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Incorporating a Robot in Intervention with Children with ASD: The Effect on Tantrum Behaviors

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ABSTRACT

Incorporating a Robot in Intervention with Children with ASD:
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This study examined the effect of intervention involving a humanoid robot on challenging or tantrum behaviors of four children with low-functioning autism spectrum disorders (ASD). The current work was part of a larger study involving the effect of the robot on functional communication skills on a variety of different interactions with different communication partners. All participants took part in a single-subject, multiple-baseline design with various session types including baseline, traditional play-based treatment, treatment including the robot, and follow-up sessions. For the purpose of this study, only the sessions including treatment with the robot where the robot interaction occurred at the beginning or the end of a 50-minute session were analyzed. Six different categories of tantrum behaviors were analyzed during the sessions including: crying/screaming; self-distracting behaviors; biting, hair pulling, squeezing or pinching; throwing/shoving; and hitting/kicking. Results indicate that for 3 out of the 4 children, tantrum behaviors decreased when the robot interaction came at the beginning of the session. The fourth child showed minimal change in tantrum behaviors. To improve understanding of the influence of a robot on children with ASD, future research should be conducted to determine what aspects of the robot interaction would be most effective on reducing these behaviors.

Keywords: autism, robot intervention, tantrum behaviors, single subject research

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DESCRIPTION OF CONTENT

This thesis was part of a larger study focusing on the impact of low-dose intervention involving a humanoid robot on the functional communication skills of children with Autism Spectrum Disorder (ASD). The current study focused on the impact of a humanoid robot on tantrum behaviors on children with ASD. The body of this thesis was written as a document appropriate for submission to a peer-reviewed journal in speech-language pathology. The analysis coding system, raw data, and annotated bibliographies are presented in Appendices A, B and C.

Introduction

Autism Spectrum Disorders (ASD) comprise a group of pervasive disorders characterized by deficits in social interaction and restricted behaviors and interests. ASD may be associated with language impairment as well as with intellectual disability (American Psychiatric Association, 2013). Recent research has indicated that children with ASD who present with deficits in expressive language often manifest more challenging behaviors than children without ASD (Maskey, Warnell, Parr, Couteur, & McConachie, 2012). Some of these behaviors are externalizing and may be characterized as tantrums. Tantrum behaviors are disruptive in social and learning contexts, and intervention programs are often implemented to address the externalizing behaviors associated with tantrums. The purpose of this study is to observe the effects of low-dose robot intervention on the frequency of tantrum behaviors in children with ASD.

Autism Spectrum Disorders and Challenging Co-existing Behaviors

The Diagnostic and Statistical Manual of Mental Disorders-V (DSM-V; American Psychiatric Association, 2013) describes individuals with ASD as having deficits in communication such as responding inappropriately to conversation, "misreading non-verbal instructions, or having difficulty building friendships appropriate to their age," (p. 1). Additionally, those with ASD may be overly dependent on consistent routines and schedules, show a high sensitivity to environmental changes, and may focus on inappropriate items (American Psychiatric Association, 2013). These factors are considered the core behaviors typical to individuals with ASD, however, the manifestations of these behaviors vary greatly, and the array of behavioral difficulties individuals with ASD demonstrate range from mild to severe.

Although the communication deficits faced by individuals with ASD pose challenges to interaction with other individuals in the environment, secondary behaviors, including emotional

and behavioral difficulties, are often of great concern. There are a number of factors that can put children with ASD at risk for these secondary behaviors. These can include high sensitivity to change in their environment, difficulty communicating needs and wants, aversion to a change in routine, and many other possible factors. The co-existing challenges may be manifest in a variety of different ways depending on the individual and circumstance. Some emotional and behavioral problems, however, can include sleep, feeding, and eating problems and sensitivities; learning and intellectual disabilities; anxieties, fears, and phobias; and disturbed and aggressive behaviors (Maskey et al., 2012).

Studies have found that for individuals within the closest social circles of children with ASD, such as parents and teachers, "the co-existing conditions can be of equal or greater concern than the core features of ASD, and have a significant impact on behaviour management, learning acquisition and the development of social relationships" (Maskey et al., 2012, p. 851). Although the core behaviors of ASD limit a child's ability to function and participate in life events, these secondary behaviors, especially acting out or externalizing behaviors, interfere with a child's ability to interact with others, to form relationships, to manage the environment, and to acquire new knowledge and skills. Although the core deficits that present in children with ASD must be addressed, it is equally important to address the secondary behaviors. In research on problem behavior interventions for children with ASD, Horner et al. (2002) highlighted the importance of decreasing challenging behaviors in intervention by writing, "Young children who engage in problem behaviors are at increased risk for exclusion and isolation from educational settings, social relationships, typical home environments, and community activities" (p. 423). Successful intervention must help a child manage problem behaviors so that the child will be available to learn and employ appropriate social and communication skills in meaningful contexts.

Tantrum Behaviors in Children with ASD

Children with ASD may demonstrate a wide variety of problem behaviors. Recent research has indicated that one of the most common challenging behaviors present in children with ASD is a high frequency of tantrum behaviors (Horner, Carr, Strain, Todd, & Reed, 2002; Maskey et al., 2012). Tantrum behaviors can occur during daily activities and may be particularly prevalent during transitions between activities and events (Sterling-Turner & Jordan, 2007). Giesbrecht, Miller, and Muller (2010) define tantrums as "brief but intense emotional episodes characterized by explosive, impulsive and out of control displays of emotion" (p. 479). In addition, Österman and Bjorkqvist (2010) stated that tantrums "are usually defined in terms of physical behaviours" (p. 448) such as "crying, screaming and shouting, hitting parents or siblings, hitting objects, throwing self onto the floor, being unable to control one's self, deliberately hitting one's own head against something, breaking things, throwing things, running away, and biting" (p. 449).

Several types of secondary behaviors seem to correlate with different levels of abilities in specific social communication areas. For example, sleep, hyperactivity, and sensory difficulties seem to have a higher prevalence rate in children with ASD with lower language ability and for those who attended special schooling. Tantrum behaviors, however, seem to be independent of individual factors (Maskey et al., 2012). That is, regardless of age, language ability and schooling of the child, tantrum behaviors and aggression shown towards others remain consistent. Tantrum behaviors also greatly inhibit the child's ability to focus on a task or accomplish a desired assignment and as such, constitute a major obstacle for social and educational development (Matson, 2009). Horner et al. (2002) emphasized this point when he stated, "problem behaviors such as physical aggression, self-injury, property destruction, pica,

stereotypy, defiance, tantrums, and disruption are major barriers to effective education and social development" (p. 423).

There are a myriad of factors that can lead to disruptive behavior in a child with ASD. Although determining specifically what precipitated each instance of poor self-regulation or tantrum behavior is helpful, it can also be highly difficult and may not always be possible. Still, intervention designed to decrease these behaviors may result in "increased instructional time (thus, more learning opportunities for the student with autism), increased independence as the need for adult supervision decreases, and generalized effects to other settings" (Sterling-Turner & Jordan, 2007, p. 689). For these reasons, decreasing tantrum behaviors is often a high priority in intervention (Matson, 2009).

Approaches to Managing Tantrum Behaviors in Children with ASD

One of the purposes of treatment programs for any deficit or disorder is to identify and address atypical and challenging behaviors that decrease overall quality of life. This goal is consistent with therapy intended to help children with ASD. Ideally, core challenges and co-existing behaviors need first to be identified and then prioritized according to the beliefs and values of the client and his or her family. Reducing these behaviors and addressing key concerns allow for increased time when the child is available to learn as well as a more flexible and open learning environment (Sterling-Turner & Jordan, 2007). There is also considerable agreement that for ASD intervention, early and intense intervention can result in considerable gains in the child's outcomes and long-term effects (Ingersoll, 2010; Matson, 2009). Therapy and intervention must also be motivating to the client to facilitate progress (Goodrich et al., 2012). No single type of therapy has been shown to be efficacious for all children with ASD due to the high variability and differing individual needs of children in this population. Thus, different

intervention methods to decrease challenging behaviors in children with ASD have been established.

In the past, treatments to help control negative behavioral components of ASD have included complex programs incorporating restrictive behavioral and medicinal interventions. Recently, further research has been conducted to find alternative methods to treat challenging behaviors, especially in young children with ASD (Matson, 2009). Overall, four main categories of behavioral intervention for children with ASD have been described. These include antecedent manipulations, change in instructional context, differential reinforcement, and self-management (Machalicek, O'Reilly, Beretvas, Sigafoos, & Lancioni, 2007). Although many specific interventions exist with a multiple names and variants, each tends to fall under one of these four categories.

Antecedent manipulation intervention focuses on changing environmental factors that occur prior to or during the moment of a problem behavior. Many behavioral challenges that occur in children with ASD are associated with environmental factors. Additionally, these behaviors have tended to respond to learning-based interventions such as applied behavior analysis (ABA) and behavior therapy (Matson, 2009). Functional assessment, or determining why the behavior is occurring by means of informal observational measures, also falls under this category (Machalieck et al., 2007; Matson, 2009; LeBlanc & Gillis, 2012). By determining specific environmental factors that trigger tantrum or other negative behaviors, these factors could then be altered or eliminated, leading to the decrease or disappearance of the subsequent undesired behavior. Although antecedent manipulation intervention focuses on altering the negative behavior, intervention approaches such as applied behavior analysis ABA and behavior therapy simultaneously target social and communication skills. Demonstration of tantrum

behaviors is often considered a result of deficits in communication skills. Thus "methods of identifying maintaining factors for the challenging behaviors of aggression and tantrums can be important not only in describing the interfering behaviors but also addressing shortcomings in core ASD skill areas" (Matson, 2009, p. 173**)**. This intervention type can serve both as a precursor to determining an appropriate intervention technique or as part of the actual therapy. Altering the environment has shown to be a powerful tool in intervention for children with ASD.

Interventions classified as change in instructional context involve changes to the type of instruction or task to reduce subsequent challenging behavior that may arise. This type of intervention may take a variety of different forms and include different aspects of instructional change (Machalicek et al., 2007). Change in instructional context may also consist of environmental alterations made as a result of observed antecedents to negative problem behaviors. Thus, a change in instructional context may be closely tied with antecedent manipulation intervention. Examples of this type of therapy include prompting strategies, embedded instruction, and choice therapy where the client has the flexibility of choosing between two types of reinforcement (Machalicek et al., 2007; O'Reilly, Sigafoos, Lancioni, Edrisinha, & Andrews, 2005; Rispoli et al., 2012).

Differential reinforcement includes treatments that focus on reinforcing alternative behavior that is used in place of challenging behavior. Intervention of this nature not only focuses on eliminating undesired behavior but also provides an alternative behavior for the child to employ. Functional communication training (FCT) is frequently used in this type of therapy, which involves determining what maintains the challenging behavior in order to teach alternate appropriate responses (Braithwaite & Richdale, 2000; Machalicek et al., 2007). Other forms of this technique may include a picture exchange system to improve communication skills and

decrease challenging behaviors and differentially reinforced play behaviors (enforcing positive play behaviors while ignoring problem behaviors; (Nuzzolo-Gomez, Leonard, Ortiz, Rivera, & Greer, 2002).

Finally, self-management therapy includes intervention that focuses on increasing the child's ability to function independently by using cues from the environment (Machalicek et al., 2007). One therapy technique used to introduce and teach self-management employs a clear, outlined picture schedule. Results of this approach have been mixed and success seems to be dependent upon the specific client (Machalicek et al., 2007; Mancina, Tankersley, Kamps, Kravits, & Parrett, 2001; Massey & Wheeler, 2000). Whether or not true independence is achieved with the use of a visual schedule may also be argued. However, this method has been reported to be highly successful in reducing tantrum behaviors for some children with ASD in certain contexts.

Intervention to manage tantrum behaviors in children with ASD is rarely restricted to just one of the above subsets of intervention. In fact, the therapy techniques that have presented the most promising results combine two or more types of behavior focused intervention. In a recent research analysis of behavioral treatments in schools, Machalicek, O'Reilly, Beretvas, Sigafoos, and Lancioni (2007) found that the most effective behavioral interventions for decreasing tantrum behaviors included antecedent manipulation and change in instructional context techniques. Although the research study conducted by Machalieck et al. (2007) applied specifically to school settings, the results can also apply to additional therapy locations, such as in homes or treatment clinics, with appropriate alterations to the intervention to fit each setting (Schindler & Horner, 2005).

Intervention approaches designed to increase communication skills in children with ASD may influence tantrum behavior. In some cases, managing tantrum behavior may be a direct component of the intervention, and in other cases, it may be a byproduct of instruction to increase communication. The use of a robot in therapy is a recent example of a unique intervention that implemented some aspects of antecedent manipulation as well as a change in instructional context. It has been argued that introducing a robot into the child's learning environment might decrease challenging behaviors due to the child's interest in the robot and/or the child-robot interaction. Additionally, adding the robot to intervention could be expected to alter the instructional context of learning. Different types of robot interventions have been attempted including varying the amount of robot use in therapy and the type of robot used, such as humanoid or non-humanoid, to increase social communication abilities in children with ASD (Diehl, 2012; Goodrich et al., 2012; Shamsuddin, 2012). The effect of introducing a robot on a child's self-regulation and tantrum behaviors has not yet been detailed, however.

Recent studies completed at Brigham Young University using an interactive humanoid robot have achieved varying results in increasing social engagement, particularly reciprocal play (Blanchard, 2013; Dodge, 2012; Nelson, 2013; Ririe, 2013; Roueche, 2013). It was also suggested that the intervention involving the robot might have resulted in decreasing co-existing challenging behaviors, such as tantrums. Describing the children with ASD who participated in the study, Ririe (2013) noted "there were instances in which the robot seemed to support their behavioral regulation as well as their social connection with their mothers and clinicians" (p. 38). Should these secondary, challenging behaviors be decreased or eliminated through low-dose robot therapy, increased availability to learn and subsequent advancement in learning appropriate

pragmatic behaviors could result.

Purpose

This study is part of a larger project conducted at Brigham Young University exploring the effects of low-dose intervention incorporating a robot for children with ASD. Results of previous parts of this study have shown varied results in the participants with regard to social engagement. The previous work raised questions about the influence of the robot on challenging behaviors. Thus, the purpose of this study is to explore the effects of low-dose robot intervention on tantrum behaviors in four children with ASD.

Method

Participants

Four children (2 boys and 2 girls) previously diagnosed with ASD participated in this study. Each participant showed significant deficits in joint attention and social communication. In addition, each child demonstrated severe deficits in language comprehension and expression. (Nelson, 2013). Participants also displayed frequent tantrum-like and dysregulated behaviors. These behaviors included crying, yelling, self-injurious behaviors, hitting, pulling hair, and ear covering. A pilot assessment and intervention were conducted to determine the effects of the treatment on social communication. After reviewing the data collected, it was determined that further data analysis was warranted to explore the effects on self-regulation and tantrum behaviors as a result of interaction with a robot (Ririe, 2013). The case history and individual assessments for each of the four participants in these studies are provided below. The following information was obtained from the case histories and initial assessments conducted in 2011 at Brigham Young University.

