



The Effects of a Modified PEERS Curriculum on Accurate and Novel Responding of Children with Autism Spectrum Disorder

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Abstract

Social skill training for individuals with autism spectrum disorder (ASD) frequently targets skill accuracy. However, restricted and repetitive social behaviors are infrequently addressed. The present study evaluated the efficacy of a modified version of the Program for the Education and Enrichment of Relational Skills (PEERS) intervention for improving social skill accuracy as well as increasing novel responding in three children with ASD. The intervention was facilitated by graduate student researchers in a clinic-based setting, and targeted social skills included Two-way Conversation, Finding Similar Interests, and Starting a Conversation. A multiple baseline design across skills was utilized to evaluate the effects of the modified PEERS. Results demonstrated that the intervention was generally effective in improving skill accuracy across participants, as well as increasing novel responding in response to prompts delivered by both researchers and parents. The current study provides a model for modification of extant social skill training curricula to incorporate strategies that may address restricted and repetitive social behaviors in individuals with ASD.

Keywords Lag schedule · Social skill training · Autism spectrum disorder · PEERS

Deficits in social communication, such as atypical prosody (Tager-Flusberg et al. 2005), difficulty interpreting social cues (Weiss and Harris 2001), and poor conversational turn taking (Paul et al. 2016), have been suggested to be the most salient features of autism spectrum disorder (ASD; Carter et al. 2005). These deficits are associated with poor long-term outcomes, such as difficulties establishing friendships (Howlin et al. 2000), obtaining employment, and maintaining social relationships (Howlin and Moss 2012). Other researchers have found that adults with ASD have minimal engagement in social activities across a range of settings (Cederlund et al. 2008) and experience limited independence from caregivers (Lawrence et al. 2010). Given poor long-term outcomes associated with social skill deficits, early social skill intervention is frequently prescribed and utilized for individuals with ASD (Reichow and Volkmar 2010).

In general, positive effects of social skill training programs are most evident when discrete skills (e.g., how to join in a conversation) are taught instead of general social behaviors (e.g., making friends; White et al. 2007). The Program for the Education and Enrichment of Relational Skills (PEERS; Laugeson and Frankel 2011) is an example of a social skill curriculum targeting discrete social skills that are common deficits in individuals with ASD (Laugeson et al. 2012). Skills in the PEERS curriculum are introduced through didactic instruction in which a facilitator provides rationale and instructions for skill use. Didactic instruction is accompanied by modeling of the target skill by a facilitator, followed by behavioral rehearsal, and the provision of performance feedback. During modeling and behavioral rehearsal, participants are encouraged to answer perspective taking questions in order to enhance understanding of skill use.

Research evaluating the PEERS curriculum has been group design in nature and has consistently documented improvements in parent and teacher report of social skill use (e.g., Laugeson et al. 2009, 2015). Additionally, researchers have documented increased frequency of social get-togethers of participants, improved friendship quality, and knowledge of target social skills (Laugeson et al. 2015). These improvements have been documented following training in both clinical (Karst et al. 2015) and educational (Laugeson et al. 2014) settings, with treatment

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gains being documented at long-term follow-up (Mandelberg et al. 2014). Finally, evaluations of the curriculum have found it to be efficacious across cultures (e.g., Yoo et al. 2014).

Although PEERS and other discrete social skill training programs have demonstrated utility in improving social communication skills in children with ASD, these interventions rarely assess outcomes related to restricted and repetitive social behaviors (Wolfe et al. 2014). Although a separate diagnostic feature, restricted and repetitive behaviors often manifest in social contexts through restricted patterns of responding, restricted conversational interests, or use of repetitive phrases (Fisher et al. 2013; Ganz et al. 2008). Recent research has found that discrete social skill training programs utilizing didactic instruction, behavioral rehearsal, and performance feedback produce minimal effects on restricted and repetitive social behaviors of children with ASD (Radley et al. 2017a). As such, interventions should specifically program for addressing restricted and repetitive behaviors through direct reinforcement of variable and flexible responding (Wolfe et al. 2014).

