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Abstract

Social skills in autism spectrum disorders (ASD) have been targeted in a number of ways including the use of various software programs. This pilot study compared one simulation-based program to traditional therapy as a means to teach social skills to children with ASD. Participants included 8 males, ages 6 years to 13 years old with a diagnosis of ASD. Participants engaged in the simulation-based program (intervention group) or traditional speech therapy (control group) for a six-week period. The Pragmatic Language Skills Inventory (PLSI) was administered before and at the conclusion of the program to measure changes in social skills for both groups. Results indicated a significant group by time interaction. For Classroom Interaction and Personal Interaction items, those in the intervention group performed significantly higher post-test than those in the control group. The findings from this pilot study indicate that a computer-based program may prove beneficial for targeting social skills in the ASD population. Future research could include further examination of social skills programming by comparing traditional speech therapy methods and computer-based social skills programs with a larger participant pool.

Introduction

The Center for Disease Control (CDC) states that social issues are one of the most common symptoms in all types of ASD (U.S. Department of Health and Human Services, 2015). Individuals with ASD present with a number of symptoms including an avoidance of eye contact, a preference to play alone, limited interactions, flat affect (i.e. reduced emotional expression), avoidance of physical contact, and difficulty understanding their own emotions and the emotions of others (U.S. Department of Health and Human Services, 2015). Speech language pathologists often target skills in these areas during therapy sessions to improve behaviors.

Social skills in the ASD population have been targeted in a number of ways, including approaches that focus on play, music, movement, and technology. One approach introduced in 1947 (Axline, 1969) that has been used widely is child-centered play (Kenny, Dinehart & Winick, 2016; Ray, Sullivan, & Carlson, 2012). Child-centered play includes play interactions in which the child sets the direction of the activity and is allowed to make all of the decisions. The therapist does not force progress or tell the child what to do. It is believed that the children with ASD who have difficulty expressing their feelings may engage in emotional expression through child-centered play (Axline, 1969). Child-centered play therapy has been noted to have positive effects on the social skills of children with ASD (Salter, Beamish,& Davies, 2016; Ware Balch & Ray, 2015).

Family-centered music therapy (Thompson, 2012; Thompson, McFerran, & Gold, 2013) is another technique that has been used to target social skills in children with ASD. In one study, Thompson, McFerran, and Gold (2013) examined the social skills of 23 children with ASD, age 36-60 months. Children were assigned to either a control group that received early intervention therapy or an experimental group that received early intervention therapy plus family-centered music therapy. Family-centered music therapy included songs and structured and improvised activities led by a music therapist. Standardized parent-report assessments, parent interviews, and clinician observation were used to measure performance. Results indicated a significant effect in favor of family-centered music therapy. Children and parents engaged in the intervention group reported that their parent-child relationship grew stronger.

Another approach that has been used with children with ASD is movement and dance. This approach began gaining popularity in the 1970s and targets areas such as self-awareness, empathy, well-being, body awareness, and social skills (Koch, Mehl, Sobanski, Sieber, & Fuchs, 2015). Approaches using movement therapy can include such things as yoga, and dance, and have yielded mixed results with regard to improved social skills in children with ASD (Hildebrant, Koch, & Fuchs, 2016; Koch et al., 2015; Miramontez & Schwartz, 2016; Rosenblatt et al., 2011).

One intervention that has been gaining popularity when targeting social skills in the ASD population is the use of simulation software. This can include interaction with avatars or animated characters in a virtual environment or the use of computer-generated activities. There have been several studies conducted to explore these interventions. Moore, Cheng, McGrath, and Powell (2005) examined the use of virtual environments with individuals with autism. Their participants included 34 children between the ages of 7 and 16 years. They measured the participants' ability to understand basic emotions that were presented using a computer-generated avatar. They found that over 90% of the participants did in fact recognize the emotions that were displayed.