Participant 1: AH. AH was a 4;11 (year; month) year-old girl living at home with her mother and father. The primary language spoken at home was English. AH did not have any siblings, but was attending a developmental preschool for children with ASD. Both parents were employed outside the home. Additional interaction outside the home included extended family members and children at school and church. AH's communication was characterized by vocalizations and physical manipulation of communication partners. Although basic signs were taught to AH in her preschool setting, she was not observed using them independently for communication purposes. AH rarely showed an appropriate affective response to activities or stimuli around her (Dodge, 2012).

In addition to deficits in social communication, including joint attention and symbolic play, AH also presented with behavioral problems, including yelling, screaming, and crying. These tantrum behaviors were sometimes associated with AH's apparent inability to successfully communicate her needs or wants. For example, when the zipper on AH's jacket was broken at the end of a baseline session, she began to cry and attempted to leave the interaction. In another instance, AH began to cry and yell every time she entered the clinic room. She only calmed down after leaving the room and pushing a bucket or riding in a wagon through the clinic hallways with the assistance of the clinician. The factors eliciting tantrum behaviors were usually not obvious, although fatigue seemed to be an important influence. It was concluded that AH's tantrum behaviors, which occurred in every sessions, interfered with her ability to participate in therapeutic activities.

Participant 2: KR. KR was an 8;1 year-old girl. She lived with her parents and had five siblings (ages 3, 5, 9, 19, and 23). English was the primary language spoken at home. Her father worked outside the home while her mother worked at home as a homemaker. KR's early

education began at a developmental preschool created specifically for children with ASD. She later was enrolled in various local elementary schools. At the time the study began, KR began attending a self-contained classroom for children with autism.

KR presented with marked deficits in social communication. Her vocal production consisted of jargon interspersed with a few recognizable words. Although KR showed immature communication skills, she seemed to enjoy interaction with others. She showed inconsistent affect in response to stimuli. KR also presented with behavioral challenges in addition to communication deficits.

Tantrums and dysregulated behavior were most frequently manifested in self-injurious behavior (such as hand biting), yelling and throwing objects. The antecedent events associated with these secondary behaviors could not always be determined, but at times they seemed to be correlated with KR not getting her way. For example, KR began to yell and bite her hand when the clinician took a magnet from KR momentarily to demonstrate how it worked (Dodge, 2012).

Participant 3: LR. LR was a 5;5 year-old boy. He lived with both his parents and five siblings (ages 3, 5, 9, 19, and 23). His mother worked at home as a homemaker, and his father was employed outside the home. The primary language spoken in the home was English. When the study began, LR attended a local developmental preschool designed specifically for children with autism.

LR produced no verbal communication and vocalized only with prolonged vowel sounds and isolated inconsistent consonant sounds. LR also presented with repetitive motoric behaviors, such as hand flapping, and fixation on objects. Although LR did not exhibit typical signs of tantrum behaviors such as crying, screaming, or self-injurious behaviors, he frequently covered his ears. This behavior was not consistent with the presence of noise or multiple items in the

environment, which otherwise would suggest oversensitivity to stimuli. Rather, this behavior seemed to occur in attempt to dismiss or avoid interaction with communication partners or activities.

Participant 4: LS. LS was a 9;1 year-old boy. He lived with both his parents and four siblings (ages 11, 14, 16 & 18). LS was born in Japan and lived there for the first four and a half years of his life; however, the main language spoken in the home was English. LS's mother worked in the home as a homemaker, and his father was employed outside the home. At 3 years old, LS was enrolled in a mainstream preschool and at age 4, transferred to a developmental preschool designed for children with autism. Later, he attended a kindergarten for children with autism. At the time of the study, LS attended a local elementary school in a self-contained classroom for children with ASD and other severe disabilities. According to parent report, LS enjoyed interaction with his siblings. Although he had further opportunity to interact with children and individuals outside the home at church and his Cub Scout troop, he rarely participated in interactions with children outside his immediate family (Dodge, 2012).

At the time of the study, LS displayed an expressive vocabulary of approximately 150 words. However, his functional communication was limited to structured requests in the *I want ____, please* form, one to two word utterances, and frequent echolalia. LS used expressive language to request and protest events or activities, while language for the purpose of commenting or showing was not observed during this study. Meaningful eye contact to communicate with others was inconsistent. Sometimes, eye contact seemed meaningful and indicated engagement, while other times the intent to establish a personal connection seemed absent.

LS was particularly sensitive to sensory stimuli, especially sounds and textures. When he became over stimulated, he quickly became dysregulated and demonstrated tantrum behaviors such as yelling, screaming, and aggression towards others, such as pulling hair. LS also frequently showed signs of positive affect prior to and during periods of dysregulation and tantrum behaviors. Events preceding tantrum behaviors were difficult to predict as they occasionally occurred immediately after a successful attempt at social communication (Dodge, 2012).

Procedures

This study was part of a larger research project conducted at Brigham Young University in 2011 that analyzed changes in social engagement behaviors in four children identified with ASD. Baseline sessions were first conducted to assess the level of social communication of each participant before treatment began. Each child was assigned to 3, 4, 5 or 6 sessions of baseline and traditional treatment. After the traditional treatments were conducted, treatment sessions involving the robot were commenced. These consisted of 50-minute therapy sessions involving both traditional intervention and intervention involving the humanoid robot. As a part of the treatment involving the robot, each child participated in 40-minutes of traditional therapy. At an assigned time during each session, the child, along with the graduate student clinician, the child's parent and assistant clinician, also interacted in 10-15 minutes of therapy involving the robot. In total, each client received a total of 20 treatment sessions, excluding baseline and follow-up procedures. At the conclusion of the treatment sessions, each client received three follow-up sessions. As part of the baseline and follow-up sessions, each child participated in four different interactions including one with a parent, one with a familiar adult, one with two familiar adults,

and one with an unfamiliar adult. The order and sequence which each of these interactions took placed varied between sessions.

Each individual participant was assigned to work with a different graduate student during the study. Each graduate student conducted baseline, treatment, and follow-up sessions for each individual child as assigned. A summary of the distribution of the various types of sessions for each child is provided in Table 1 (Nelson, 2012). In addition to the main graduate clinician assigned to each child, an additional graduate student clinician was present to provide assistance during portions of the baseline, follow-up, and treatment sessions including the humanoid robot.

Table 1

Number of Each Session Type Assigned to Participants

	Participant			
Session type	AH	LS	KR	LR
Baseline	3	4	5	6
Traditional treatment	3	4	5	6
Treatment with robot	17	16	15	14
Follow-up	3	3	3	3

Traditional treatment. Each participant took part in 3, 4, 5, or 6 50-minute traditional treatment sessions. These sessions did not include interaction with the robot and based on child-centered, play-based therapy principles (Prizant, Wetherby, Rubin, & Laurent, 2003). They were designed to be highly interactive between the graduate clinician and the child. Treatment goals focused on improving different aspects of intentional social communication through increasing

social engagement with others, improving play skills, and communication using expressive language through verbalization and/or sign.

Treatment with the robot. A humanoid robot, referred to as Troy, was created through the collaboration of the Mechanical Engineering and Computer Science departments at Brigham Young University. Troy measured 63.5 cm in height and weighed approximately 6.8 kg and consisted only of an upper body. These measurements roughly equate to the size of an average 4-year-old child. The body of the robot consisted of a trunk, base, two arms, neck, and a head. Each of his arms was mobile and had four degrees of freedom enabling shoulder rotation, extension and flexion and elbow flexion and extension. Troy's head was comprised of a 17.78 cm computer screen capable of displaying three emotional facial expressions including happy, sad, and neutral. Troy was capable of interacting appropriately with the children throughout the sessions through actions, as well as verbalizations. These included basic greetings, songs, rhymes, and both positive and negative affect expressions (e.g., *yay* or *uh oh*). The verbalizations were recorded by a BYU Music-Dance-Theatre major and thus mimicked typical the human vocal patterns. Actions were limited to Troy's arm movement, but allowed Troy to demonstrate actions to songs, wave to participants, and interact in turn taking exchanges, such as pushing a ball back and forth. Troy was controlled during each session by the graduate clinician by a Wii™ remote with functions that were pre-programmed to allow for quick access to the desired specific actions according to the reactions of the participant during the interaction.

Treatment with the humanoid robot took place in 10- to 15-minute segments. Each child participated in 14, 15, 16, or 17 sessions involving the robot. These low-dose treatment sessions occurred at various times throughout each individual treatment session, ranging from occurring at the beginning of therapy to concluding with the therapy involving the robot. Brinton et al.

(2013) described the purpose and goal of robot interaction by stating; "the focus was on using the robot to engage the child in activities with the other human participants. Activities were structured to be highly interactive and infused with affect. It was hoped that the low-dose intervention and the compelling nature of the interaction would facilitate generalization to interactions with human conversational partners when the robot was not involved*"* (p. 1). Activities that were included during treatment with the robot consisted of a triadic interaction including the child's parent, a graduate student clinician, and the child. The robot acted as another interactive partner controlled by the graduate student clinician using a remote control. Additionally, an assistant graduate student clinician was present during a treatment with the robot to offer hand-over-hand support in activities.

Videotaping procedures. All baseline, follow-up and treatment sessions involving the robot were video recorded using two cameras. The first camera, operated by a research assistant in the therapy room, focused specifically on the child throughout all interactions. The second camera was mounted in the clinic room controlled manually outside the room by another research assistant. The mounted camera was capable of pivoting in all directions in order to capture any movement of activity in the room. This camera captured the entire interaction during each session in order to provide greater information about the interaction between the child and his or her interactive partners. The purpose of having two video recordings of each session with different angles was to allow the observation of all participants as well as subtle social communication behaviors displayed by the child.

Data analysis for the present study primarily used the hand-held camera footage. This provided adequate information regarding tantrum behaviors produced by the child while giving a

reasonable picture of the context and environment, providing information on antecedent actions when applicable.

Data Analysis

Using the video recordings, tantrum behaviors that occurred during baseline, treatment, and follow-up sessions were identified. For the purpose of this study, however, only the intervention sessions where the robot was introduced either at the beginning or the session or at the end of the session were considered. This allowed a comparison between approximately 40 minutes of therapy prior to introduction of the robot and 40 minutes following the introduction of the robot.

Tantrum behaviors were divided into five different categories including (a) crying or screaming, (b) self-distracting behaviors (throwing oneself on the floor and bilateral ear-plugging not related to oversensitivity of stimulus), (c) biting oneself or another, (d) pulling hair, squeezing, pushing or pinching, and, (e) throwing or shoving an object. The total time of each session was divided into 10-second bins. Each section was analyzed for the presence of tantrum behaviors. Each time a tantrum behavior was observed, it was marked in the appropriate time segment it occurred. If a tantrum behavior continued for longer than a 10-second bin, a consecutive mark was made in the following bin and so on until the behavior ceased. If more than one type of tantrum behavior occurred in one, 10-second bin, each was recorded during that time segment. For example, if a variety of short tantrum behaviors, such as throwing an object and pulling hair, occurred in the same 10-second segment, each occurrence was marked in the appropriate bin. If all tantrum behavior stopped for 30 or more seconds, subsequent tantrum behavior was considered a new occurrence.

During the course of the study, the children produced a number of behaviors that were not necessarily conducive to the intervention process but were not considered as tantrums. The following behaviors were not identified as tantrum behaviors during data analysis: throwing a toy or other object in the absence of negative affect; crawling or lying on the floor in the absence of a specified tantrum behavior; screaming or yelling in the absence of negative affect (such as when having fun or vocalizing); attempting to leave the therapy room without a specified tantrum behavior listed above; or biting a toy in the absence of another tantrum behavior.

Once the data were collected on all the sessions, the time spent displaying tantrum behaviors as well as the frequency of tantrum behaviors for each therapy session involving the robot were noted. Detailed guidelines for coding the data and analyzing the results are given in the Tantrum Coding Manual found in Appendix A.

Reliability

In order to establish inter-judge agreement on the identification of tantrum behaviors, three students were trained to identify tantrum behaviors using a coding manual. A coding manual was created that described each type of tantrum behavior. A training period was conducted in which students coded a segment of video from each participant according to the given definitions in the coding manual. Subsequently, each student coded two sessions for each participant independently. The data collected by each student were then compared. From this procedure, 89% inter-rater agreement was established for 10% of the data included in this study.

Results

Tantrum behaviors identified for each of the four participants are discussed individually. As previously indicated, tantrum behaviors that occurred during sessions when the robot was introduced at the beginning of the session and those that occurred when the robot was introduced

in the concluding minutes of the session were compared. All tantrum behaviors occurring at any time within these sessions were identified.

Participant 1: AH

The tantrum behaviors that AH exhibited were in the category of screaming/crying, with occasional self-distracting behaviors, specifically ear-plugging. AH did not display other types of tantrum behaviors during the intervention sessions.

All tantrum behaviors that AH exhibited decreased markedly when the 10-minute robot session occurred at the beginning of the session compared to when the robot session was introduced at the end of the session (Figure 1). The average time of tantrum behaviors was taken of all sessions where the robot intervention fell at the immediate beginning or ended the 50-minute session. This included five sessions when the robot interaction was at the beginning and three sessions when the robot interaction fell at the end. AH spent an average time of 4 min 6 s displaying tantrum behavior during the total session when the robot segment occurred at the beginning. In contrast, she spent 12 min 28 s of tantrum behaviors when the robot segment did not occur until the end. These results indicate a decrease of tantrum behaviors when the robot intervention began the 50-minute therapy session.

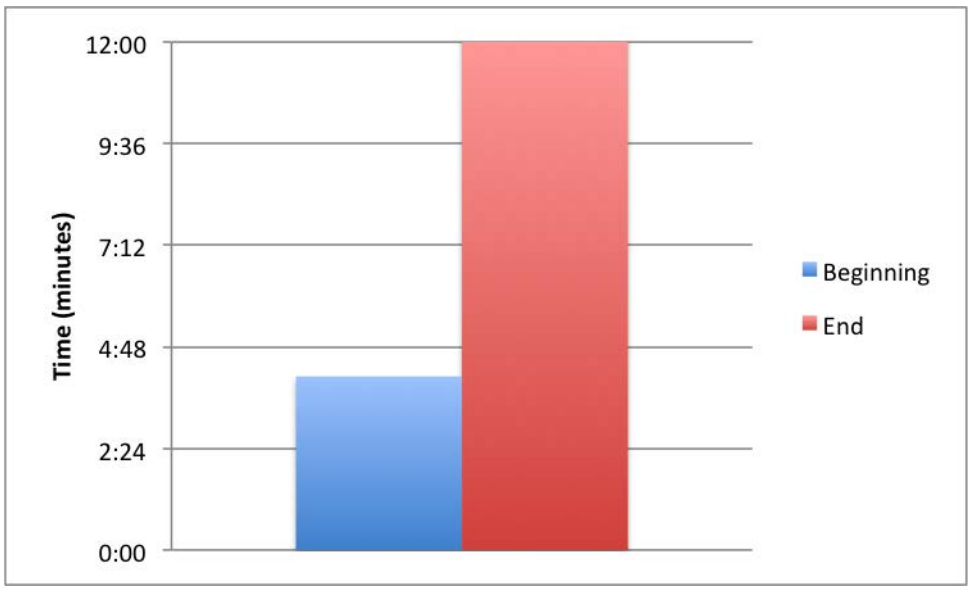

Figure 1. Average time spent displaying tantrum behaviors (AH).