In their review of 14 studies targeting promotion of variable behavior in individuals with ASD, Wolfe et al. (2014) identified lag schedules of reinforcement as the most frequently implemented intervention strategy. A lag schedule of reinforcement describes a procedure in which reinforcement is only provided following a response that differs from a predetermined number of prior responses (Page and Neuringer 1985). When using a lag 2 schedule, for example, reinforcement would be provided only for a response that differed from the two immediately preceding responses. Lag schedules of reinforcement have been utilized to promote variability in a range of social behaviors, such as responding to questions (Susa and Schlinger 2012) and varied conversational topics (Lepper et al. 2017).

Despite the apparent utility of lag schedules of reinforcement, even when incorporated into previously established intervention strategies (e.g., functional communication training; Adami et al. 2017), no existing social skill curricula incorporate lag schedules to address restricted and repetitive social behaviors. Recently, researchers have begun to examine modification of extant curricula to incorporate lag schedules of reinforcement. Radley et al. (2017a) evaluated the effect of incorporation of lag schedules of reinforcement in the Superheroes Social Skills program (Jenson et al. 2011) on accurate and variable responses of children with ASD between the ages of 7 and 9. In their study, Radley et al. (2017a) implemented the Superheroes Social Skills program without modification, finding implementation to result in increased skill accuracy but little increase in variable responding. Following, the program was modified to incorporate lag schedules of reinforcement during role-play portions of the intervention. Results indicated increases in variable responding beyond training without lag procedures without resulting in decreases in skill accuracy.

In a follow-up study conducted with younger children with ASD, the incorporation of lag schedules of reinforcement into

an extant social skill curriculum was found to produce similar improvements in variable responding relative to training without lag schedules of reinforcement (Radley et al. 2017b). Together, these studies suggest that incorporation of lag schedules into extant social skill curricula may result in benefits that are apparent in both the primary domains of deficit of individuals with ASD (i.e., social communication, restricted and repetitive behavior).

Whereas social skill curricula incorporating didactic instruction, modeling, behavioral rehearsal, and performance feedback have been found to be useful in promoting improvements in social communication, outcomes rarely assess changes in restricted and repetitive social behaviors (Wolfe et al. 2014). When researchers have assessed repetitive responding, social skill training without incorporation of contingencies for response variability has been found to have minimal effects on restricted and repetitive responding—with the addition of lag schedules of reinforcement being effective in increasing the number of novel responses of participants (Radley et al. 2017a, b). Given these findings, the purpose of the current study was to evaluate the effect of a subset of lessons from the PEERS, matched to participant deficits as reported by parents and modified to incorporate lag schedules of reinforcement, on novel responding of participants with ASD. Additionally, the current study sought to extend the PEERS literature through direct observation of skill accuracy as a dependent variable. Whereas previous evaluations of the PEERS have relied on parent, teacher, and self-report of dependent variables of interest, the current study is unique in that independent observers directly evaluated the performance of the discrete skills taught as part of the intervention.

Method

Participants

Prior to conducting the study, study procedures were approved from the affiliate university's Institutional Review Board, and consent and assent were obtained from guardians and participants. Participants in the study included three children with ASD that were self-referred to a university-based clinic for social skill training. All participants had previously been diagnosed with ASD by a licensed psychologist. Additionally, all participants had special education classifications of autism from school multidisciplinary teams. To confirm diagnosis, the Autism Spectrum Rating Scale (ASRS; Goldstein and Naglieri 2009) was administered prior to data collection. Previous evaluations of the ASRS have indicated adequate internal consistency across scales ($\alpha = 0.73$ to 0.95), with content, criterion, and construct validity also indicated (Simek and Wahlberg 2011).