Hopkins, Gower, Perez, et al. (2000) used a software program called *FaceSay*, a computer-based social skills training program for children with ASD. The authors conducted a randomized control study (n = 49) using computerized avatars to measure eye gaze, and discrimination of facial features and emotions. They found that participants demonstrated improvements in emotion recognition and social interactions. Finally, Trepagnier, Olsen, Boteler, and Bell (2011) used virtual conversation partners from SIMmersion software to measure the feasibility of using an avatar for targeting social skills in adults with ASD. The participants strongly agreed that the experience was useful as it increased their interest in talking with people, while providing a less stressful platform than interaction in the real world.

Several other studies examined social interaction in a virtual environment. Mitchell, Parsons, and Leonard (2007) examined the judgements and explanations of teenagers with ASD as they interacted in a virtual cafe. Raters judged them as exhibiting significant improvements. Didehbani, Allen, Kandalaft, Krawczyk, and Chapman (2016) found an increase in emotion

regulation, social attribution, attention, and executive functions in individuals 7-16 years with ASD when they participated in social cognition training in a virtual environment. The authors stated that they found that the virtual environment provides a "promising and motivating platform to safely practice and rehearse social skills for children with autism spectrum disorder" (p. 703).

Similarly, Cheng, Chiang, Ye, and Cheng (2010) found that when using a collaborative virtual environment, 8-10 year old children with ASD not only demonstrated significant positive results in their use of empathy, but also were enthusiastic about using the program. Lorenzo, Lledo, Pomares, and Roig (2016) also found that 7-12 year old children with ASD demonstrated significant presence of more appropriate emotional responses when interacting in an immersive, virtual environment as compared to a desktop application. A separate study demonstrated that children with autism preferred human interaction to that of an avatar (Carter, Williams, Hodgins, and Lehman, 2014). The study examined 4-8 year old children with autism in terms of their responsiveness to a human therapist, an interactive avatar, and a cartoon character. They found that the children responded best to the human therapist, and poorest to the cartoon character.

Forbes, Pan, and Hamilton (2016) and Kim et al. (2014) found mixed results. Forbes et al. (2016) examined both typically developing children and children with autism and their ability to copy the actions of a socially engaged avatar and a socially disengaged avatar. They found that neither group mimicked actions based on the social engagement of the avatar. Kim et al. (2014) also examined typically developing children as compared to children with autism. They instructed participants to use a joystick to position themselves closer or farther from an avatar while trying to identify the avatar's emotions. No group differences between accuracy of emotion recognition were noted, however the children with ASD displayed significantly less approach behaviors to the positive or happy emotions.

Additional studies have focused on computer-based social training for children with ASD without the use of a virtual environment. Bernard-Ortiz, Sriram, and Nakhoda-Sapuan (2001) found that addressing social problems using computer animation resulted in a steady increase across sessions with children with ASD. Hourcade, Bullock-Rest, and Hansen (2012) used multi-

touch tablets to teach social skills to children with ASD and found that participants understood emotions, expressed themselves, and increased pro-social behavior.

The results of these studies indicate that the use of computer programs, virtual environments, and avatar interactions may prove to be positive and effective methods for teaching social skills to children with ASD.

Methods

The Current Pilot Study

The current pilot study sought to evaluate the effects of a new computer program designed to promote social skills in children with ASD. The Social Interactive Learning Avatar Software (SILAS, http://silassolutions.com/) was specifically designed to help children with ASD practice social skills. The unique feature about SILAS is that it was also designed specifically for children to interact with other children, unlike other avatar software where children use the software and practice social skills in isolation. The use of simulation software has gained popularity when targeting social skills in the ASD population and there have been several studies conducted to explore the efficacy of this type of intervention, which have found positive outcomes. Given these past findings, we hypothesized that children utilizing the SILAS software to learn social skills will demonstrate a significant improvement in such skills over a comparable control group learning social skills utilizing a more traditional method without the use of software.

Participants

Eight participants ages 6 to 13 years (M = 7.63, SD = 1.06) with a diagnosis of ASD were recruited for this study. All participants were male. Participants were verbal communicators who have been identified by their parents as having delayed social skills. Baseline characteristics for the participants in the control and intervention groups are shown in Table 1 for all subscales of the Pragmatic Language Skills Inventory (PLSI).

