on a mixed-design methodology with the intended outcome being viability of use of social robots in therapy for autism. In particular, the study sought to establish the use, benefits, and effectiveness of using social robotics in pediatric therapy sessions for children with autism. Consequently, the results would influence occupational therapy by encouraging use of social robots in place of the conventional therapy so that developers of such robots can understand important areas of focus to enable efficient application of the robots in the profession. The results could also contribute to occupational therapy's vision by motivating active collaboration between parents and occupational therapy practitioners who are considered key stakeholders in implementation of effective interventions that enhance development for autistic children. We also hope that the results and the information provided in this study may stimulate further discussion and research about the potential use, benefits, and effectiveness of a social robot.

For future implications in the world of occupational therapy, this study provides a stepping stone into continuing the holistic viewpoint that OTPs strive towards. A part of holistic practice involves continuing professional development through education, and keeping up-to-date with new and innovative therapy interventions, as well as public perception of current therapies. For instance, applied behavior analysis therapy has been identified as having a negative impact on children with ASD, and due to a social robot's ability to be controlled in a repetitive and continuous manner, social robotics have also been considered in the similar, negative view. It is important for future research to also

consider how current discussion may impact their study. Furthermore, our study allows the OTPs and parents to not only research about social robotics in pediatric intervention but to utilize this study

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Table 1

Results of Likert Scale Questions From Occupational Therapy Practitioners (OTPs)

Occupational Therapy Practitioners (OTPs)	strongly disagree	disagree	neutral	agree	strongly agree
The robot seemed friendly				4	1
I like the robot's physical appearance				5	
There were positive feelings after watching the video			2	2	1
There were negative feelings after watching the video	3		1	1	
I would feel safe letting my child interact with the robot seen in the video		2		3	
I can see how the robot can be implemented in therapy for children with autism	1		2	1	1
I can see that there is a possibility for improvement in motor skills in my child if they were to work with the robot			4		1
I can see that there is a possibility for improvement in social skills in my child if they were to work with the robot.	1		2	1	1
Using the robot with my child would be worth my time.	1		3	1	
The robot seemed easy to understand and use			1	4	

Table 2

Results of Likert Scale Questions From Parent Participant

Parent	strongly disagree	disagree	neutral	agree	strongly agree
The robot seemed friendly				1	
I like the robot's physical appearance					1
There were positive feelings after watching the video				1	
There were negative feelings after watching the video		1			
I would feel safe letting my child interact with the robot seen in the video					1
I can see how the robot can be implemented in therapy for children with autism					1
I can see that there is a possibility for improvement in motor skills in my child if they were to work with the robot				1	
I can see that there is a possibility for improvement in social skills in my child if they were to work with the robot.				1	
Using the robot with my child would be worth my time.					1
The robot seemed easy to understand and use					1