No participant demonstrated echolalia, with all participants being capable of demonstrating age-appropriate expressive

language. Pseudonyms are used throughout. Mick was a 10-year-old Caucasian male in fifth grade. On a parent-completed ASRS, Mick received a total score of 71, which is in the very elevated range. Christine was a 10-year-old Caucasian female in the fifth grade. On a parent-completed ASRS, Christine received a total score of 70, which is in the very elevated range. John was a 7-year-old Caucasian male in the third grade. On a parent-completed ASRS, John received a total score of 79, which is in the very elevated range. All parents reported highly restricted and repetitive communication by participants. For Mick, this was cars; for Christine, this involved books, specifically the Babysitters club; and for John, this involved dinosaurs. At the time of the program, none of the three participants were receiving concurrent services targeting social skills. However, parents of participants reported that all participants were receiving school-based special education services for academic skills in inclusive settings.

All procedures in the current study took place in a university-based clinic in the Southeastern United States. Although the PEERS is frequently implemented in school settings (e.g., Laugeson et al. 2014), a more controlled clinic setting was selected to provide increased internal validity for the pilot study. The room contained a long rectangular table and chairs in the center of the room, as well as a dry erase board. Social skill groups were conducted one afternoon per week for 12 weeks, with each social skill group being 1.5 h in duration.

Materials The PEERS curriculum for school-based professionals (Laugeson 2014) was utilized as the intervention for this study. This program is an adaptation of a parent-/caregiver-assisted social skill intervention for high-functioning adolescents with ASD (Laugeson and Frankel 2011). The curriculum intended to be implemented by teachers in a classroom setting, with skills being introduced sequentially. However, for the current pilot study, the procedures were modified to allow for implementation once per week in a non-school setting. Specifically, trained skills were selected based on participant deficits and no homework assignments were provided. Homework was omitted from the current study as the unmodified PEERS curriculum is intended to be implemented for 30 to 60 min, 4 to 5 days per week with one of these days designated solely to homework review. Due to the time constraints and frequency in which the participants received intervention, homework was omitted in the modified version.

In addition to the PEERS manual, toys and games were used during free time periods and during skill probes. Toys and games utilized during the group included Jenga, Guess Who, Legos, blocks, and toy figurines.

Measures

Cumulative Novel Responses The primary dependent measure of the current study was the cumulative novel responses

produced by the participants for three target skills. Target skills included Two-way Conversation, Finding Similar Interests, and Starting a Conversation. Finding Similar Interests was a sub-section under the Choosing Appropriate Friends lesson from the PEERS curriculum for school-based professionals. The same opportunities to engage in a target skill were provided throughout each phase of the study (Table 1). The conversation topic that was selected for Finding Similar Interests skill was informed by parent report of their child's preferred items. Two to three opportunities to engage in a skill were provided during baseline and maintenance phases per session. Nine opportunities to engage in a skill were provided for target skills in intervention during each session, with additional data collected dependent upon data stability. Two school psychology doctoral students who did not facilitate social skill lessons provided opportunities to engage in target social skills.

A novel response was defined as a response that is topographically different than all previous responses given, but still contextually appropriate for the given opportunity to engage in a target skill. For example, a participant response of "How is your day going?" meets the criterion of being different than a response of "What are you going to do when you get home?". However, a response of "What are you going to do when you get home?" in response to the opportunity to engage, "Hey I heard you were interested in dinosaurs" would not meet the criterion, as it does not represent a contextually appropriate response. Additionally, responses that had the same meaning as a previous response and differed only by omission of words were not considered to be novel (e.g., "how is your day going" and "how is your day").

Novel responding was measured based upon a single step within the task analyses for each skill. For Two-way Conversation, the step that was evaluated for variable responding was step three, ask an open-ended question. For Finding Similar Interests, step three, ask a question about hobbies/interests, was evaluated. For Starting a Conversation, step four, make a comment/open the conversations by bringing up a topic, was evaluated for novelty. Following provision of an opportunity to engage in a skill, researchers recorded the verbatim response of the participant to determine whether criteria for a novel response were met.