Participant 2: KR

KR presented a wide range of tantrum behaviors. Depending on outside stimuli and circumstances, the type of challenging behavior ranged from crying/screaming, biting, throwing objects, hitting and throwing herself on the floor. There was no evident pattern that predicted when each of these types of tantrum behavior occurred, however typically the more frustrated KR seemed, the more types of tantrum behaviors she displayed simultaneously.

Analysis of the data collected for KR showed a marked decrease in time spent displaying tantrum behaviors when the robot was introduced at the beginning of an individual session. When the robot was not introduced until the end of the session, KR demonstrated more time displaying tantrum behaviors when the average of time of all sessions was calculated (Figure 2). Data included all of the available sessions where the robot intervention began or ended a 50-minute session. This included two sessions where the robot was at the beginning and two sessions where the robot interaction was at the end. KR spent an average of 15 s displaying

tantrum behaviors when the robot was introduced at the beginning and 1 min 50 s of tantrum behaviors were recorded when the robot fell at the end.

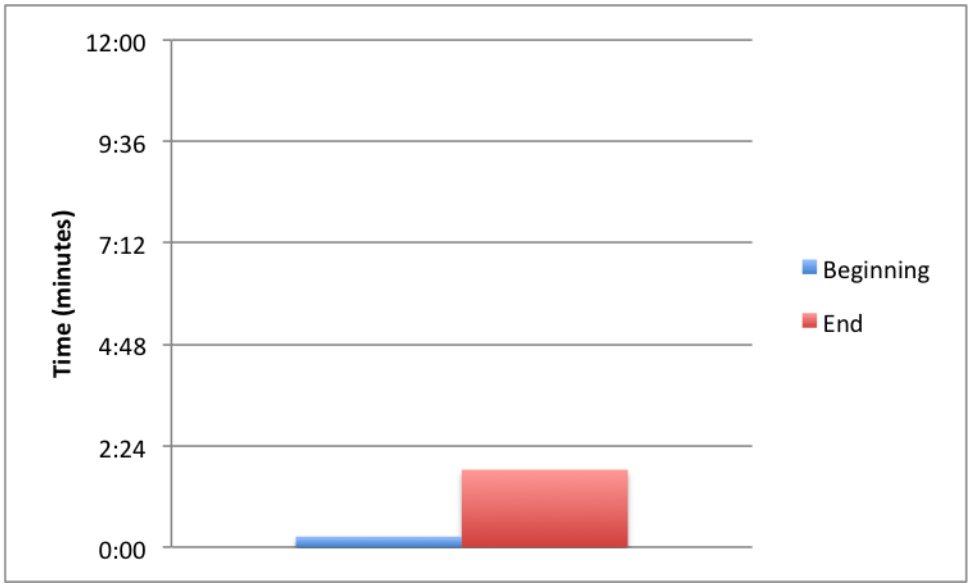

Figure 2. Average time displaying tantrum behaviors (KR).

Participant 3: LR

LR was unique in how he demonstrated tantrum behaviors, as the majority presented were self-distracting behaviors, specifically bilateral-ear plugging when a loud noise was not present. LR also had occasional episodes of crying/yelling, however these were minor compared to the ear-plugging behavior. Ear-plugging most frequently occurred during activities in which LR seemed to have little interest or no longer wished to participate in. LR did not display other types of tantrum behavior throughout the study.

The average time LR spent in tantrum behaviors in sessions when the 10-minute robot segment started the session and when it concluded the 50-minute session are shown in Figure 3. This analysis included all available sessions where the robot began or concluded a session. Therefore, the analyzed sessions included three sessions with the robot at the beginning and two sessions with the robot at the end. Tantrum behaviors nearly doubled when the robot was not

introduced until the last 10-minutes of the 50-minute session. 2 min 10 s were spent displaying the behaviors when the robot interaction occurred at the end, while only 1 min 7 s were taken by these behaviors when the robot interaction started the session.

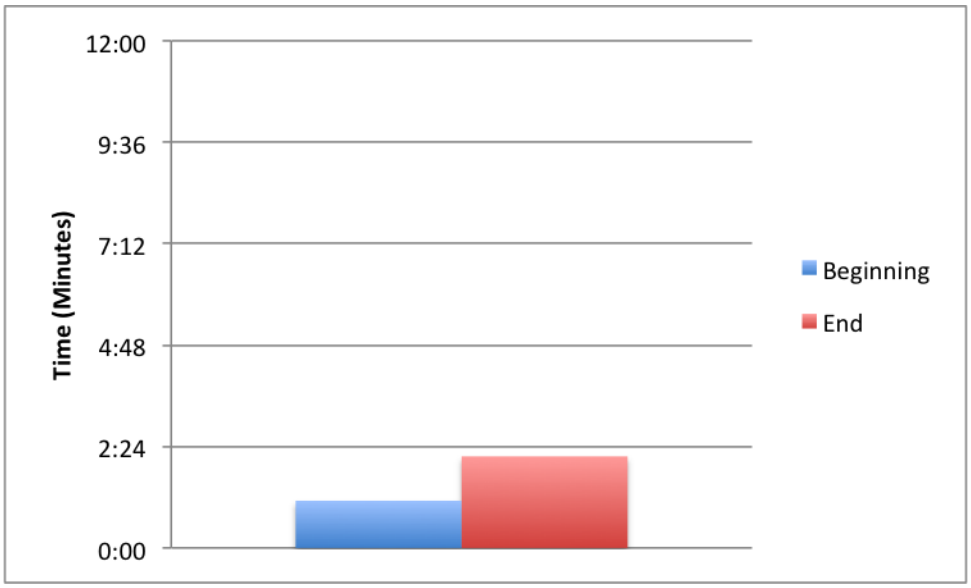

Figure 3. Average time displaying tantrum behaviors (LR).

Participant 4: LS

LS most frequently demonstrated tantrum behaviors in the form of hair pulling, yelling, and squeezing the clinician's or his mother's arm. On one occasion, LS also displayed biting behavior within a tantrum but apart from this individual occurrence, no other type of tantrum behaviors were observed. Occasionally, these behaviors seemed to be the result of not getting what he wanted, however the majority of the time the behaviors seemed to be the result of overstimulation or general dysregulation, or internal factors. This was unique to LS compared to the other participants in this study as the majority of observable tantrums of the other three participants seemed to be elicited by external factors.

Analysis of the data indicating the average time of tantrum behaviors when the robot session occurred at the beginning of the session and when it occurred at the end of the session are presented in Figure 4. Similar to the other participants, LS spent an average of less time in tantrum behaviors when the robot segment occurred at the beginning. However, the difference was minimal, partly because the overall time spent in tantrum behaviors was brief. When LS did display tantrum behavior, however, the behaviors tended to be intense, disruptive, and sometimes injurious. Total sessions analyzed for this data included two sessions where the robot intervention was at the beginning and four sessions where the robot intervention concluded the session. LS displayed an average total of 45 s in tantrum behaviors when the robot was at the end of the session, and 40 s of tantrum behaviors when the robot interaction fell at the beginning. (Figure 4).

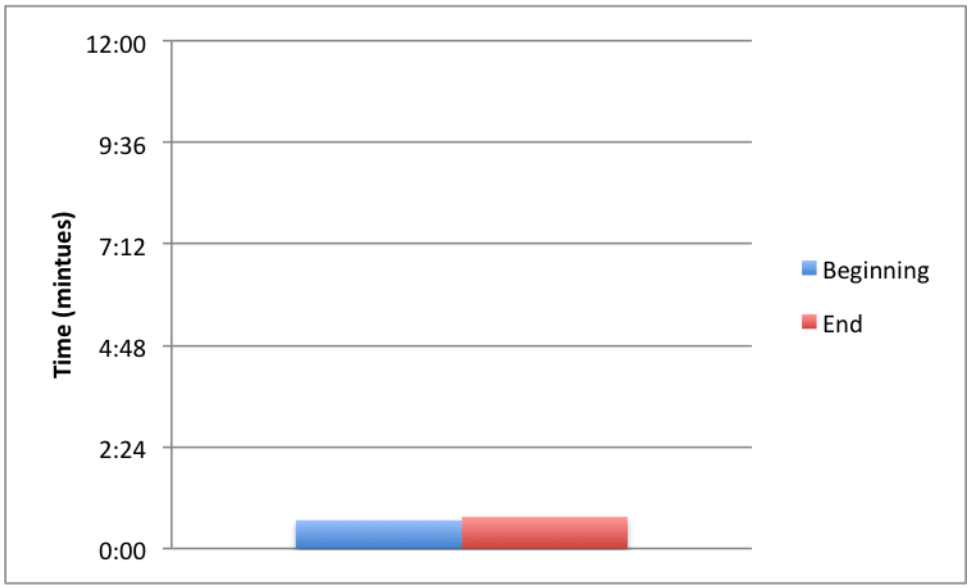

Figure 4. Average time displaying tantrum behaviors (LS).

Discussion

This study focused on analysis of the average time spent in tantrum behaviors during a full 50-minute session when the robot segment began the session versus when the robot segment

came at the end of the 50 minutes. All four participants displayed some tantrum behavior, although the behaviors varied in terms of time and intensity. Even though the four participants in the study varied in terms of general levels of functioning and tantrum behaviors, all four participants showed less overall time displaying tantrum behaviors when the robot interaction came at the beginning of the 50-minute session. Individual participants are discussed below.

Participant 1: AH

AH was the youngest and lowest functioning of the four participants. Throughout the intervention, it was difficult to engage AH in therapy tasks. She seemed to have difficulty attending to input, and she tired of activities and materials quickly. She often became dysregulated and produced tantrum behaviors that disrupted intervention. Once AH began to show tantrum behaviors in a session, it was difficult to get her back to a regulated state so that treatment could continue. However, when the robot was introduced, the interaction generally seemed to calm AH for what remained of the session. This was the case even though AH did not often engage in interactive exchanges with the robot. Rather, she spent most of the 10-minutes observing the interaction between the robot, the clinician, and her parent. She needed hand-over-hand support to engage in these collaborative group activities. It might be speculated that AH required more time to learn to participate more actively in the reciprocal activities with the robot. Still, the robot interaction seemed to be an effective tool for limiting her tantrum behaviors both when the robot was present and after it was removed from the session. Introducing the robot at the beginning of the session resulted in an increase in the time available for learning.

Participant 2: KR

KR showed a variety of tantrum behaviors. Many of these challenging behaviors followed the clinician's attempt to direct or channel her behavior in some way. KR seemed to

enjoy interacting with her conversational partners, but on her own terms. KR's tantrum behaviors were particularly disruptive to her intervention as they were frequent and often aggressive. Therefore, it was particularly positive that interacting with the robot was associated with a decrease of tantrum behaviors for the remainder of the session. In some ways, however, KR presented the most challenges in employing the robot in treatment sessions. She sometimes hit the robot or pushed its head backwards repeatedly. This required the clinician to intercede to prevent damage. Overall however, after the robot interaction, there was a marked decrease of the disruptive tantrum behaviors.

Participant 3: LR

Unlike the other participants, LR did not display a variety of tantrum behaviors. On rare occasions he yelled and/or cried, but his mother attributed these behaviors to this exhaustion. Typically, LR exhibited self-distracting behaviors and more specifically, covering both ears even in the absence of loud noise. Although in other contexts this may not be considered a tantrum, LR seemed to produce this behavior most frequently when he did not comply with an activity or direction given by a parent or clinician. As such, it was distracting to the learning environment and considered a category for a tantrum behavior in this study. However, despite the different nature of his tantrum behavior, the robot interaction seemed to have a positive impact on this behavior, as tantrum behaviors showed a decrease in overall production when the interaction was at the beginning of the session, rather than the end. Although the actual amount of time spent showing these tantrum behaviors varied from session-to-session, the overall average showed a marked improvement when the robot segment came first. Once again, introducing the robot at the beginning of the session resulted in an increased availability to learn.

Participant 4: LS

LS, was the oldest and the highest functioning participant with the most language ability. Of the four participants, LS responded most positively to the intervention in terms of improving social behaviors and joint attention (Dodge, 2012). His tantrum behaviors, however, were highly variable. There were many sessions where little or no time was spent displaying tantrum behaviors. On the days where tantrum behaviors were present, therapy was highly disrupted. Even if few tantrum behaviors were recorded, those that did occur resulted in LS becoming less focused and showing decreased interest in therapy activities. This contributed to decreased learning time. Because of such a high variability from session-to-session in LS's behaviors, the influence of the timing of the robot segment was less clear when compared to the other three participants. Just like other techniques that were used to try to calm or reduce tantrum behaviors, such as changing activities, giving opportunities for choice, or giving multiple breaks, the robot interaction did not seem to make a significant difference in the amount of time tantrum behaviors occurred regardless of placement in the session.

Overall, results of this study show a decrease in tantrum behaviors for all four participants when a 10-minute, low-dose intervention with a humanoid robot came at the beginning of a 50-minute session. For three out of the four participants, the reduction of problem behaviors was clinically significant, resulting in more time when the children were available to learn. Although the types and intensity of tantrum behaviors varied for all participants, the robot still seemed to decrease the tantrum behaviors of these three children for the remainder of the session. Although tantrum behaviors decreased for the fourth participant as well, the decrease seemed less influential clinically. This child, however, responded most readily in terms of social engagement in the robot intervention as shown in previous studies (Dodge, 2012; Nelson, 2013;

Ririe, 2013; Roueche, 2103). It should be noted that other methods were used to attempt to calm the participants when tantrum behaviors occurred. During traditional treatment times, when a tantrum behavior occurred, a graduate clinician would attempt to calm the child. For example, the clinician attempted to change the activity, redirect the child's attention, remove the antecedent to the tantrum, or cease treatment for a time until the child could calm himself or herself. Occasionally, this involved the child leaving the treatment room and going for a walk or getting a drink. Although often the child would eventually calm by these methods, valuable treatment time was lost. When the child was calmed by means of robot intervention, not only did the tantrum behaviors decrease, but treatment was able to continue, having the desired result of increased learning time.

Study Limitations and Recommendations for Future Research

Although the data from this study show promising results for the use of an interactive humanoid robot for the decrease in specific tantrum behaviors in children with ASD, there were some limitations that should be considered in the interpretation of the findings.

Although the introduction of the robot was associated with decreased tantrum behavior, it is not possible to determine what features of the robot or individual aspects of the interaction were most influential in decreasing tantrum behaviors. A variety of toys were used in the traditional intervention segments including electronic musical toys and mechanical toys. Other traditional toys such as balls, play dough, and bean bags were also introduced. However, no other technical devices or toys were specifically investigated as tools of self-regulation. In future studies, alternate toys or activities could be studied to determine their effects compared to the use of a humanoid robot.