Figure 1

Breakdown of Parent to OTP Ratio

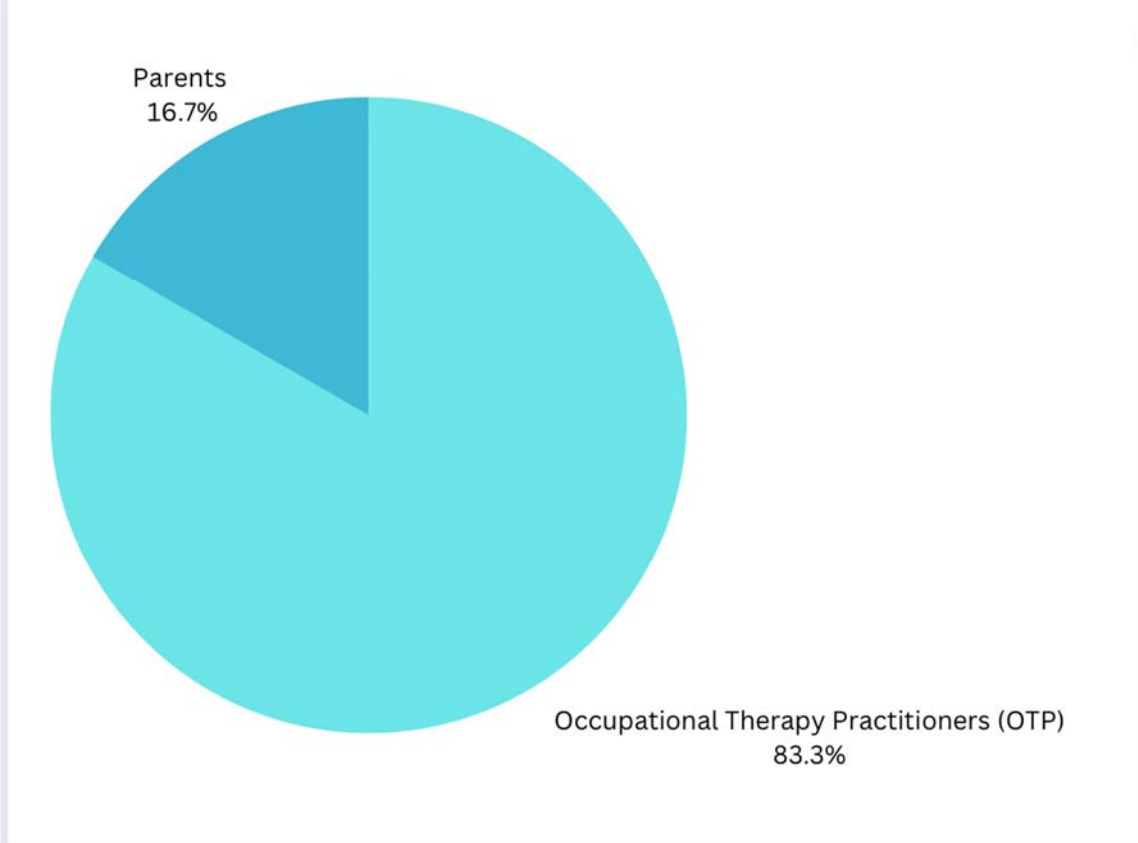


Figure 2

Percentage of Participants' Perception of 'Attention' Factors Regarding the Use of QTrobot