Generalized novel responding was also assessed across persons. Specifically, participant's novel responding when provided an opportunity to engage in a skill by a parent was assessed identically as in the training setting. For Two-way Conversation and Starting a Conversation, opportunities to respond were provided by participant's own parent. For Finding Similar Interests, opportunities to respond were provided by another participant's parent. Parents were trained to deliver opportunities to engage in target skills via behavioral skills training by a school psychology doctoral student who did not facilitate social skill lessons. Additionally, parents

Table 1 Task analyses of target skills

Two-way conversation	Finding similar interests	Starting a conversation
<p>Opportunity to engage in the skill: Hey (participant's name)</p> <ol style="list-style-type: none"> 1. Orient head/shoulders towards the person 2. Make eye contact within 5 s and sustain for 3 s 3. Ask open-ended question, ask a question that requires more than one-word answers (use how or why) 4. Listen by remaining oriented towards and maintain eye contact w/ conversation partner or nod head 	<p>Opportunity to engage in the skill: Hey (participant's name), I heard you like _____</p> <ol style="list-style-type: none"> 1. Orient head/shoulders towards the person 2. Make eye contact within 5 s and sustain for 3 s 3. Ask a question about what hobbies they like/what their interests are 4. Listen by remaining oriented and maintaining eye contact w/ partner or nod head 5. Respond with a relevant response (e.g., I really like to do that, how long have you done that) 	<p>Opportunity to engage in the skill: Sit next to participant</p> <ol style="list-style-type: none"> 1. Orient posture towards conversation partner 2. Give a signal to obtain the partner's attention 3. Make eye contact within 5 s and sustain for 3 s 4. Make a comment, open the conversation by bringing up a topic 5. Listen by remaining oriented and maintaining eye contact w/ a conversation partner or nod head 6. Provide a relevant comment in response

were cued to provide opportunities to engage in the target skill by the same doctoral student who pointed to their clipboard to indicate which opportunity to engage in a skill to provide. All generalization probes were conducted in the same room that training was implemented in.

Skill Accuracy A secondary dependent measure of the current study was the percentage of skill accuracy of three target skills in the training setting. Skill accuracy was assessed in response to the same opportunity to engage in a skill and simultaneously to assessment of novel responding. Following provision of an opportunity to engage in a skill, researchers recorded the number of skill steps accurately demonstrated and divided the total number of accurate steps by the number of possible steps to calculate the percentage of skill accuracy. A task analysis of skill steps for each target skill was derived from the PEERS manual (Table 1). Generalized skill accuracy data were also collected as a secondary measure.

Autism Spectrum Rating Scale The ASRS (Goldstein and Naglieri 2009) was completed by parents of participants prior to collection of baseline data and upon conclusion of the study. The ASRS is a 71-item measure that may be utilized in diagnosis, intervention development, and progress monitoring. Items on the ASRS are rated on a five-point Likert scale, with items ranging from 0 (never) to 4 (very frequently). The ASRS yields a total score and a DSM-5 scale, as well as several subscales. Subscales of interest in the current study included the Atypical Language subscale, which includes items related to off-topic and repetitive spoken communication, and the Behavioral Rigidity subscale, which includes items related to doing things the same way each time and insistence on routine. Finally, the Peer Socialization and Adult Socialization subscales were included as subscales of interest.

Procedure

Skill Identification Prior to collection of baseline data, parents of the participants completed the Autism Social Skills Profile (ASSP; Bellini and Hopf 2007). Information obtained from the ASSP was used to identify skill deficits, with three target skills from the PEERS manual selected based upon this information. Although the PEERS is typically implemented as a whole, selection of three target skills was performed to tailor the program to the specific deficits demonstrated by participants and not spend time addressing skills in which the participants already demonstrated proficiency.