Table 1 – *Baseline characteristics (M, Mean; and SD, Standard Deviation) for study participants by control and intervention groups for all subscales of the Pragmatic Language Skills Inventory (PLSI).*

	Control Group		Intervention Group	
	M	*SD*	*M*	*SD*
Classroom Interaction Pretest	6.25	2.75	6.50	1.92
Classroom Interaction Posttest	7.00	3.16	10.00	3.65
Social Interaction Pretest	6.75	2.99	8.75	1.26
Social Interaction Posttest	7.25	2.50	10.50	4.66
Personal Interaction Pretest	8.50	4.93	9.50	3.11
Personal Interaction Posttest	7.00	4.23	11.50	4.80

Instruments

The Pragmatic Language Skills Inventory (PLSI) is a norm-referenced rating scale designed to assess children's pragmatic language abilities ages five to thirteen. The PLSI is a 45-item scale with three subscales: Personal Interaction Skills, which assesses initiating conversation, asking for help, participating in verbal games, and using appropriate nonverbal communicative gestures; Social Interaction Skills, which assesses knowing when to talk and when to listen, understanding classroom rules, taking turns in conversations, and predicting consequences for one's behavior, and; Classroom Interaction Skills, which assesses using figurative language, maintaining a topic during conversation, explaining how things work, writing a good story, and using slang appropriately.

A parent questionnaire was designed for this study and given to all parents at the end of the intervention. Eight questions asked parents to rate several of their child's behaviors related to social interaction including initiating and maintaining eye contact and conversations. Parents rated their child's behavior on a scale of 1 (Skills have greatly decreased since beginning the social skills program) to 5 (Skills have greatly improved since beginning the social skills program).

Experimental Procedures

This pilot study utilized an experimental design with a pre-test, an intervention, and a post-test. Four participants were randomly selected for the intervention group and four were randomly selected for the control group. Parents of participants from both groups were given the Pragmatic Language Skills Inventory (PLSI) as a pre-test to determine their child's baseline for social skills. Participants in both groups were taught lessons to increase specific social skills in the areas of increasing eye contact, making introductions, generating conversational topics, elaborating on conversational topics, and concluding conversational topics. Participants then worked together as a dyad with a CO-PI to learn a targeted social skill. The CO-PI met with each dyad for fifteen minutes and taught the target skill using traditional play activities such as board games and building games.

The experimental and control groups then practiced the target skill that they just learned in one of two ways. In the control group, the dyad practiced the learned skill using the same board games and building games. In the intervention group, the dyad engaged in a computer-based activity using the SILAS Social Skills Program to practice using the learned skill. For both the experimental and control groups, the practice session was 45 minutes and was guided by the co-project investigator (Co-PI) and supervised by the lead-PI. This occurred twice per week for a period of six weeks, with a new skill targeted each week. At the conclusion of the six weeks, parents of participants from both groups were given the Pragmatic Language Skills Inventory (PLSI) as a post-test to determine their child's social skills as well as the parent survey.

Results

Prior to conducting the ANOVA, we wanted to ensure that given our small sample size ($n = 8$) the assumption for a repeated measures ANOVA was appropriate. Levene's test for equality of variances was not violated for any of the dependent variables in either group or at either time. Shapiro-Wilk's test for normality of the distribution was not significant at $p<0.05$ for all of the dependent variables in both groups and at both times. Finally, to ensure there were no outliers in the data, the Shapiro-Wilk's test for normality of the distribution of the Studentized Residuals was not significant at $p<0.05$ for all of the dependent variables in both groups and at both times.