Finally, this study only took into account the increase and/or decrease in time spent in tantrum behaviors before or after the interaction with a robot. It would be informative for future research to consider specific tantrum behaviors and the precipitating events or contexts that seemed to trigger those behaviors. It might be the case that interaction with the robot provided children with an interesting distraction that calmed them. It is also possible that introducing the robot would be more effective for helping children regulate some behaviors as compared to others. More in-depth research is warranted to investigate the influence of the introduction of a robot on specific disruptive behaviors within intervention sessions.

Conclusion

The use of interactive robots in therapy for children with ASD has drawn attention as a potential tool to improve communication and social skills. However, such robots also seem to have a positive impact on behavioral concerns as well. All participants in this study were diagnosed with low-functioning ASD, functioned at very different levels, were at different ages, and produced a variety of different tantrum behaviors. Despite this large range of individual differences, a 10-minute interaction with the robot was associated with a decrease in a wide variety of tantrum behaviors, thus increasing learning time in a 50-minute therapy session. Thus, further research is warranted to investigate the effectiveness of introducing interactive activities using a robot to decrease challenging behaviors and increase learning time for children with ASD.

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Appendix A

Tantrum Coding Manual

Types of Tantrum Behaviors:

Behavior	Coding Symbol
Crying/Screaming	C
Self-Distracting Behaviors (Throw Self on Floor, plugging ears)	F
Biting (self or other)	B
Pulling Hair/Squeeze/Pinch/pushing	PH
Throwing/Shoving Object	TO
Hitting /kicking	H

Rules:

- Time segments split up into 10 second bins, mark each behavior that occurs within that segment in that bin
    - If behavior occurs on a bin line, mark in previous bin
- New tantrum if child stops all tantrum behavior for 30 seconds (3 consecutive 10 second bins)
- More than one tantrum behavior can be marked within a 10 second bin
- If a violent (non-verbal) behavior (biting, hitting, throwing, pulling hair, throwing self on floor) occurs more than once in a tantrum, note each time it happens
- If displaying tantrum behavior(s) BUT still cooperating with the adult requests, it is still coded as a tantrum
- Category: Self-Distracting Behaviors
    - Plugging ears – Child plugs/covers both ears in reaction to not wanting to continue an activity or not wanting to listen to something that is said by an adult
        - Attempt to distract self or ignore so do not have to listen or do the activity
        - Must be with both hands
        - Not coded as tantrum behavior in ears are plugged due to loud noise
        - Must cover ears for more than 2 seconds after noise to be considered tantrum
        - Ex. LR Robot 13 (1:15:09) – plugging ears behavior
- Crying must last 1 second to be considered a Tantrum
- When in doubt, DON'T code it

NOT a Tantrum:

- Just throwing an toy/object without negative affect is not considered a tantrum (Ex. AH B3, 38:36)
- Just crawling/lying on the floor is NOT a tantrum
- Listed Coding behaviors have to be in anger, frustration, sadness – screaming or yelling because having fun or vocalizing is NOT a tantrum
- Trying to leave WITHOUT crying/screaming or other tantrum behavior is NOT a tantrum (AH F1, 1:23:11)
- Biting toys/beanbag without other tantrum behaviors NOT a tantrum (AH F2, 1:27:27)

Appendix B

Raw Data

Participant 1: AH

Robot at beginning of session

Session Date	Session Number	Tantrum behaviors (minutes)
April 11, 2011	1	3:40
April 27, 2011	2	8:20
May 4, 2011	3	1:20
May 25, 2011	4	2:20
June 3, 2011	5	4:50
Average Time:		4:06

Robot at end of session

Session Date	Session Number	Tantrum behaviors (minutes)
April 18, 2011	1	16:20
May 9, 2011	2	9:20
June 1, 2011	3	11:40
Average Time:		12:28

Participant 2: KR

Robot at beginning of session

Session Date	Session Number	Tantrum behaviors (minutes)
May 26, 2011	1	0:10
June 3, 2011	2	0:20
Average Time:		0:15

Robot at end of session

Session Date	Session Number	Tantrum behaviors (minutes)
May 23, 2011	1	1:00
June 6, 2011	2	2:40
Average Time:		1:50

Participant 3: LR

Robot at beginning of session

Session Date	Session Number	Tantrum behaviors (minutes)
April 17, 2011	1	1:30
May 9, 2011	2	0:30
May 23, 2011	3	1:20
Average Time:		1:07

Robot at end of session

Session Date	Session Number	Tantrum behaviors (minutes)
May 25, 2011	1	2:30
June 1, 2011	2	1:50
Average Time:		2:10

Participant 4: LS

Robot at beginning of session

Session Date	Session Number	Tantrum behaviors (minutes)
April 29, 2011	1	1:20
May 13, 2011	2	0:00
May 27, 2011	3	0:30
Average Time:		0:40

Robot at end of session

Session Date	Session Number	Tantrum behaviors (minutes)
May 6, 2011	1	0:00
May 17, 2011	2	0:10
May 20, 2011	3	2:40
May 31, 2011	4	0:10
Average Time:		0:45

Appendix C

Annotated Bibliography

American Psychiatric Association. (2013). DSM-5 Autism spectrum disorder fact sheet [Fact sheet]. Retrieved from http://www.dsm5.org/Documents/Autism%20Spectrum%20Disorder%20Fact%20Sheet.pdf

Purpose of work: To describe the changes involved in the DSM-V as they relate to Autism Spectrum Disorder.
Summary: The changes made from the DSM-IV to the DSM-V are most significant as they relate to ASD. While under the DSM-IV several distinct disorders were separated although all closely related to ASD, the DSM-V collapses these labels to all fit under the disorder of ASD. This change was made for the purpose of simplifying the diagnosis of ASD in individuals without limiting the sensitivity of the criteria or changing the number of children being diagnosed.
Conclusions: The changes that occurred in the DSM-V allow for those who did not previous fit under a specific diagnosis to fit on the general spectrum of ASD and get access to the necessary treatment.
Relevance to the current work: The most current definition of ASD as given by the DSM-V is important to understand when working with children diagnosed with ASD.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.

Purpose of work: Manual describing the changes made with regards to definitions, diagnostics and statistics involving several physical and neurological disorders.
Summary: This manual describes the official definitions, codes and diagnostic standards of several disorders. This includes any changes made since the DSM-IV for any of the disorders. Emerging measures and models are also included to aid in clinical decision-making process for all the disorders mentioned.
Conclusions: The Diagnostic and statistical manual of mental disorders covers physical, psychological and neurological disorders by specifying the necessary traits needing to be apparent in an individual in order to be diagnosed along with emerging measures and models related to these disorders.
Relevance to the current work: The DSM-V has specific and important changes to the definition of ASD.

Blanchard, K. (2013). *The effects of utilizing a robot on the social engagement behaviors of children with Autism in a triadic interaction* (Unpublished master's thesis). Brigham Young University, Provo, UT.

Purpose of the study: This study sought to determine the effect of a humanoid robot on the social engagement abilities of children with low-functioning ASD.
Method:
Participants: Four children between the ages of 4- and 9- years of age with low-functioning ASD.

Procedures: The participants were assigned a number of baseline therapy sessions followed by treatment with and without the robot. The sessions with the robot consisted of 40 minutes of tradition treatment based on the SCERTS model, and 10 minutes of treatment involving interaction with the robot. Part of the baseline and follow-up sessions included a triadic component involving the child, the clinician and one unfamiliar adult. This study focused on the social engagement of each child during the triadic interaction.
Results: Three out of the four participants showed improvement in reciprocal action in a triadic setting after intervention with the robot was completed.
Conclusions: After the study was conducted, the robot sessions and interaction have a positive effect on the participant's social engagement abilities in that it has the potential to facilitate reciprocal action between children with autism and adults.
Relevance to the current work: This work emphasizes the use of a robot in therapy and it's effects on the child's communicative behavior.

Braithwaite, K., & Richdale, A. (2000). Functional communication training to replace challenging behaviors across two behavioral outcomes. *Behavioral Interventions, 15,* 21–36.

Purpose of the study: The purpose of the study was to determine the effectiveness of an intervention that involved elimination of problem behaviors by replacement of functional communication behaviors in a child diagnosed with ASD in a school setting.
Method:
Participants: Participants included a 7-year old boy diagnosed with ASD and intellectual disability.
Procedures: All observation and treatment took place in a school setting. Target behaviors of aggression were selected and set as goals to be changed or replaced by other behaviors. After observations and interviews, analysis suggested that the target behaviors were a result of a desire to escape difficult tasks. Treatment then consisted of teaching an alternative reaction of verbal requests while simultaneously injurious behavior was placed on extinction.
Results: With the acquisition of alternate request methods, self-injurious and aggressive behaviors became non-existent which was maintained when a 5 second delay was implemented.
Conclusions: The author concludes that problem behaviors can be replaced by with functional communication in the case of this study.
Relevance to the current work: This study addresses eliminating or decreasing problem behaviors in children with ASD.

Brinton, B., Fujiki, M., Robinson, L., Colton, M., Goodrich, M., Blanchard, K.,…Stabenow, A. (2013, November). *Using a humanoid robot to facilitate social interaction in children with ASD*. Poster presented at the annual conference of the American Speech-Language Hearing Association, Chicago, IL.

Purpose: The purpose of the current study was to determine if intervention including a robot could increase social interaction in four children with Autism Spectrum Disorders (ASD).
Method:

Participants: Four children between ages 4- and 9-years of age diagnosed with ASD and presented with persistent deficits in social interaction and communication, poor behavioral regulation, and marked repetitive and stereotyped behaviors.
Procedure: Measures of participation in interaction were obtained in several contexts including baseline sessions, a series of 50-minute treatment sessions, 10 minutes of which involved the humanoid robot and three follow-up sessions. The children's social-interactional behaviors were measured by considering their responses to adult bids for participation in collaborative activities. Children's responses were analyzed in terms of establishing eye contact, participating in reciprocal action, language, and initiating further interaction.
Results: Three of the four children demonstrated increases from pre treatment to post treatment sessions in reciprocal action in collaborative activities. Language production and initiation of interaction were not changed from pre to post sessions. The children's performance in all sessions was highly variable.
Conclusion: The results were notable considering that the children improved in the same kinds of collaborative turn-taking behaviors that the robot was attempting to elicit. However, eye contact was not improved in the children and may be tied to the fact that the robot's face (a flat screen) could not model.
Relevance to the current work: This work focuses on the effect a humanoid robot may have in therapy for children with ASD.

Cabibihan, J., Javed, H., Ang, M., & Aljunied, S. (2013). Why robots? A survey on the roles and benefits of social robots in therapy of children with Autism. *International Journal of Social Robotics, 5, 593-618.* doi:10.1007/s12369-013-0202-2

Purpose of work: The purpose of this study is to review different types of robotic therapy that were used in intervention with children with autism. It gave an overview of the results of how robots were used in different studies, how effective the results were and how robots can be used in intervention for children with autism.
Summary: A description was provided of robots used in different studies in therapy throughout the world. Different characteristics, such as appearance, functionality, safety features and autonomy of these robots were analyzed according to what features seemed to be most necessary and important in regard to effectiveness in therapy. The purpose of each robot, or what behaviors the robot was attempting to elicit, were also taken into account with regard to effectiveness in therapy.

Robots have begun to be used in therapy in working with children with autism because of their interactive ability and increased simplicity when compared to human communication partners. Robots have been used in a variety of roles including as a diagnostic agent, a playmate, a behavior eliciting agent, a social mediator or actor, and as a personal therapist. The different roles of robots used in different studies were analyzed and compared in this study.
Conclusions: The ultimate purpose of this study was to answer the question of why robots may be useful in therapy when working with children with ASD. Ultimately, the effectiveness of interactive robots as communicative partners as opposed to just human partners results from three main differences; 1) robots are less complex, 2) robots make embodied interactions possible, 3) robots are less intimidating than humans. However, this study emphasized that the use of interactive robots cannot be isolated if generalization of behavior is to take place. Future research is necessary to determine the effectiveness of behavior generalization.

Relevance to the current work: This work relates directly to the use of robots in autism therapy in regards to improving social and communication behavior in children with ASD.

Dautenhahn, K., & Werry, I. (2004). Towards interactive robots in autism therapy. *Pragmatics & Cognition, 12:1,* 1-35.

Purpose of work: The purpose of this work was to explore the potential use of interactive robots in therapy for children with autism spectrum disorder (ASD). Specifically, the study known as the Aurora project was used to outline the effectiveness of the use of robots in intervention therapy for children with ASD to improve social skills and interaction. The Aurora project focused on child-directed play therapy with minimal structure, guided by the child and supervised by an adult. Interactions used to analyze the effectiveness of the study included those important to human social behavior such as eye contact, joint attention, avoidance, and imitation games. Children who participated in the Aurora project were diagnosed with ASD, were non-verbal and were between 8-12 years of age.

Summary: In the Aurora Project, the study began with the rationale that non-humanoid robot use in therapy would act as a bridge between predictability of inanimate toy objects used in therapy and unpredictability of human social interaction. It was hypothesized that the robot could engage the child in interactions that demonstrate important aspects of human interaction. Then, as the unpredictability of the actions of the robot are increased, the child could be guided to interact with a more complex form of interaction that would become increasingly more human-like. No control group was used in the Aurora project, as the focus was not on the nature of ASD but rather the possible educational and therapeutic potential for robot use in therapy.

In order to explore the effectiveness of robot therapy for intervention for children with ASD, some selected concepts about ASD found in recent research were used to act as a rationale. One of these concepts included limited ability in Mindreading (the interpretation of the purpose of movements and actions in humans whether goal-directed, intentional, social or "mentalistic") compared to typical developing children. This concept also included aspects such as executive functioning and theory of mind. Due to this observed decrease in behavior, it was proposed that robots could potentially "be a useful tool for diagnostic purposes, as well for theory-of-mind research in autism" (12).

A second theory used to provide a rationale for robot use in therapy was interaction and imitation games. Imitation, as a key skill for improving social interaction, was found to be most effective in children with ASD and was most efficient in improving the frequency and duration of object manipulation. This was especially true in children with non-verbal ASD. Imitation is a concept that could easily be incorporated into robot therapy. However, generalization to human-human interaction was unclear.

Virtual versus reality type environments for learning were also explored for effectiveness in use for therapy for children with ASD. Virtual environments were those that are computerized and controlled by a certain order of actions. They were more structured than those of reality environments and could be implemented in any type of environment, whether that is school or at home. Virtual environments may also hold more interest to children with ASD that a typical environment, however, it was unclear how such experiences would generalize to the real world.