Baseline Following identification and development of task analyses of the target skills, baseline data commenced. During baseline, doctoral students and parents provided opportunities to engage in the target skill to participants for the three target skills. Data collection began by either a doctoral

student or parent providing an opportunity for a participant to demonstrate a target skill (see Table 1). Following presentation of an opportunity to demonstrate a skill, a doctoral student recorded the number of skill steps demonstrated by the participant and recorded the participant's verbatim response to determine novel responding. No performance feedback regarding skill accuracy or novel responding was provided during this phase. Probes were provided in the order in which they were to be trained according to the PEERS manual. At the conclusion of probes, participants were thanked for their participation. No other reinforcement was provided.

Intervention All social skill training procedures were facilitated by two third-year school psychology doctoral students. Social skill training was conducted once per week for 1.5-h sessions. A modified version of the PEERS curriculum for school-based professionals was utilized during intervention. At the beginning of the social skill lesson, participants were greeted and the daily schedule was reviewed. Next, the target skill was introduced and the rationale incorporated within the PEERS manual was explained. Following, the two facilitators modeled accurate and inaccurate demonstration of skill utilizing the scripts from the PEERS manual. For the Finding Similar Interest lesson, however, a script was developed (Table 2) as no specific script for this skill was available in the manual. Three exemplars of each target behavior were modeled prior to the role-play session (Table 3). Participants then role-played using the target skill with the two facilitators and were provided with corrective feedback or praise dependent on performance. To address restricted and repetitive responding, a lag 2 schedule of reinforcement was used during the intervention phase, meaning that in order for a participant to receive praise they had to provide a response that was both accurate and that differed from their two previous responses to the same opportunity to engage in the target skill. Consistent with previous applications of lag schedules, praise was provided based only in accurate responding during the first role play (e.g., Wolfe et al. 2014). During the second role play, praise was provided following a response that was accurate and differed from the response to the first probe (i.e., identical to lag 1). During all following role plays, praise was provided following responses that met the lag 2 schedule.

Contingent upon incorrect demonstration of skill or failure to meet the lag requirement, facilitators provided corrective feedback using a least-to-most prompting procedure (e.g., Murzynski and Bourret 2007). For failure to meet the lag requirement, the facilitators stated, "you have already said that, try a different response next time." Additionally, if participants still did not meet the requirement, the facilitators stated "you have already said that, next time try [previously modeled response]." Role play continued until each participant met the lag 2 requirement one time. Lastly, participants played a game involving the entire group in which the target skill was used. More specifically, the game for Two-Way Conversation was "Treasure Hunt," in which a participant had to ask the facilitators and other participants questions to locate a specific toy; the game for Finding Similar Interests was "Question Ball," in which the participants had to ask a specific question (as indicated by the question ball) to another participant; the game for Starting a Conversation was "Heads Up, Seven Up," in which the participants were required to maintain eye contact when making a guess on who pushed their thumb down.

Following the game, probes were conducted while participants engaged in a free time period. Probes were delivered by two school psychology doctoral students who did not facilitate the social skill lessons. The opportunities to engage in a target skill utilized during intervention phase probes were identical to those used during baseline. Praise (e.g., "good job!") was provided for accurate skill demonstration and demonstration of varied responses. Error correction was provided for inaccurate skill use. For responses that were accurate but did not meet the lag 2 schedule, prompting was provided using the same procedures that were used during the role-play sessions. Generalization data was collected using these same procedures; however, the parent was the person providing the prompt, praise, and, if necessary, corrective feedback to the participant. Praise and corrective feedback were left in place during generalization probes as a means of sequential modification (Stokes and Baer 1977). At the end of the lesson, participants that had demonstrated at least seven responses that met the lag 2 criteria were rewarded with a small toy from a prize box. Seven responses were selected because the participants were given nine opportunities to respond, and seven responses most closely approximated meeting the lag 2

Table 2 Finding similar interests' script

Speaker	Inappropriate	Appropriate
Person 1	Hey, I heard you like gymnastics.	Hey, I heard you like gymnastics.
Person 2	Yes, it's my favorite. I really like all the things you can do. Beam is my favorite. Bars really hurt my hands. Vault is cool because you can run and jump and do really cool flips. (go on and on)	Yes, I really do! What do you like to do in your free time?
Person 1		I like _____.
Person 2		Oh, that's really cool—so do I!