To test our hypothesis, participants that utilized the SILAS software were compared to the control group, a 2 (Group: Intervention vs. Control) x 2 (Time: Pretest vs Posttest) repeated-measures analysis of variance (ANOVA) was conducted to examine whether the PLSI subscales (classroom interaction, personal interaction, social interaction) increased for intervention group participants over time. The ANOVA model included time and group main effects and time x group interactions. There was a significant main effect of time on social interaction, $F(1,6) = 18.45$, $p < .01$, $\eta 2 = .76$, with scores increasing from pretest to posttest. There was a significant time x group interaction effect for social interaction, $F(1,6) = 7.72$, $p < .05$, $\eta 2 = .56$, and for classroom interaction, $F(1,6) = 6.39$, $p < .05$, $\eta 2 = .52$.

Analyses of the main effects showed that classroom interaction and social interaction significantly increased for members of the intervention group (posttest) with little change in the control group over the same period of time. Analysis indicated that the estimated marginal means for PLSI subscale of social interaction for the pretest (Time 1) vs. the posttest (Time 2) were linked (Fig. 1). There was a significant increase in social interaction for the intervention group and little change in the control group over the same time period.

Further analysis also demonstrated that the estimated marginal means for PLSI subscale of classroom interaction for the pretest (Time 1) vs. the posttest (Time 2) were different (Fig. 2). There was a significant increase in classroom interaction for the intervention group and a decrease in classroom interaction in the control group over this same time period of time.

We also explored differences in the parent-reported social behaviors of their children at posttest. The data indicate that the largest mean was in the intervention group's initiation of conversation and the smallest means were in the control group's initiation of and ending of conversation (Table 2). The greatest standard deviations were evident in the intervention group's eye contact, sharing, and cooperative play. The smallest standard deviations were seen in the control group with regard to initiation and ending of conversation.