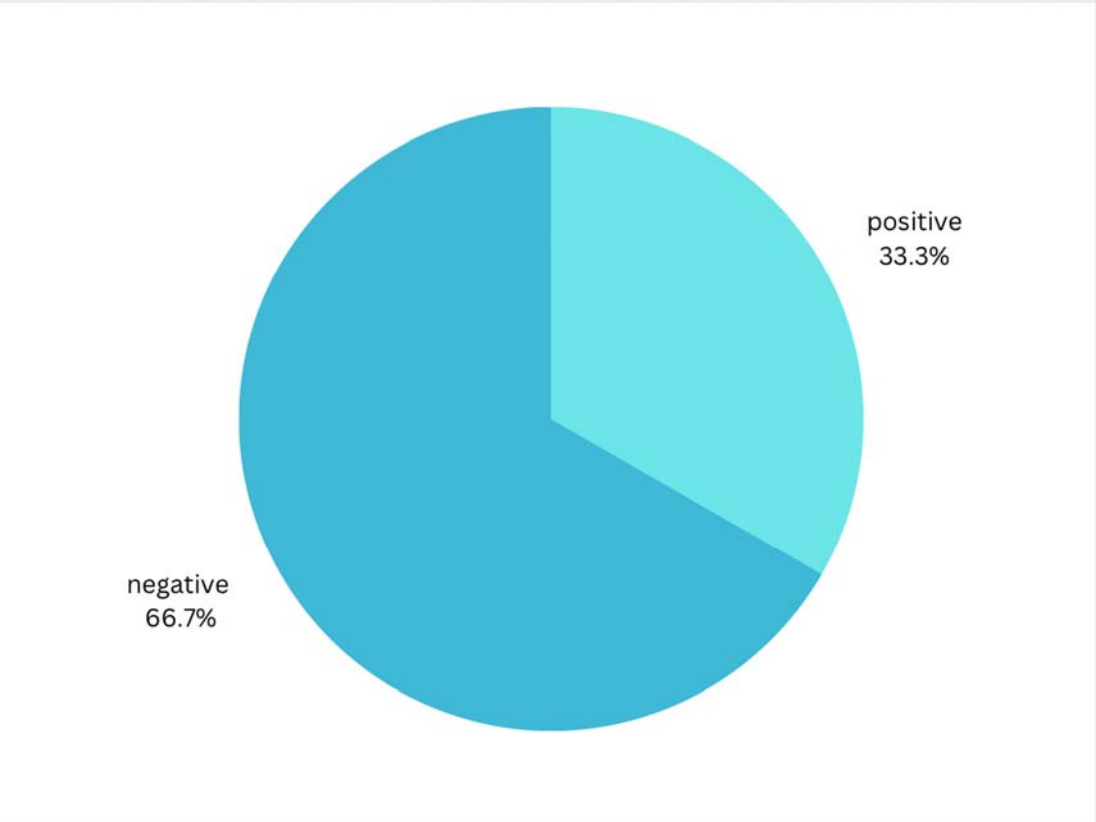
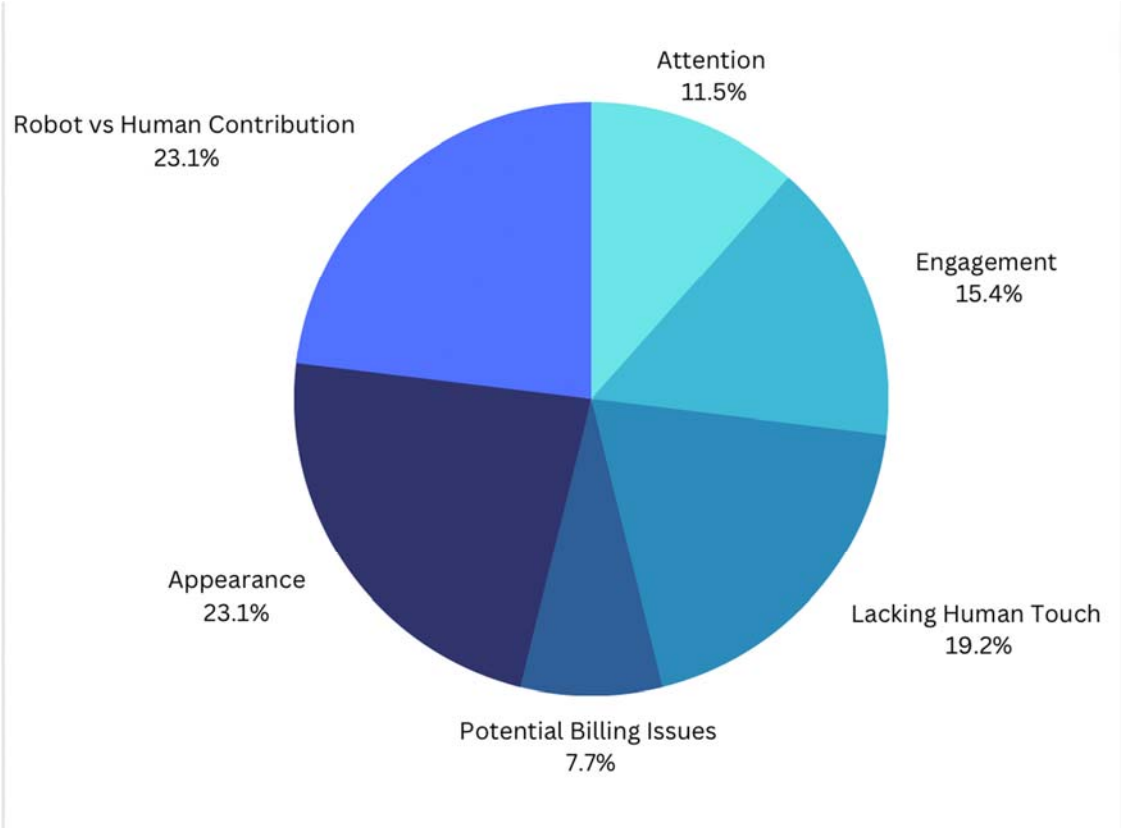