Conclusions: The Aurora project was instituted to provide a basis of understanding of the effectiveness of robot use in therapy for children with ASD. This article addressed the background, motivation and challenges involved in developing an interactive, robotic system as a

educational and therapeutic device. The goal of the Aurora project as well as this article was to explain the rationale of using a robot in therapy to not only interest children with ASD in therapy and ultimately improve quality of life, but also help the children develop social skills that can be generalized to human-human interaction. The effectiveness of the later of these goals will only be determined with further, long-term studies. It was found that it is unlikely that one generic robot design will be effective generally due to the dynamic nature of ASD. The question of environment type was also addressed and it was determined that "…(different types of) robotic therapeutic tools might serve for (different sets of) requirements addressing primarily bodily, physical interaction, while (different types of) virtual environments might serve for (different sets of) requirements addressing primarily imaginative and cognitive skills" (26-27).
Relevance to the current work: This work addresses the rationale for the use of robot interaction in intervention for children with ASD.

Diehl J., Schmitt, L., Villano, M., & Crowell, C. (2012). The clinical use of robots for individuals with Autism Spectrum Disorders: A critical review. *Research in Autism Spectrum Disorders, 6*, 249–262. doi:10.1016/j.rasd.2011.05.006

Purpose of the study: The purpose of this article was to review the clinical uses of a robot in intervention for children with Autism Spectrum Disorder (ASD). Previous to this study, much attention in various studies was given to what type of robot was most effective for intervention purposes (humanoid vs non-humanoid) but little research was conducted regarding how a robot would be best integrated into therapy. This article reviewed literature on the different application and uses of a robot in intervention for children with ASD and outlined where promising research was conducted, where further research was necessary and where limitations may apply. The goals of this study consisted of understanding the current status of empirically based evidence for this experimental therapeutic technique, identify gaps in literature and provide a foundation for future research in this area (251).
Method:
Participants: Participants ranged from at least one individual with ASD to 32 individuals depending on the study that was reviewed. Each study was individual and independent of the others included in this review.
Procedures: A literature search was conducted using several journal research sites. The articles found were chosen on the requirements that each article found had to be peer reviewed and involve data that were collected on at least one individual with ASD. In addition, data from the study had to be a direct result of therapeutic intervention, have implications for group identification or diagnosis, or be a study that compared type, speed and/or frequency of interactive responses a robot in comparison to a human or non-robotic object (251). A total of 15 articles were found that matched these criteria and were then divided up into four subcategories depending on the role of the robot in intervention. These categories were studies that tested preference for robot-like characteristics; studies that used a robot to elicit behavior; studies that used a robot to model, teach or practice a skill; and studies that used a robot to provide feedback or encouragement (251-254). The studies were then analyzed within the above framework.
Results: Summaries of results were divided by subcategories.

1. Response to robots or robot-like characteristics

"Seven studies suggest that some but not all individuals with ASD prefer interactive robots compared to passive toys, initially prefer robot-like

characteristics over human-like characteristics in social interactions and respond faster when cued by robotic movement versus human movement" (p. 255). Important factors to consider with these studies included small sample size and inconsistency of results, limiting interpretability and varied information given about participants of the groups (diagnosis, verbal/cognitive abilities) which limited ability to investigate patterns of ability that may account for individual differences. Further studies including larger groups as well as a comparison groups will be needed to determine results about wide variability. These results may reflect the heterogeneity of ASD and thus greater attention needs to be given predictors that may account for an individual's pattern of response to human versus robotic interactions.

2. Robots used to elicit behavior

Preliminary results of seven studies indicated that robot-child interaction has some potential to elicit behaviors in individuals of different ages and abilities. Most of the research on this subject was theoretical, and literature published on data of actual robot effectiveness was limited. Studies ranged from focusing on eliciting stereotypical behaviors to prosocial behaviors in children with ASD. All studies that were analyzed were limited by small sample size and results varied significantly. This is a promising area of research but there is a great need for studies that examine incremental benefit of using a robot to elicit behaviors using larger sample groups. Understanding of individual predictors of which individuals with ASD are more likely to positively respond to a robot would also be clinically useful.

3. Robots used to model, teach or practice a skill

Only one study was found and analyzed that contained robot intervention focused on modeling, teaching or practicing skills. In this study "Duquette et al. observed greater interest in individuals with ASD toward a robot therapeutic partner than human, but in most cases participants showed better verbal and non-verbal imitation performance in response to a human partner" (258). This imitation was in response to an explicit imitation request. Studies in this area would benefit from integrating robots into established interventions, such as Applied Behavior Analysis (ABA) to examine wider possible benefits of this therapy.

4. Robots provide feedback and encouragement

Only one study was found where the robot played the role of providing feedback and encouragement. Thus there was very limited information with regard to the results of the robot in this role in therapy. In one study there was evidence of a robot reading a child's affect and responding accordingly, but the robot reacted to antecedent actions rather than feedback. Thus, information was too limited to provide results regarding effectiveness of the use of a robot in intervention in this manner.

Conclusions: Further studies and research need to be conducted in order to obtain more accurate information regarding the effectiveness of using a robot in intervention for individuals with ASD. Future studies need to focus on not only what type of robot may be effective, but also what role the robot can play that will be most successful in therapeutic services. They will also need to examine the importance of the robot being an active and interactive participant in

therapy, rather than simply reactive (260). There are potential advantages in using interactive robots in clinical settings with individuals with ASD. These advantages include intrinsic interest of technology to individuals with ASD, robot's ability to produce simplified and isolated social behaviors repetitive, and the fact that robots can be programmed to each child's individual needs in treatment (261).
Relevance to the current work: This analytical study outlined the different roles that a robot in intervention might play. Of particular interest for this study was the use of robots to elicit behavior. Tantrums are the opposite of a pro-social action. If robots in intervention for children with ASD can help model positive social behavior, this might suggest that intervention including a robot might reduce tantrums in children with ASD.

Dodge, S. (2012). *The effect of intervention using a robot on the social engagement behaviors of four children with Autism in interaction with an unfamiliar adult* (Unpublished master's thesis). Brigham Young University, Provo, UT.

Purpose of the study: The purpose of this study is to determine the effect of low-dose intervention with a robot on the social engagement skills of children with ASD during an interaction with an unfamiliar adult.
Method:
Participants: Four children diagnosed with ASD.
Procedures: A single subject, multiple-baseline design was used involving four types of intervention provided consecutively. These included baseline, traditional treatment, treatment with the robot, and follow-up sessions. During the treatment with a robot, 40-minutes were spent in play-based intervention methods, and 10-minutes were spent interacting with a humanoid robot. Pre- and post-intervention sessions (baseline and follow-up) were compared to determine any change in social engagement behaviors.
Results: Results indicated that any social engagement behaviors displayed by the participants remained constant or decreased. Reciprocal and collaborative actions, however, did increase.
Conclusions: The most promising results gained from this study were an improvement in engagement during reciprocal and turn-taking activities. Further studies should be made on this subject when a longer period of intervention can be provided.
Relevance to the current work: This study focuses on the results and impact of the use of a robot on children with ASD during therapy.

Giesbrecht, G., Miller, M., & Muller, U. (2010). The anger–distress model of temper tantrums: associations with emotional reactivity and emotional competence. *Infant and Child Development, 19,* 478-497. doi:10.1002/icd.677

Purpose of the study: The purpose of this study was to assess the validity of the anger-distress model of tantrums and to examine the associations between temper tantrums, emotional reactivity and emotional competence in preschool-aged children.
Method:
Participants: Participants included 133 parents and their preschool-aged children.
Procedures: Different scale measures (one administered to the children and one to the parents) were used to test the validity of the Anger-Distress model of Temper Tantrums. These included the Children's Coping Scale and the Children's Behavior Questionnaire. Additionally, non-

standardized testing was used to gain data about the children's understanding of identifying emotion correctly.
Results: Anger and distress are separate but overlapping in tantrum processes. Temper tantrum anger and distress were related to emotional reactivity and competence. Results of this study, overall, support the Anger-Distress Model.
Conclusions: Children's temper tantrums are systematically related to the organization of emotion and behavior in preschool-aged children.
Relevance to the current work: This work discusses temper tantrums that are to be expected in children without a diagnosed disorder and possible contributing factors. This is an important statistic to consider when analyzing tantrum behaviors in non-typical children.

Goodrich, M., Colton, M., Brinton, B., Fujiki, M., Atherton, J., & Robinson, L. (2012, March/April). Incorporating a robot into an Autism therapy team. *IEEE Computer Society,* 52-59.

Purpose of the study: Children with Autism Spectrum Disorder (ASD) present with deficits in social interaction. Specifically these may include "the inability to use non verbal behaviors (such as eye contact and facial expressions) and to regulate social interactions" (52). Additionally about "50 percent of children identified with ASD present with insufficient language for effective communication" (52). Social interaction does not motivate children with ASD and so traditional methods of therapy used for other developmental delays may not be effective for these children. Thus, another mode of intervention must be established.

Past research of intervention involving a humanoid robot have been successful in increasing social behaviors between the robot and children with ASD. The goal of this study was to incorporate this robotic technology in such a way not only to create social interaction between the robot and the child but also to generalize these behaviors to interactions between the child with ASD and human conversational partners. The team conducting this study claimed, "…social engagement with a robot is not a goal but rather a means for helping such children interact socially with other humans" (52-53).
Method:
Participants: Two children identified with ASD, three-year-old Alex and eight-year-old Chris participated in this study. Both children were enrolled in special services through their respective school districts. Both participants also had been followed by Brigham Young University's Comprehensive clinic for intervention targeting joint attention and social-engagement behaviors. They both demonstrated moderate to severe levels of impairment in social communication as well as restricted interests and repetitive behaviors (56).
Procedures: The participants came for 16 treatment sessions over the period of three months. Each session consisted of 40 minutes of treatment without the robot and 10 minutes robot interaction. This amount of robot interaction per session was considered "low dose" and focused on two specific goals, engaging the child and catalyzing social interactions (53). Those involved with therapy included the child, a primary clinician, a secondary clinician, and the child's parent. In both the treatment with and without the robot, all members of the therapy team mentioned participated in reciprocal activities. "The expression of positive or negative affect was intrinsic to each interaction" (57).
Results: Pre- and post-treatment sessions were analyzed using a previously constructed coding system that analyzed target behaviors in five-second intervals. Interjudge reliability for coding was 89 -91 percent across behaviors coded following analysis. Clinical observations of social

communication were also recorded. Behaviors that were analyzed included "initiating social engagement and responding to joint social engagement using language or gesture, eye contact, display of affect, and imitation" (57).

Alex showed significant increases in socially engaged behavior, and Chris's gains were less dramatic. Alex increased from 11 to 120 engagements initiated from pre- to post- treatment analysis while Christ increased from 48 to 65. Also, Alex increased in the number of engagements he responded to from 108 to 488, while Chris increased from 107 responses to 146. **Conclusions**: In addition to the promising quantitative data collected from this study, clinical observations were also of interest. "Both children were highly motivated to interact with the robot, and both were more interactive with clinicians without the robot following treatment" (57). Several significant behaviors that had not been observed before the intervention were noted after the removal of the robot. These included greeting clinicians, symbolic and pretend play, sharing toys and decreased restricted interests and repetitive behaviors. This research study uncovered several more research opportunities and questions, including the need to identify clinical approaches that fit the wide scope and individual nature of autism spectrum disorder. **Relevance to the current work:** This study provided background and rationale for the current thesis project.

Horner, R., Carr, E., Strain, P., Todd, A., & Reed, H. (2002). Problem behavior interventions for young children with Autism: A research synthesis. *Journal of Autism and Developmental Disorders. 32,* 423-446.

Purpose of the study: The purpose of this study was to provide a synthesis of research regarding behavioral interventions for children (8 years or younger) with autism. This research study was commissioned by the National Academy of Sciences to explore conceptual and clinical themes to guide current and future intervention studies as well as future research. "Problem behaviors such as physical aggression, self-injury, property destruction, pica, stereotypy, defiance, tantrums, and disruption are major barriers to effective education and social development" (423). The authors concluded that children with autism are at particular risk for developing problem behaviors. As these behaviors are developed, they can become an established part of the child's behavioral repertoire. "Unless there are changes in the value of, availability of, or access to the consequences maintaining problem behaviors, there should not be an expectation that problem behaviors will decrease" (423-424). Ultimately, early intervention for children with autism should include functional behavior assessment and intervention for problem behaviors.
Method:
Participants: Participants included 24 children (mean CA;57 months). Five were girls and 19 were boys. Each of the participants was diagnosed with autism with varying degrees of intellectual disability ranging from mild to severe. Within the participants, 37 comparisons were evaluated regarding a variety of different types of identified problem behaviors. A "comparison" was defined as "an independent opportunity to compare the level of problem behavior during a baseline for a participant with the level of problem behavior during an intervention phase" (430).
Procedures: A search of a variety of different peer-reviewed articles dating between 1996 and 2000 relating to autism and behavior problems was conducted. Nine articles were then reviewed and kept for analysis by meeting the following criteria: "a) subjects with autism under 97 months old, b) used problem behaviors as a dependent variable, c) employed an experimental design that allowed identification of a causal relationship between reduction in problem behavior and application of an intervention, d) provided data for individual subjects, and e) included at least

three data points for pre-intervention and three data points for post-intervention phases" (430). These articles were then analyzed according to the type of problem behaviors most identified and intervention procedures that were used.

Results: Each article that was included in the study was analyzed according to four different variables including demographics, assessment practices, intervention strategies, and outcome effects. Demographics included analysis of items such as year of publication, number and age of participants, diagnosis of participants involved, and type of problem behaviors identified and analyzed in each study, and number of "comparisons" in each study. Assessment practices "are the procedures used to identify the events that reliably set the occasion for and/or maintain problem behaviors" (430). Four categories were possible for this section including no functional assessment conducted, and indirect functional assessment, direct observation of the problem behavior under natural conditions without manipulation of the environment, and functional analysis (or direct observation of a problem behavior in a controlled environment). Intervention strategies included the type and coding procedures used during each study as well as the intervention context (school, home environment or hospital or clinical setting). Finally, outcome effects included an assessment of the results of the studies based on four different measures. These included percent reduction of problem behavior, duration or maintenance of intervention/maintenance/follow-up phases, the extent to which specific non-problem behaviors were assessed and whether documentation was provided for broader lifestyle changes over time.

In 28 of 37 comparisons, tantrums were the problem area of concern.. Aggression, stereotypy, and self-injury were also problem behaviors studied. Of the nine studies, the most common functional assessment approach was interview of a person who knew the child followed by direct observation. A variety of intervention procedures were used in each of the studies. Most commonly, stimulus-based and instruction-based interventions were used. Interventions were most likely to be conducted in the home or at school and the intervention agent was typically a parent or a teacher.

In the 37 comparisons that were described, an average reduction of problem behaviors was 85%, with a median reduction of 93.2%. In the nine studies assessed, the mean length that maintenance of behavior was assessed as 12 weeks, with the longest assessment being 1-year post intervention. "In all cases, the level of behavior reduction remained with 15% of initial levels documented during the intervention phase" (433). Generalization patterns were not included in this study due to low percentage of participating studies.

Conclusions: Children with autism spectrum disorder (ASD) are at high risk for developing problem behaviors that can inhibit learning and social abilities. Therefore, determining effective early intervention for children with ASD is critical. By reviewing nine peer-reviewed articles regarding children with ASD and interventions involving problem behaviors, a series of common questions were answered and the following conclusions were compiled.