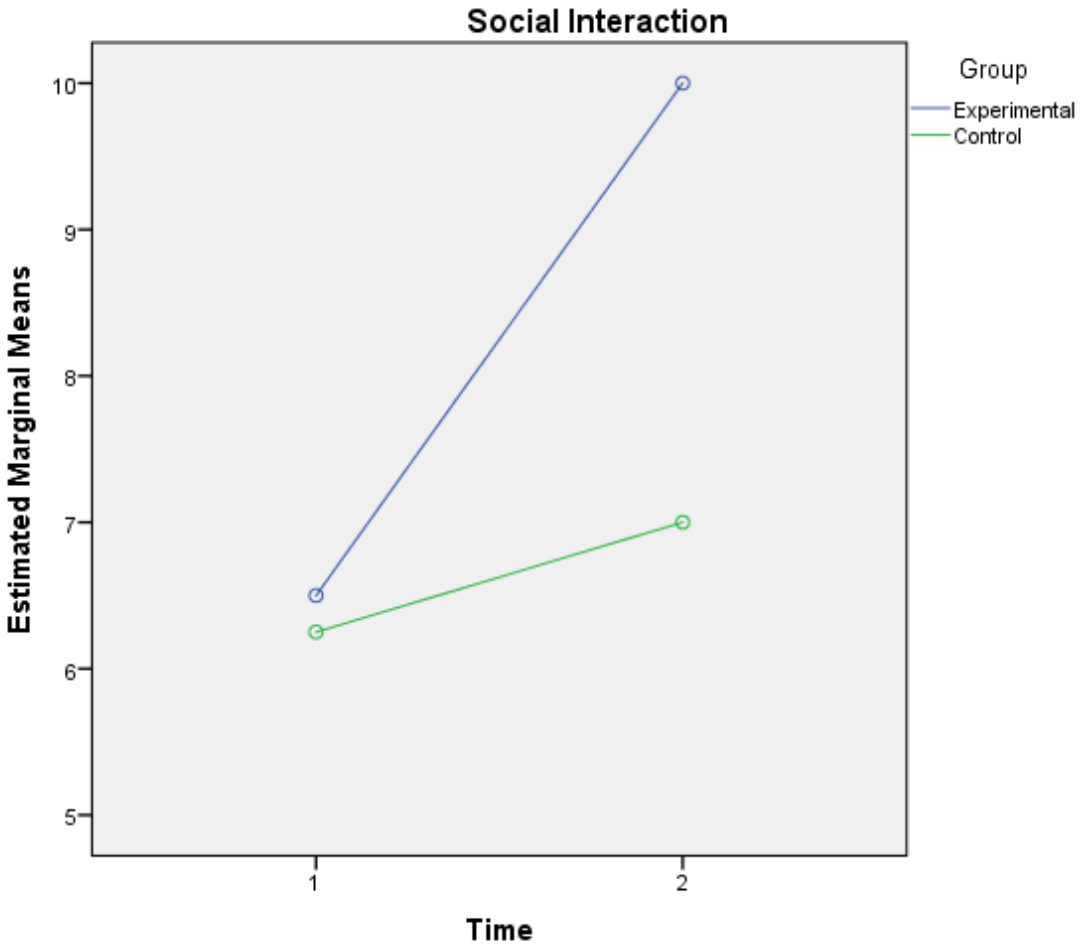

Figure 1 – *Time x Group Interaction shown for marginal means of PSLI subscale of social interaction for pretest (Time 1) versus posttest (Time 2) of Experimental (blue) and Control (green) Groups.*