Figure 3

Representation of Themes Through Qualitative Data



Appendix A

Survey Questions for Both Groups

The following questions were asked to the OTP participants:

Likert Scale Questions

- The robot seemed friendly.
- I like the robot's physical appearance.
- There were positive feelings after watching the video.
- There were negative feelings after watching the video.
- I would feel safe letting my client interact with the robot seen in the video.
- I can see how the robot can be implemented in therapy for children with autism.
- I can see that there is a possibility for improvement in motor skills in my client if they were to work with the robot.
- I can see that there is a possibility for improvement in social skills in my client if they were to work with the robot.
- Using the robot with my client would be worth my time.
- The robot seemed easy to understand and use.

Open-Ended Questions

- What potential issues can you see arising with the use of robots in therapy sessions with children with Autism Spectrum Disorder?
- What benefits do you see for using the robot to promote child creativity? Please provide at least one example.
- What was the most memorable thing the robot did in the video[s] that would make you feel comfortable having your client around the robot?
- Were there any particular features of the robot your perceived *positively* based on the video? If so, please state them below.
- Were there any particular features of the robot your perceived *negatively* based on the video? If so, please state them below.
- What benefits over traditional human intervention for improving social behaviors do you think a social robot may be able to provide?

The following questions were asked to the parent participants:

Likert Scale Questions

- The robot seemed friendly.
- I like the robot's physical appearance.
- There were positive feelings after watching the video.
- There were negative feelings after watching the video.
- I would feel safe letting my child interact with the robot seen in the video.
- I can see how the robot can be implemented in therapy for children with autism.

- I can see that there is a possibility for improvement in motor skills in my child if they were to work with the robot.
- I can see that there is a possibility for improvement in *social skills* in my child if they were to work with the robot.
- Using the robot with my child would be worth my time.
- The robot seemed easy to understand and use.

Open-Ended Questions

- What potential issues can you see arising with the use of robots in therapy sessions with children with Autism Spectrum Disorder?
- What benefits do you see for using the robot to promote child creativity? Please provide at least one example.
- What was the most memorable thing the robot did in the video[s] that would make you feel comfortable having your child around the robot?
- Were there any particular features of the robot your perceived *positively* based on the video? If so, please state them below.
- Were there any particular features of the robot your perceived *negatively* based on the video? If so, please state them below.
- What benefits over traditional human intervention for improving social behaviors do you think a social robot may be able to provide?

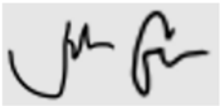
Appendix B

Institutional Review Board Approval

Dear Dr. Shain Davis and Students,

The Stanbridge University Institutional Review Board has completed the review of your application entitled "Perspectives on the Use of Robotics in Occupational Therapy Intervention for Children with Autism Spectrum Disorder." Your application (#03MSOTRS001) is approved and categorized as Expedited.

IRB Application Number	#03MSOTRS001
Date	04/20/2023
Level of Review	Expedited
Application Approved	X
Conditional Approval	
Disapproved	
Comments	The requested Minor changes have been reviewed and confirmed as completed by the IRB. (04/20/2023)

Signature of IRB Chair	

Please note that any anticipated changes to this approved protocol requires submission of an IRB Modification application with IRB approval confirmed prior to their implementation.