Aggression/destruction, tantrums, self-injury, and stereotypy were the behaviors that are most likely to be targeted in published research. In the nine studies that were analyzed in this study, tantrums were the most targeted behavior. Given this result, however, it cannot be inferred that the same prevalence in problem behaviors in these research results represents prevalence in clinical settings. Stimulus-based and instruction-based intervention procedures are most represented in studies found in the literature. In the nine articles that were reviewed in this study, "60% of the comparisons reported 90% reduction in problem behavior" (434). This study indicated that intervention approaches derived from functional assessment are more effective in reducing problem behaviors. However, more research should be conducted from this area and

from the current studies the author suggests "considerable care should be taken in incorporating functional assessment results into the content of comprehensive behavioral interventions" (434). Intervention techniques that have been identified that are specifically effective for children with ASD include the principle that "interventions should be developed based on a thorough analysis of the biological, antecedent, and consequence events that control them" (435). More specifically, current literature suggests that effective intervention for children with autism should include: controlled environment, a reward system, and a high level of child engagement.

Future research is needed on intervention for problem behaviors in children with autism before more confident conclusions can be drawn. This includes more specific information about intervention in a variety of different contexts, the effectiveness of the use of functional assessments, greater information on generalization and maintenance and finally further research on prevention of problem behaviors.

Relevance to the current work: This study compiles literature focusing on problem behaviors that frequently occur in children with autism under the age of 8. Tantrum behaviors comprised one of the main problem behaviors that were identified. Intervention types and techniques that are effective for children with ASD were also reviewed.

Ingersoll, B. (2010). Teaching social communication: A comparison of naturalistic behavioral and development, social pragmatic approaches for children with Autism Spectrum Disorders. *Journal of Positive Behavior Intervention, 12,* 33-43. doi:10.1177/1098300709334797

Purpose of the study: This article provides a comparison between two treatments to teach social communication in children with ASD. These treatments are naturalistic behavioral and developmental and social pragmatic/relationship-based intervention.

Summary: Although the two types of intervention differ greatly in theory, in practice they share many commonalities that make the actual therapy quite similar. There are a number of areas that have a potential for combining the two approaches in practice.

Conclusions: As greater understanding of both intervention types is increased, an improved understanding of what aspects of each approach are most effective can be gained, leading to new approaches that can improve social communication in children with ASD even more.

Relevance to the current work: This work discusses different intervention approaches that can improve social communication in children with ASD. It recommends combining approaches to create new therapy techniques that lead to great improvements. This can also be applied to approaches that decrease behavioral problems to increase time for learning

LeBlanc, L., & Gillis, J. (2012). Behavioral interventions in Autism. *Pediatric Clinics of North America, 59,* 147-164. doi:10.1016/j.pcl.2011.10.006

Purpose: This article provides a summary of current behavioral interventions available for children and adolescence with ASD who struggle with behavioral problems.

Summary: Although this article is directed to pediatricians, the advice and information is useful to families and clinicians that are interested in finding interventions for behavior problems in children with ASD. Recommendations are given for those seeking for the appropriate treatment including using evidence-based practices rather than treatments without proven gains, using qualified providers for services, maintaining optimistic expectations for the outcomes, and including the patient and their family as a resource for how treatment is going.

Conclusions: This article outlines those treatments available and recommends appropriate use of these interventions to pediatricians.
Relevance to the current work: This article outlines different current approaches for helping children with ASD improve behavioral problems.

Machalicek, W., O'Reilly, M., Beretvas, N., Sigafoos, J., & Lancioni, G. (2007). A review of interventions to reduce challenging behavior in school settings for students with Autism Spectrum Disorders. *Research in Autism Spectrum Disorders, 1,* 229-246. doi:10.1016/j.rasd.2006.10.005

Purpose: This article evaluated the research on the treatment of challenging behaviors of children with ASD in school settings.
Summary: Electronic database searches were used to identify studies published between 1995 and 2005 on treatment of challenging behaviors in children with ASD. Twenty-six studies were identified and separated in to four different categories including antecedent manipulations, change in structural context, differential reinforcement and self-management techniques. Results of these studies report that generally all four types of intervention were effective in reducing challenging behavior. These procedures were then discussed in relation to characteristics of the participants, assessment procedures carried out prior to intervention, feasibility of classroom treatment, and social validity of intervention procedures.
Conclusions: Effectiveness of the procedures were not related to completion of a previous functional behavior assessment. Reported measures of social validity in the studies that were reviewed have positive reports from stakeholders, but the utility of the measures as they are in theory is questioned. It is recommended that different interventions and research should be considered in future studies.
Relevance to the current work: It is important to understand the current practices in improving challenging behaviors in children with ASD and their effectiveness to use as a comparison for the current study.

Mancina, C., Tankersley, M., Kamps, D., Kravits, T., & Parrett, J. (2000). Brief report: Reduction of inappropriate vocalizations for a child with Autism using a self-management treatment program. *Journal of Autism and Developmental Disorders, 30(6),* 599–606.

Purpose of Study: The purpose of this study was to examine the effects of a self-management program used to reduce the rates of inappropriate vocalizations in a child with ASD in a school setting.
Method:
Participant: The participant of this study was a 12-year-old girl with ASD that displayed high rates of inappropriate vocalizations.
Procedures: Self-management treatment in a multiple-baseline design was taught to the participant including self-assessment, self-recording and self-reinforcement during multiple settings including leisure, pre-vocational and reading tasks.
Results: A decrease of the inappropriate vocalizations was observed when self-management techniques were applied in multiple settings.
Conclusions: Teaching self-management techniques in a school setting had a positive effect on verbal behavioral problems in a child with ASD.

Relevance to the current work: This is a successful example of behavioral treatment in a child with ASD and could be a reference when analyzing the affects of behavioral treatment in the current study.

Maskey, M., Warnell, F., Parr, J., Couteur, A., McConachie, H. (2012). Emotional and behavioral problems in children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 43,* 851-859. doi:10.1007/s10803-012-1622-9

Purpose of the study: The purpose of this study was to explore the impact of co-occurring conditions in children with Autism Spectrum Disorder (ASD), and to apply these findings to improve future intervention planning for each individual with ASD suited to his or her individual needs. Co-existing conditions can vary greatly including emotional and behavioral problems; sleep, feeding and eating problems and sensitivities; learning and intellectual disabilities and mental health diagnoses. "However, for parents and teachers, the co-existing conditions can be of equal or greater concern than the core features of ASD, and have a significant impact on behaviour management, learning acquisition and the development of social relationships," (851).

Method:

Participants: Participants for this study included those from the database of children with autism spectrum disorder living in the north east of England (Dasl^{n}e) which consists of children ranging from ages 2 – 18, diagnosed with ASD. Dasl^{n}e was a group established in 2003 to obtain and maintain accurate information via questionnaire by parents and guardians about their children with ASD and is used for local planning and to obtain recruitment for research studies. For this study, this group data consisted of 863 children with ASD with ranging abilities presenting with co-existing conditions.

Procedures: Parents of these children were issued a questionnaire including information about the child's diagnosis, other developmental disorders, current language level, the child's education provision as well as family information. The questionnaire also included a rating scale ranging from frequent (behavior is present more than 3 times a week) to never or rare, and in the past only. Using this rating scale, parents were asked to describe the frequency of 10 reported common problems co-occurring with ASD including habit disorders, and other emotional and behavior problems. The problems that were reported as frequent by parents were then analyzed.

Results: Analyses of data was completed by using "descriptive statistics for the rates of co-existing conditions…Multiple regression analysis was used to investigate which of the significantly related variables explained unique variance…Analyses were conducted using the Statistical Package for the Social Sciences v17.0 (SPSS)" (853).

Under the category of rates of developmental disorders and medical conditions, the most commonly reported co-existing condition reported by parents was a developmental and/or learning delay. Within the entire sample taken, 52.6% of the children were reported to have four or more of the 10 common co-occurring problems listed in the questionnaire. Of these, sensory reactions and "faddiness about eating" were the most common problems listed under "frequently" (854). In agreement with this result, "Leekam et al. (2007) found that adverse sensory reactions occur in at least 90 % of individuals with ASD, and highlighted that these problems may cause disturbed and aggressive behaviour in low functioning individuals unable to explain their distress; in addition sensory reactions contribute to anxiety" (852).

With regard to language ability, the most common problems occurred more frequently in children with less well-developed language. "However, language level did not differentiate the likelihood of frequent temper tantrums, aggression to others, and anxiety, fears and phobias"

(854).

Analysis also compared child school placement comparing those who attended a mainstream school to those who attended any other type of school. Common problems listed in the questionnaire were more common in those who attended special schools than those children who were mainstreamed. However, like language level, "school type did not differentiate the likelihood of frequent temper tantrums, aggression to others, and anxiety, fears and phobias" (854).

Many of these individual categories are difficult to separate entirely as categories such as school placement and language level will correlate based on the child's abilities. It was also noted after further analysis that "age, language level and whether the child attended mainstream school or not significantly predicted unique aspects of the variance" (855).

Conclusions: Over half the children included in this study experienced four or more of the 10 common problems reported by parents frequently (three or more times a week). This confirms the previous conclusion that many children with ASD experience a myriad of co-existing conditions along with their initial diagnosis. The findings of this study highlight the importance of identification of these other conditions by parents and professionals, so that they can be properly addressed and treated in an intervention plan. "In keeping with the findings of the small study by Dominick et al. (2007), most problem behaviours occur more frequently in children with lower expressive language ability, and in those children attending special school. We also found age to be a significant predictor, with older children generally having fewer of the common problems…However, anxiety, fears and phobias are still frequent in secondary school age participants and those with fluent language, as has been found by others for more able children" (855).

This study, through its findings, indicated that the type of ASD diagnosis is not a predictor of behavior problems and suggests that cognitive function rather than ASD subgroup diagnosis is of greater value. Although parents have found to be accurate with their reports, there may be limitations with this study as parents may underestimate their child's level of learning difficulties. Parents also were asked to estimate their responses when uncertain, adding to potential further inaccuracy. However, despite limitations, the results of this study are expected to be generalizable.

"The knowledge that children with ASD in mainstream school have frequent co-existing conditions such as temper tantrums, anxiety, eating issues and sensory sensitivities puts an onus on clinicians to discuss all co-existing conditions with all parents, and together with other professionals, offer intervention, or management advice about adapting the environment, and managing behavior" (858).

Relevance to the current work: This study discusses the variability that is evident in Autism Spectrum Disorder. It also suggests the need for individualized intervention based on each child's presenting problems, both those inherent to ASD as well as the co-existing conditions. This article also includes the commonality of the co-existing condition of tantrum behaviors present for children with ASD at a variety of functioning levels.

Massey, N., & Wheeler, J. (2000). Acquisition and generalization of activity schedules and their effects on task engagement in a young child with Autism in an inclusive pre-school classroom. *Education and Training in Mental Retardation and Developmental Disabilities, 35,* 326–333.

Purpose of Study: The purpose of this study was to determine the efficacy of individualized activity charts for a 4-year-old child with autism.
Method:
Participants: The participant of this study was a 4-year-old child with autism.
Procedures: The participant received treatment in an integrated public school using graduated physical guidance and a system of most-to-least prompts with the eventual fading of all prompts and teacher proximity.
Results: The results of the study supported previous studies of that a young child with autism could successfully acquire the skills required to independently follow an activity chart and generalize them to other settings.
Conclusions: The results indicated the efficacy of an activity schedule for the use of a young child with autism in facilitating higher levels of self-management behaviors with minimal assistance. This increased self-management behaviors and as a result, reduced levels of challenging behaviors.
Relevance to the current work: This study addresses using activity schedules as a treatment for improved self-management, which as a result decreases challenging behavior in children with ASD.

Matson, J. (2009). Aggression and tantrums in children with Autism: A review of behavioral treatments and maintaining variables. *Journal of Mental Health Research in Intellectual Disabilities, 2,* 169-187. doi:10.1080/19315860902725875

Purpose of work: The purpose of this study was to present a literature review on behavioral based therapy focused on improving positive behavior and decreasing aggression and tantrum behaviors in children with ASD.
Summary: This summary outlined the apparent increase of challenging behaviors in individuals with ASD and similar disabilities. The literature review suggested that many of these challenging behaviors seem to stem from environmental factors, suggesting a reason why behavioral therapy in children with ASD has proven successful for many cases. Behavioral therapy types that were discussed included traditional applied behavior analysis (ABA) and functional analysis. Literature using and describing these two methods of behavioral intervention were discussed.
Conclusions: Functional assessment and analysis received the greatest attention in literature for intervention for children with autism. However, functional assessment is not a treatment in and of itself, but rather a guide or model to lead to treatments focusing on behavioral challenges in addition to therapy focused on communication improvement. The goal is to change challenging or aggressive behavior by providing an alternative rather than simply suppressing the behavior. The overall success of functional treatment is unknown, especially in regard to generalization. However, functional assessment has been shown to be an enhancement to traditional therapy, improving its effectiveness. Studies comparing intervention with and without functional assessment are warranted in order to understand the efficacy of such treatment in children with ASD. However, behavioral intervention was shown to be highly preferred over the previous pharmacological methods used to control aggression and tantrum behaviors.
Relevance to the current work: This work reviewed literature regarding aggression and tantrum behaviors in children with ASD, and specifically focused on types of intervention that may help to decrease these challenging behaviors and replace them with positive ones.

Nelson, H. (2013). *The effects of robot intervention on compliance of four children with Autism to requests given by their mothers* (Unpublished master's thesis). Brigham Young University, Provo, UT.

Purpose of the study: The purpose of this study was to examine the effects of a humanoid robot on social engagement in children with Autism Spectrum Disorders (ASD) during therapy. Specifically, compliance and accompanying social engagement behaviors of the child in response to two types of requests given by their mother were observed. These requests included physical manipulation to request an action or obtain the child's attention and verbal requests of an object or action using gestures and models (8). These requests were given during interaction with a humanoid robot. This study was an addition to a previous study that observed social engagement changes due to robot intervention, with the purpose of exploring the effects of robot therapy on social abilities and joint attention in children with ASD.

Method:

Participants: Four children, 2 male and 2 female, ranging from ages 4 to 9 that were previously diagnosed with autism, participated in this study. Each of the children presented with severe challenges in social communication, joint attention and language development. Parents of each of the children consented to their child's participation in this study.

Procedures: Each child was assigned a number of baseline and traditional treatment sessions, followed by sessions including treatment with the robot. Follow-up sessions, following the same pattern as the baseline sessions, were also conducted with each child to determine any progress made.

Results: Each session was videotaped for purposes of accurate data collection. Two types of directives were analyzed including the use of physical manipulation and verbal request of an object. Detailed guidelines were used to focus these data and used consistently on all participants. Data was compared from baseline results to the follow-up results for each child individually.

Results for physical manipulation and verbal request were variable between participants. Two participants made gains in both areas, one remained constant throughout the treatment, and one decreased in compliant behavior.