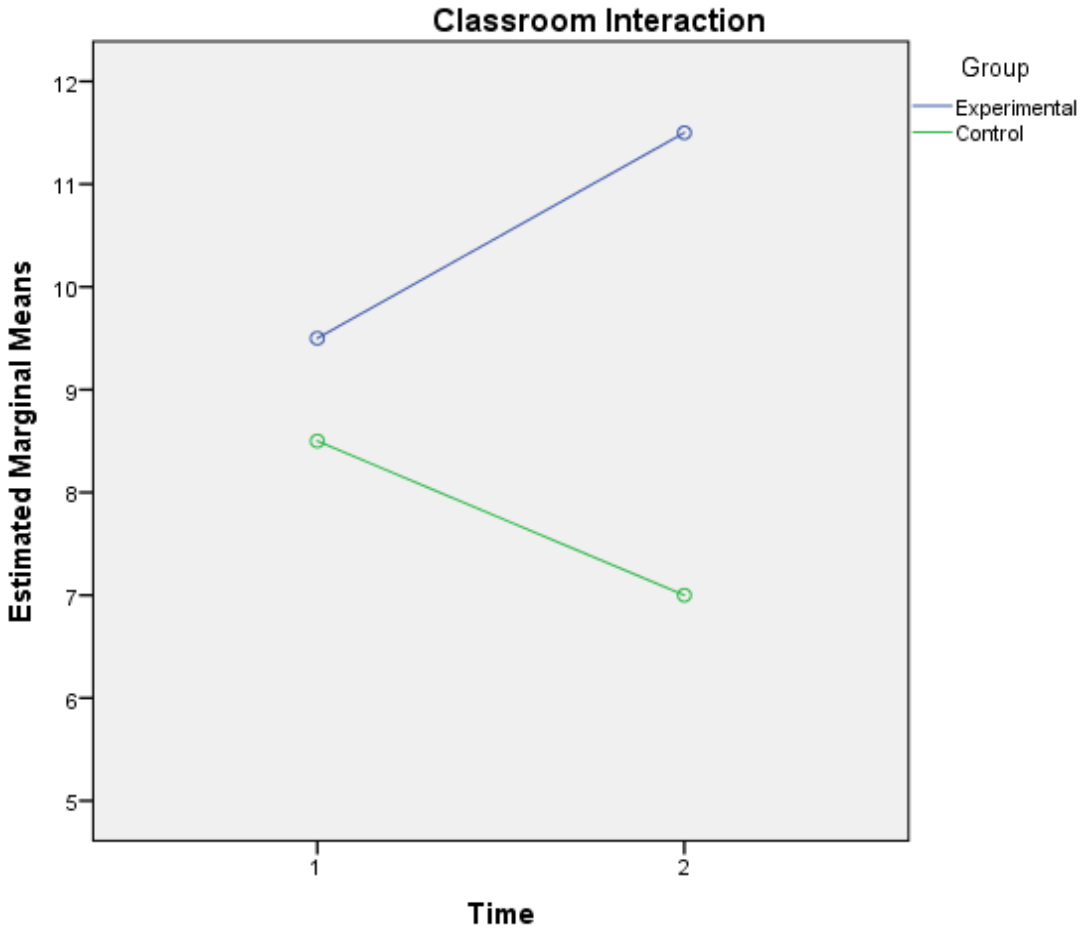

Figure 2 – *Same as **Fig. 1** but for PSLI subscale of classroom interaction.*

An independent samples *t*-test found that parents in the intervention group rated their children higher in initiating a conversation, $t\ (6) = 5.00$, $p < .01$, and higher in ending a conversation, $t\ (6) = 5.00$, $p < .01$, than parents in the control group at posttest. No other significant differences were found between the two groups at posttest.

Table 2 – *As in Table 1 but for parent-reported social behaviors of study participants (M, Mean; and SD, Standard Deviation) by control and intervention groups.*

	Control Group		Intervention Group	
	M	*SD*	*M*	*SD*
Eye contact	3.25	.50	4.00	.82
Introduce themselves	3.25	.50	3.50	.58
Initiate a conversation	3.00	.00	4.25	.50
Maintain a conversation	3.25	.50	3.75	.50
End a conversation	3.00	.00	3.75	.50
Take turns	3.25	.50	3.50	.58
Share	3.38	.48	4.00	.82
Cooperative play	3.50	.58	4.00	.82

Discussion

This study adds to the current body of research regarding computer-based social skills programs and their effectiveness with children with ASD. Similar to Didehbani et al. (2016) this study found that the virtual platform proved to be a safe environment for children to interact with other communication partners. Interactions could be monitored and participants could engage in social activities without the fear and pressure that is present in the "real world". This could account for the participant's improvement in initiating a conversation and ending a conversation. The virtual environment provides a comfortable medium to develop and practice skills that have not yet been mastered.

Classroom Interaction scores and Social Interaction scores reflect skills such as turn-taking, talking and listening, providing explanations, topic maintenance, prediction, and using figurative language. Participants may have improved skills in these and related areas due to two factors. The first, as mentioned above, is that participants may have felt more secure to engage in turn-taking and conversational activities, thus increasing scores in those areas. Second,

participants in the intervention group simply found the program to be fun. They enjoyed participating and therefore, enthusiastically explored the program and its elements.

This excitement and enthusiasm may have contributed to greater engagement in the program and increased scores in those areas of social skills. While the control group enjoyed the games and table top activities, these activities were not novel to them. In addition, conflicts that arose in the control group were happening face-to-face in the "real" world. Conflicts in the intervention group, on the other hand, were happening between avatars in a virtual world. This difference could suggest that the intervention group was more willing to initiate and take social risks than the control group.

While this pilot study does add to the research literature on computer-based interventions for teaching social skills, it does have several limitations. The first limitation is the small sample size. However, all of the multivariate assumptions were met and the effect sizes ranged from $\eta 2$= .52 to .76. Cohen (1988) interpreted .01 as small, .09 as medium and .25 as large when all of the effect sizes in the current study were large. While such small samples are common in controlled experiments in the fields of psychology and other clinical studies (Oberfeld & Franke, 2013), our small sample size limits our ability to generalize these findings to the broader population of individuals with ASD.

Our generalization is also limited by the self-selection of the participants. While this study did use an experimental design with random assignment of participants, parents did choose to participate in the social skills training program. One could assume that the parents believed their child to be lacking in social skills. Finally, the current study relied solely on parent-reported data. Obtaining additional data such as teacher report would be helpful in assessing the impact of the program in a variety of settings.

The aim of a pilot study is to inform both the decision to conduct a larger confirmatory trial as well as the design of such a confirmatory trial, therefore, statistical significance should be interpreted with caution because of low statistical power (Lee, Whitehead, Jacques & Julious, 2014). Future research should assess the SILAS program on a larger, more diverse sample of children, possibly over a longer period of time utilizing a varied battery of assessments from multiple sources.

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