Sincerely,

Julie Grace, M.S., M.A.

IRB Chair

Appendix C

Site Approval Forms

Research Site Agreement Form
Stanbridge University

AGREEMENT

Research Site: Stanbridge University

Research Site Address: 2041 Business Center Drive, Irvine, CA 92612

Title of Proposed Research: Perspectives on the use of Robotics for Children with Autism Spectrum Disorder

RESEARCH STUDY INFORMATION

Student Investigator(s) Name(s):

1. Sarah Lebada
2. Lyneth Mercado
3. Erin Patterson
4. Sara Yusi

Principle Student Investigator Name: Shain Davis

Email address: sdavis@stanbridge.edu Phone Number: (562)242-6830

Duration of the study: 4/10/2023 - 7/28/2023

Authorization Effective Date: 4/10/2023 Authorization Expiration Date: 7/28/2023

Allowed Number of Contact Hours: _____ The study will be completed by (date): _____

Description of Research:

Through a mixed methods approach, we are conducting a research study aimed at examining the use of social robotics for children diagnosed with Autism. Pending IRB approval, we plan to survey parents of children with autism and occupational therapy practitioners in order to gather perspectives on the value of using social robotics, the QTrobot in particular, as an intervention tool. With the results of this study, we hope to gain more knowledge on client preferences and clinical practice considerations regarding social robotics.

Research Site Agreement Form

Stanbridge University

Intellectual Property Statement:

Stanbridge University reserves the right to use, publish, and disseminate the results of the research findings. The University shall provide the research site with a copy of the final research product at the earliest practicable time.

Thesis Advisor Contact Information:

Name: Shain Davis

Email address: sdavis@stanbridge.edu Phone Number: 562-242-6830

RECRUITMENT PLAN

Means by which the researcher(s) will contact and/or recruit participants:

We would like to ask permission from Stanbridge University to do the following:

-Contact Stanbridge MSOT alumni and pertinent Stanbridge MSOT faculty for potential study participation

-Create and use media featuring the QTrobot in our study survey in order to gain perspectives from study participants on robot features including, but not limited to, lesson plans, physical features and ease of use.

-Create and use media featuring the QTrobot in our study recruitment flyers.

SITE REPRESENTATIVE AGREEMENT

I agree to the recruitment and data collection methods to be used in this study, and I authorize the investigator to conduct research at:

Facility Name/Research Site Name: Stanbridge University

Representative authorizing agreement: Kelly Hamilton

Title: Vice President of Instruction

Kelly Hamilton Digitally signed by Kelly Hamilton DN: cn=Kelly Hamilton, o, ou, email=khamilton@stanbridge.edu, c=US Date: 2023.03.14 07:59:54 -07'00'

Signature Date

Research Site Agreement Form

Stanbridge University

STANBRIDGE UNIVERSITY AGREEMENT SIGNATURES

I/We accept the terms of this agreement.

Student Investigator 1: Sarah Lebada Title: Stanbridge MSOT Student

Signature 3/9/23 Date

Student Investigator 2: Lyneth Mercado Title: Stanbridge MSOT Student

Signature 3/9/23 Date

Student Investigator 3: Erin Patterson Title: Stanbridge MSOT Student

Signature 3/9/23 Date

Student Investigator 3: Sara Yusi Title: Stanbridge MSOT Student

Signature 3/9/23 Date

Faculty Thesis Advisor: Shain Davis Title: OTD, OTR/L

Signature 3/9/23 Date

Program Director: Myka Persson Title: MSOT Program Director

Signature 3/13/23 Date

Dr. Kelly Hamilton
Vice President of Instruction, Stanbridge University

Kelly Hamilton Digitally signed by Kelly Hamilton DN: cn=Kelly Hamilton, o, ou, email=khamilton@stanbridge.edu, c=US Date: 2023.03.14 08:01:04 -07'00'

Signature Date

STANBRIDGE UNIVERSITY