Conclusions: Since the results were so variable but showed potential in improvement in the participants, further research should be conducted involving longer periods of baseline and intervention sessions, more systematic identification for probes that were successful for each individual child, and better documentation of the child's emotional state for each session.

Relevance to the current work: This study directly relates to my current study as the same participants were involved and studies the behavior of the participants with relation to therapy.

Nuzzolo-Gomez, R., Leonard, M., Ortiz, E., Rivera, C., & Greer, D. (2002). Teaching children with Autism to prefer books or toys over stereotypy or passivity. *Journal of Positive Behavioral Interventions, 4(2),* 80–87.

Purpose of the study: The purpose of this study was to test the correlation between either toys or books as conditioned reinforcers to the frequency of passivity or stereotypy.

Method:

Participants: Four students with ASD in a school-based setting.

Procedures: Two experiments were conducted, one with 1 child and the other with 3 children. Experiment 1 consisted of 1 preschool-aged student who showed frequent patterns of passivity and low frequency of looking at books during free play. Several training sessions were conducted involving pairing reinforcers with looking at books. Experiment 2 involved a multiple-baseline design with 3 students. Baseline data were conducted, followed by toy-play conditioning sessions and observation of the children at play.
Results: Experiment 1 showed the results of engaging in more frequent looking at books during free play, and decreased levels of passivity. Experiment 2 showed the results of 2 students who often showed high levels of stereotypy, decrease in these behaviors, and all 3 students in this experiment showed an increase in toy play.
Conclusions: For Experiment 1, books acquired stimulus control due to the book conditioning training with the participant. In other words, the books became a means of focusing or calming the student, redirecting the passivity into a learning activity. In Experiment 2, an increase in toy-play and decrease in stereotypy showed that toy play had stronger stimulus control than stereotypical behaviors. Ultimately, the results of both experiments show promise in replacing non-preferred behaviors in children with ASD with preferred ones through reinforcement therapy.
Relevance to the current work: This study reveals ways that a decrease in problem or non-preferred behaviors were altered using specific types of therapy for children with ASD.

O'Reilly, M., Sigafoos, J., Lancioni, G., Edrisinha, C., & Andrews, A. (2005). An examination of the effects of a classroom activity schedule on levels of self-injury and engagement for a child with severe Autism. *Journal of Autism and Developmental Disorders, 35,* 305–311. doi:10.1007/s10803-005-3294-1

Purpose of the study: The purpose of this study was to determine the effects of an individualized schedule on levels of engagement and self-injurious behaviors of a school-aged child with severe ASD.
Method:
Participants: The participant of this study was a single, school-aged child with severe ASD who frequently showed self-injurious behaviors.
Procedures: This study was conducted in a classroom setting. The study first consisted of an in-depth functional analysis to determine if a pattern was present for when self-injurious behaviors occurred. The only external stimulus these behaviors seemed correlated with was academic demands. An individualized schedule was created for the participant and its use was analyzed within the context of his regular curriculum.
Results: The use of an individualized activity schedule produced significant reduction in self-injurious behavior as well as an increase in engagement. These results were maintained as the child was observed for 5 months after the study.
Conclusions: The findings of the study indicate that functional analysis methodologies may be helpful in developing individualized schedules for children who do not have the skills to comprehend and follow a general schedule in a school-based setting.
Relevance to the current work: The use of an activity schedule with a child with severe ASD seemed to improve tantrum-like behaviors. Different successful intervention methods for decreasing tantrum behaviors are imperative to understand as new methods are tested, such as in the current study.

Österman, K., & Bjorkvist, K. (2010). A cross-sectional study of onset, cessation, frequency, and duration of children's temper tantrums in a nonclincial sample. *Psychological Reports, 106,* 448-454. doi: 10.2466/PR0.106.2.488-454

Purpose of the study: The purpose of this study was to determine the relationship between verbal skills and frequency of temper tantrums in young children.
Method:
Participants: The participants of this study were 132 parents of young children that were selected from a population in Finland.
Procedure: The questionnaire "Parent's Experiences of Temper Tantrums in Children," was administered to the parents with the instruction to fill it out with one of their children in mind.
Results: Results of the questionnaire indicate that 87% of parents reported their child had temper tantrums, with the majority of these tantrums beginning in the child's second or third year and ceased before the child reached 5 years of age. By age 9, only a fraction of the sample displayed any temper tantrums. Most individual temper tantrums lasted between 5 and 10 minutes. No significant difference was apparent between the results of boys and girls.
Conclusions: Decline in temper tantrums was highest in children between 3- and 4-years of age, coinciding with increased vocabulary use and verbal abilities. This could indicate that children of this age find verbal ways to express anger and frustration than a physical tantrum. This results correlates with other studies that have been conducted on verbal skills and temper tantrums.
Relevance to the current work: This study provides a sample of typical children and frequency, length and common age of temper tantrums. It acts as a control to compare these statistics with temper tantrums in children with ASD.

Peters-Scheffer, N., Didden, R., Sigafoos, J., Green, V., & Korzilius, H. (2013). Behavioral flexibility in children with Autism Spectrum Disorder and Intellectual Disability. *Research in Autism Spectrum Disorders, 7,* 699-709. doi: 10.1016/j.rasd.2013.02.016

Purpose of the study: The purpose of this study was to compare behavioral flexibility in children diagnosed with autism spectrum disorder (ASD) with intellectual disability (ID) to children with ID alone. An additional purpose of this study was to observe factors that may predict or are influenced by behavioral flexibility in these children and to then analyze the difference in scores between children with ASD plus ID and those with Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS) and ID. It was hypothesized that as "the severity of autism increased, behavioral flexibility would decrease" (700). In correlation with this hypothesis, it was also expected that "children who are responsive, attentive and have high receptive language skills may have a better understanding of their parents' communication and consequently able to anticipate unexpected changes in their environment" (700). Ultimately it was expected that children with higher flexibility scores would display fewer emotional and behavioral problems.
Method:
Participants: Participants in this study included 176 children ranging from ages 3- to 9-years-old. Of the total amount of participants, 111 children were part of the experimental group and were diagnosed with ASD or PDD-NOS and ID of varying levels ranging from borderline ID to profound ID. The remaining 65 children comprised the control group and were diagnosed with non-specific ID, physical impairment, Angelman syndrome and Down syndrome. All participants both in the control and experimental groups attended the same preschools and

schools and therefore were considered comparable in terms of cognitive functioning (702).
Procedures: A variety of different factors were measured for each child using a variety of rating scales including behavioral flexibility, cognitive functioning, adaptive behavior, autism level, early communication and language, emotional and behavioral problems, and parental stress.

Participants were chosen by approaching local preschools for children with ID in The Netherlands. Children that could participate had to meet the criteria of being between the ages of 2 and 10 years of age, an documented diagnosis of having ID and/or ASD, and living at home so parents could provide accurate information about their child. Four standardized questionnaires were administered to parents of the participants by mail a week before in home interviews were conducted. At the time of the in-home interviews, two standardized tests were also administered in the home. During the same month the interviews were held, the final three standardized tests and language tests were administered at the school or preschool of each child. Results of the questionnaires, interviews, standardize tests and language tests were then analyzed.
Results: For each standardized test that was conducted, overall and sub-scale tests total means were calculated. Interview and questionnaire results were also analyzed and standardized scores were collected.

Overall, the multivariate analyses of a variety of standardized tests, questionnaires and interviews indicated that diagnosis significantly affected behavioral flexibility. The exact nature of this relationship was not clear from initial analysis, however, and thus further exploration was conducted in the group of children with ASD plus ID to determine what factors were associated with behavioral flexibility. These analyses revealed "significant associations between behavioral flexibility and cognitive functioning (i.e., developmental age, IQ, non-verbal IQ), adaptive behavior, autism severity, emotional and behavioral problems, parental stress and early social communication, and language" (704).

Specifically, there was a significant effect of autism severity on behavioral flexibility, and also behavioral flexibility was greatly affected by the developmental age of a child. There was found to be significant difference of behavioral flexibility between children with a developmental age of 15-20 months and 21-26 months. Emotional and behavioral problems also had significant correlation with behavioral flexibility. Sleep problems, attention problems, and withdrawn behavior were found to be significantly correlated to behavioral flexibility, however with small outward effects. Ultimately, results showed that "the associations between behavioral flexibility and adaptive behavior can be explained in terms of developmental age. There is a positive linear relation between developmental age and behavioral inflexibility and between developmental age and adaptive behavior, therefore, when developmental age is not controlled for, significant correlations were found between behavioral flexibility and adaptive behavior" (706).
Conclusions: This was the first study that explored variables associated with behavioral flexibility in children with ASD and ID. The main finding of this study was that an increase in developmental age and autism severity was associated with an increase in behavioral inflexibility. This finding was in accordance with previous findings (Bartak and Rutter 1976, Didden et al. 2008, Green et al. 2006) where higher functioning children with ASD had more rigid rituals and experienced greater difficulties adapting to new situations than children with low-functioning autism. However, Bartak and Rutter (1976) also found that lower functioning children "displayed more resistance to environmental change than higher functioning children with ASD.

Further research is needed in order to determine the causal relations between behavioral flexibility and maternal stress. However, maternal stress and behavioral problems do affect the effectiveness of early behavioral intervention (708). Thus the need for early behavioral flexibility intervention seems critical. Further research in effective intervention types in this area are also warranted.

Limitations of this study include the accuracy of parent interviews, uneven sample sizes included in the different categories of this study including PDD-NOS plus ID, ASD plus ID and children with ID. Also the generalization of the findings of this study is unclear as it was "not able to assess the relationship between behavioral flexibility and other variables in children with ID only" (708). It is important to note that recent studies have highlighted the need for developing interventions that involve focus on problem solving and tolerance building rather than on the behavioral inflexibility itself.

Relevance to the current work: This study attempts to document the factors involved in behavioral flexibility in children with ASD and ASD plus ID. Behavioral flexibility is closely linked to tantrum behaviors.

Prizant, B., Wetherby, A., Rubin, E., & Laurent A. (2003). The SCERTS model: A transactional, family-centered approach to enhancing communication and socioemotional abilities of children with Autism Spectrum Disorder. *Infants and Young Children, 16,* 296-316.

Purpose of work: The purpose of this work was to present an intervention model (SCERTS) for children with autism spectrum disorder (ASD). Previously, interventions have focused either heavily on the knowledge of typical child development, or a more traditional applied behavior analysis (ABA) approaches primarily centered on learning theory and operant conditioning. More recently, a combination of the two basic model types have been attempted to be molded together using a ""patchwork quilt" strategy borrowing from different practices along the continuum, even when such practices are not easily integrated, resulting in a fragmented approach to programming" (297). Such types of integration of both strategies may cause confusion to the children, as therapy switched between being highly structured and drill-based, to more child-based and more loosely structured. The SCERTS model was created to provide a comprehensive, educational treatment model including the following features: "(1) the model is based on the most current research in child development and ASD; (2) it is flexible enough to incorporate different perspectives (ie, developmental and contemporary ABA); (3) it can be applied in an individualized manner while addressing the "core deficits" of ASD; and (4) it is family-centered, taking into account critical individual differences across families in reference to their priorities" (298).

Summary: The SCERTS model seeks to address the core challenges of children with ASD. The SCERTS model is based on recent empirical evidence, and includes goals in three main areas of Social Communication, Emotional Regulation, and Transactional Supports.

The goal of Social Communication is based on evidence that "positive long-term outcomes for children with ASD are strongly correlated with the achievement of communicative competence" (299). The SCERTS model specifically seeks to focus on the core challenges faced by children with ASD in Social Communication, specifically the capacity for joint attention and the capacity for symbol use. The capacity for joint attention underlies the child's ability not only to communicate needs but also to share common, social experiences. Addressing the capacity for symbol use is also important, as it provides a structure to organize language and communication that can then be shared with communication partners. As the child develops, the

capacity for symbol use becomes an important tool for problem solving, planning and ultimately regulating behavior. In the SCERTS model, it is important to address these aspects of social communication in a variety of settings and contexts in natural environments. These natural environments provide opportunities to learn from peers and caregivers that would otherwise not be present in a constant one-on-one drill teaching approach.

Emotional Regulation is defined as "the intra and extra organismic factors by which emotional arousal is redirected, controlled, modulated, and modified to enable an individual to function adaptively" (304). There are two types of emotional regulation, self-regulation and mutual regulation. Self-regulation involves the ability to recognize a need for regulation in oneself and have the abilities to take the action necessary to become regulated. Mutual regulation involves the support of others to help become regulated. Both of these types of emotional regulation are appropriate and at times necessary depending on the cognitive and communicative abilities of the child. Children with ASD are at higher risk for experiencing heightened states of arousal or under arousal and thus have the need for strategies for emotional regulation. The SCERTS model seeks to create individualized goals for children with ASD that address each child's strengths and weaknesses in order to create both proactive and reactive emotional regulation goals.

In the SCERTS model, Transactional Supports are supports put into place to increase the child's changes of success in social communication and emotional regulation. These supports must be very individualized based on the child's needs and cannot be too structured nor too flexible. They are to act as a scaffold for the child and be modified over time as the child progresses. Three major types of transactional supports are included in the SCERTS model consisting of interpersonal support, educational support, and family support. The key between each of these types includes consistency among different communication partners. Visual supports are often useful for children, especially in educational settings, to provide a framework of understanding as to what is expected in a certain period of time. Family supports are also crucial, as family members are the main caregivers and communication partners with the child. As family members are provided with support and taught how to interact with their child, further progression and decrease in confusion and stress can be achieved. Family also is necessary in understanding the child's needs and interactional style when discussing therapy goals.

Conclusions: One of the greatest challenges faced by implementing the SCERTS model is to address the complex relationship between social communication, emotional regulation and transactional supports for children with ASD. Thus, particular emphasis needs to focus on the needs of each particular child and their families. Measures to determine the goals for each child must go beyond standardized scores, but must also include "degree of success in communicative exchange, related dimensions of emotional expression and regulation, social-communicative motivation, social competence, peer relationships, and the child's competence and active participation in natural activities and environments" (313). As analysis is conducted, it is recommended that measures should include gains in initiation of spontaneous communicative interaction as well as generalization of gains across a variety of contexts. The goal of the SCERTS model is to provide a framework for professionals to focus on the core challenges faced by children with ASD and their caregivers to help improve intervention to become a more integrated and comprehensive across a variety of settings.

Relevance to the current work: This work outlines the need for an integrative approach to intervention for children with ASD, focusing on the core challenges faced by these individuals and their families.

Ririe, S. (2013). *Intervention with children with Autism: The effect of using a robot on participation in reciprocal play* (Unpublished master's thesis). Brigham Young University, Provo, UT.

Purpose of the study: The purpose of this study was to determine the effect of a humanoid robot on the responses of directives to a child with ASD in a interactive environment between the child, a parent and clinician with the robot present.
Method:
Participants: The participants of this study consisted of 4 children with low-functioning ASD between the ages of 4- and 9-years of age.
Procedure: The participants each participated in a number of baseline, traditional, traditional with the robot and follow-up sessions. This study focused on the responses of the participants to directives given during the 10-minute segment involving the presence of the robot out of a 50-minute session involving play-based therapy. The response levels were divided into categories of following directives without assistance, hand-over-hand assistance, or did not comply.
Results: Results were highly variable between participants, but one child showed gains of higher response to directives than at the beginning of the study as determined by baseline data.
Conclusions: Although not direct improvement in following commands were observed for all participants in this study, all children seemed to benefit from the presence of the robot in regards to improved regulation. Additional research should be conducted to determine the effectiveness of robot intervention in generalizing social engagement behaviors in children.
Relevance to the current work: This work directly relates to the current study, as it is a part of the larger study this work is based off of. It also briefly addresses the possibility of improved regulation due to interaction with the robot.

Rispoli, M., Lang, R., Neely, L., Camargo, S., Hutchins, N., Davenport, K., & Goodwyn, F. (2012). A comparison of within- and across-activity choices for reducing challenging behavior in children with Autism Spectrum Disorders. *Journal of Behavior Education, 22,* 66-83. doi:10.1007/s10864-012-9164-y

Purpose of the study: Several studies have been completed comparing the effect of offering choice to children with ASD in therapy. Two types of choice have been studied including within-activity and across activity choices. Within-activity choices include maintaining the type of activity while letting the child choose materials or the environment with which the activity will be accomplished. Across-activity choices allow the child to choose between types of activities or subjects that will be covered during an intervention session. All studies that have been done show a decrease in problem and tantrum behaviors when the child with ASD is given the opportunity to choose. This decrease in problem behavior allows for an increase in instructional time for the child, and the practice of having the opportunity to choose between activities has been shown to improve social interaction and improve problem-solving skills. The main purpose of this study was to extend previous research on "choice-based interventions for challenging behavior by comparing within and across-activity choices for children with ASD" (69).
Method:
Participants: Participants included 4 children (3 boys and 1 girl) between the ages of 5 and 11. Each of the participants was diagnosed with ASD, was reported by a teacher or parent to have challenging behavior during instruction, and had scores on the Questions About Behavioral

Function (QABF) scale identifying each as using challenging behavior to escape from task demands.

Procedures: Before intervention, the QABF was distributed to a parent or teacher of each of the participants. Results showed that each child tended to exhibit challenging behavior at least in part maintained by negative reinforcement. Children were then given an option of 6 educational activities which were selected by the guidance of each individual's IEP. The children were asked to select which of the activities they liked most or disliked least. The four activities that the child did not select after being asked to choose twice were considered "non-preferred" and were selected for use in this study.

An ABAB design was constructed in order to determine the effect of choice on challenging behavior. The "A" represented a no-choice condition, while "B" consisted of alternating treatment design to compare within-activity choice to across-activity choice condition. Sessions were 5-minutes in length and were conducted 2-4 times per day, 2-4 times per week. Each session was conducted by an interventionist (teacher or trained graduate student) and observed by two other data collectors. A least-to-most prompting hierarchy was used to encourage each child to complete each task. The interventionist, time of day, and praise statements were held consistent throughout all phases of the study. Baseline data, within-activity and across activity phases were then conducted respectively.

Results: Analysis was conducted on each of the sessions by a rate per minute of challenging behaviors that arose. Two of the participants were observed in vivo, while the other two were recorded and the data later analyzed by the use of video recordings. To ensure integrity of data, 2 other observers also analyzed the same data ensuring overall reliability of 97%.

Each of the participants showed a higher level of challenging behavior in the baseline phases (A) than in the choice phases (B). Challenging behaviors in both types of choice activities were low, however the lowest frequency of these behaviors occurred in the across-activity choice condition for 3 out of the 4 participants.

Conclusions: This study examined the effects of using choice in intervention for children with ASD for reducing challenging behavior. It particularly examined the efficacy of within-activity choice conditions versus across-activity choice conditions. Results showed that the use of either choice format was more effective than a "no-choice" condition and suggested that for some children, across- activity choices may result in greater reduction of challenging behavior than within-activity choices.

Several explanations for the reduction in challenging behavior may exist. One possible reason is that the ability to make a choice may increase the child's self-determination. A second explanation is that, when given the choice, the child will select the activity that is "least aversive or more preferred" (78). This may reduce the desire to escape or avoid work, decreasing the antecedents to challenging behavior. Further research regarding investigating the association between choice effects on challenging behavior is warranted to improve future intervention techniques. Further research regarding the combination of choice types (within-activity and across-activity) is also warranted to study if a greater decrease in challenging behavior would result. Choice-based intervention is one that could easily be implemented in a variety of different environments, including classroom and inclusive settings. Academic achievement during the sessions was not evaluated; therefore, further research aimed at comparing choice formats on academic behaviors is necessary.

Relevance to the current work: This study discussed a possible intervention to decrease challenging behaviors, or tantrum behaviors, in children with ASD.

Roueche, C. (2013) *The effect of using low dose exposure to a humanoid robot to elicit social engagement behaviors in children with Autism interacting with a familiar adult* (Unpublished master's thesis). Brigham Young University, Provo, UT.

Purpose of the study: This study focused on the correlation between social engagement behaviors in children with Autism and low-dose intervention with a humanoid robot when the child is interacting with a familiar adult.
Method:
Participants: The participants of this study consisted of 4 children with low-functioning ASD between the ages of 4- and 9-years of age.
Procedure: The participants each participated in a number of baseline, traditional, traditional with the robot and follow-up sessions. This study focused on the effect of the humanoid robot after it had been removed from therapy on social engagement behaviors when interacting with the clinician (a familiar adult) to the child. Data from the baseline and follow-up sessions were used to determine any change in social engagement from each participant.
Results: 2 of the 4 participants showed improved ability in reciprocal or turn-taking activities, while the other 2 participants did not show any gains social engagement.
Conclusions: Further research should be conducting over a longer period of time to gain more detailed understanding of the effect of a humanoid robot on children with ASD. A record of behavioral regulation of the child each day therapy takes place is also important to further understand the effect of emotion in intervention.
Relevance to the current work: This work directly relates to the current study, as it is a part of the larger study of which this work is based on. It focuses on the effect of a humanoid robot on behavior and social communication skills in children with ASD.

Schindler, H., & Horner, R. (2005). Generalized reduction of problem behavior of young children with Autism: Building trans-situational interventions. *American Journal on Mental Retardation. 110,* 36-47. .

Purpose of the study: This study sought to determine the effects of functional communication training on reduction of problem behavior in children diagnosed with ASD.
Method:
Participants: Several 4- and 5-year old children diagnosed with ASD.
Procedure: Participants were assessed in primary teaching settings and in three secondary general settings. Higher impact interventions that involved functional communication training were used with a multiple baseline design in primary settings. In secondary settings, lower effort interventions were initially used. Higher impact intervention with communication training were not used in the secondary setting separately from the low-effort intervention, and were only applied once the low impact therapy was re-introduced.
Results: Lower effort interventions in secondary general settings were ineffective when implemented without higher impact treatment. Results indicate the need for trans-situational interventions across settings and must include intensive intervention that improves the impact of the lower intensity interventions.
Conclusions: When an individual with ASD displays problem behavior across multiple settings, it may be useful to conduct functional assessments to determine if factors causing the behavior remain constant. The consistency of behavior must be investigated across settings, to develop

interventions with attention to development of control, and to perform an on-going assessment of the interactive effects of high and low impact treatments.
Relevance to the current work: This study focuses on the problem behavior of children with ASD and how functional treatment can also impact challenging behavior. It also addresses the balance between high and low impact intervention.

Shamsuddin, S., Yussof, H., Ismail, L., Mohamed, S., Hanapiah, F., & Zahari, N. (2012) Initial response in HRI – A case study on evaluation of child with Autism Spectrum Disorders interacting with a humanoid robot NAO. *SciVerse Science Direct,* 1448-1455. doi:10.1016/j.proeng.2012.07.334

Purpose of the study: The purpose of this pilot study was to elaborate on and explain the observed first reactions of a child with high functioning Autism Spectrum Disorder (ASD) during a human-robot interaction (HRI) in comparison to human-to-human interaction. This study also presented a rationale for the use of robots in therapy when working with individuals with ASD, specifically focusing on the use of humanoid-robots for the purpose of further generalization. The authors noted that, "Unlike ordinary toys, robots also have the ability to "prompt responses and engage in play scenarios with ASD children" (1450).
Method:
Participants: The participant in this study, known as boy *K*, was 10-years old at the time of the study. After various standardized tests were completed to obtain *K's* IQ level as well as completing diagnostic tests, *K* was classified as having high-functioning autism due to his average to above average overall IQ level. It was also noted that *K* had no hearing and/or vision deficit, no abnormal eye movement, was able to speak and follow simple commands in English and did not display self-injurious, aggressive behaviors.
Procedures: The experimental procedure for this study was meant to serve as a platform for foundational investigation of HRI for children with ASD. During robot interaction, each child, accompanied by a classroom teacher for a "comforting presence" only, interacted with the robot. A total of 5 modules were executed by the robot, NAO, to entice a reaction or interaction from the child. These modules consisted of introductory rapport, talking, arm movements, song play and eye blinks, and song play and arm movement. The child experienced the set of modules only once, lasting for 14 minutes and 30 seconds excluding 30-second breaks between modules. Should the child at become restless and uncooperative or the child's teacher asked to stop the interaction, the sequence of the robot would have been aborted. This same child was than observed in a regular classroom in regards to interaction with a classroom teacher and classmates for the same amount of time, thus providing a comparison.
Results: During the robot modules, initial response and behavior of the child with ASD were recorded. A manual operator of the robot, NAO, not visible to the child, was monitoring the video stream from 2 external cameras. For the purpose of this study, 24 items from the Gilliam Autism Rating Scale-Second Edition (GARS-2) were used to record observations of the child with ASD to observe an increase or decrease in autistic behaviors under the subheadings of stereotyped behaviors, communication and social interaction during HRI and human-to-human interaction.

Under the subcategory of stereotyped behavior, *K* showed decreased stereotyped behavior during a single session of robot interaction compared to a classroom setting. *K* also

showed an increase in eye contact with the robot, especially when the robot's eyes are changing colors, speaking or executing eye movement.

In the robot interaction, *K* exhibited fewer autistic traits, including only speaking with a flat tone and unintelligible babbling than in a classroom interaction, where she exhibited 7 out of 10 autistic communication traits.

Conclusions: This study described the behaviors of a child with high functioning ASD in a human interaction setting (classroom) compared to those produced in interaction with a robot. Overall, *K* showed a decrease in autistic behaviors during the interaction with the robot (HRI). The authors acknowledged that behaviors could have been affected by the child's knowing he was being observed in a classroom setting versus a more comfortable setting when the child didn't know he was being observed during the robot interaction. It was also suggested that the IQ level of a child with ASD may affect the results of an HRI. In the future repeated exposure to the robot in a longitudinal study would be recommended in order to improve social and communication skills among children with ASD. Also the authors noted that the amount of time the robot is used during interaction is crucial in order to avoid "permanent attachment" and increase generalization.

Relevance to the current work: This work provides background for the current thesis.

Sterling-Turner, H., & Jordan, S. (2007). Interventions addressing transition difficulties for individuals with Autism. *Psychology in the Schools, 44*, 681-690. doi:10.1002/pits.20257

Purpose of work: The purpose of this article was to create a review of literature regarding transition activities for children and adolescents with autism spectrum disorder (ASD). Children with ASD frequently exhibit behavioral difficulties in response to a change in routine or moving from one activity to the next. This behavioral difficulty may present itself in a variety of different ways including noncompliance, aggression, stereotypical behaviors or tantrums. Such behaviors, as a result, reduce instructional and learning time, present danger to the child with ASD and others in their environment and may ultimately place the child with ASD in a more restrictive educational setting. This work sought to review present research on different intervention types to improve transitioning between activities for children with ASD.

Summary: The author discussed different intervention techniques to approach transitioning for children and adolescents with ASD by organizing the research into three separate groups. These groups included verbal and auditory techniques, visual supports, and video priming.

Verbal and auditory techniques incorporate verbal or sound cues to inform the child with ASD that a transition to a new activity is about to occur. The simplest cue is just a verbal prompt such as "it's time to go now," given by the teacher, therapist or parent. It was found that when a verbal prompt was given at the time of transition compared to advanced notice, "Stereotypic behavior was lower in the advanced warning condition when compared to the no-warning condition" (683). Other types of auditory warnings, such as tones or alarms can be used to indicate transitioning to the individual with ASD. However, these have been found to be more intrusive to a naturalistic environment and are less portable for other settings, making generalization more difficult. When these types of cues are used, it is recommended that they are always accompanied by a verbal prompt. Included in this category is also a technique called behavioral momentum. Behavioral momentum "Behavioral momentum involves interspersing requests and/or activities with a high probability of compliance with tasks/activities that have a low probability of compliance" (683-684). When used with a great variance of high-probability

requests prior to an anticipated low compliance transitioning, decreases in problem behaviors were noted.

Visual supports involved the use of pictorial cues and/or activity charts. Such cues to help communicate transitioning, especially to children with low-functioning autism. This type of communication can be permanent or be faded with time into the use of just a verbal prompt. Activity charts can also be helpful in aiding in transitions for children with ASD. "Activity schedules have been shown to be effective in increasing independent, functional skills in students with autism" (685).

The final group was known as video priming. This involves a unique application of an antecedent intervention to address transition difficulties," that uses videotape modeling to decrease problem behaviors associated with transitioning (686). In a particular study analyzing the effectiveness of video priming, challenge behaviors included tantrum-like behaviors such as crying, screaming, aggression, verbal assistance and dropping to the ground. The overall results of the study showed a decrease in problem behaviors, after the children watched a videotaped situation of a common routine demonstrating proper modeling. "The authors anecdotally noted that as problem behavior decreased, each student increased his or her use of language and became more engaged with environmental stimuli during the community outings" (686).

Conclusions: In reviewing the literature on transitioning techniques for helping children and adolescents with ASD, the author formulated several recommendations and conclusions. First, "individuals involved in treatment planning should determine what is most important to the individual with autism" (687). Second, how the children with ASD learn the best or how they best receive information should be considered and included in an intervention plan. Finally, intervention techniques that are selected should have a high probability of maintenance and generalization. Intervention plans should also be as simple as possible while still addressing the goals that have been designed for that individual or child.

Several types of verbal and visual techniques have been presented in recent literature to help children with ASD in transitioning between activities. As there is minimal literature on the evaluation of different types of techniques to aid in transitioning, it is difficult to provide definite recommendations for interventions. However, presenting different types of transitioning techniques is beneficial for developing treatment programs for those individuals with ASD that particularly struggle with transitions. If challenging behaviors during transitions can be decreased, it may result in "increased instructional time (thus more learning opportunities for the student with autism), increased independence as the need for adult supervision decreases, and generalized effects to other settings" (689).

Relevance to the current work: This work outlines different techniques that have shown results in decreasing challenging behaviors, including tantrum-like behaviors, during transitioning for children and adolescence with ASD. It suggests ways in which common tantrum behaviors in children with ASD may be reduced using different types of intervention.