Table 3 Training exemplars

Two-way conversation	Finding similar interests	Starting a conversation
1. What are you going to do when you get home?	1. What is your favorite hobby?	1. How are you doing?
2. How is your day going?	2. What do you like to do in your free time?	2. What are you up to?
3. What are you doing this weekend?	3. What are you interested in?	3. Let us do something, what do you want to do?

criteria during 80% of responses. This criterion was the same across all participants and throughout all phases.

Maintenance In order for the maintenance phase to begin, at least two participants had to demonstrate stable levels of accuracy for the target skill. Once this occurred, a new skill was introduced and the previously taught skill was moved to maintenance. As such, maintenance data collection began one week after completion of an intervention phase. For Two-way Conversation, maintenance data were collected during five sessions, for Finding Similar Interests, data were collected during three sessions, and due to time constraints and the school year ending, there were no maintenance data collected for Starting a Conversation. Maintenance data were collected to assess the extent to which skill accuracy and novel responding continued to be demonstrated. During this phase, researchers and parents provided the same opportunity to engage in a target skill utilized during baseline and intervention phases. Identical to the baseline phase, performance feedback was not provided for accurate responding or novel responses.

Interobserver Agreement Interobserver agreement (IOA) was obtained by school psychology doctoral students. Prior to the study, the doctoral students were trained by the primary researcher. Specifically, doctoral students were given the task analyses to review and then practiced coding, recording verbatim responses, and determination regarding novelty of responses while other doctoral students role-played each of the target skills. Coding of task analyses, recorded verbatim responses, and dichotomous determinations of novel responding were then compared, and error correction was provided. This procedure continued until all doctoral students demonstrated 100% IOA with the primary researcher during three consecutive role plays. During the study, doctoral students independently recorded skill accuracy of each of the target skills. The number of agreements in demonstrated steps was divided by the number of agreements and disagreements and that value was multiplied by 100 to calculate IOA. Additionally, IOA was calculated for novel responding by comparing raters' dichotomous determinations regarding the novelty of a response. All IOA was completed during the actual observations. If IOA fell below 80% for either skill accuracy or novel responding, observers were retrained by the primary researcher using the same training procedures previously described.

During each phase, IOA was collected for a minimum of 20% of observations. For Mick, IOA was calculated for 56% of all observations with a mean of 97% for skill accuracy and 100% for novel responding. For Christine, IOA was calculated for 37% of all observations with a mean of 97% for skill accuracy and 100% for novel responding. For John, IOA was calculated for 39% of all observations with a mean of 99% for skill accuracy and 100% for novel responding.

Procedural Integrity Procedural integrity was evaluated using an integrity checklist during each session. The checklist steps included data collection procedures specific to the current study, and when applicable, intervention steps derived from the PEERS curriculum for school-based professionals manual. Two doctoral students who did not facilitate the intervention completed the procedural integrity checklist in real time during each session. Procedural integrity was calculated by dividing the number of steps completed by the number of possible steps, then multiplying that value by 100. IOA for procedural integrity was calculated by dividing the number of agreements of steps completed by the number of agreements and disagreements, then multiplying that value by 100. All study procedures were implemented with 100% integrity across all sessions with IOA of 100%.

Data Analyses

The study utilized a multiple probe design across skills with concurrent replication across participants (Gast 2010). Target skills were assessed across three phases, baseline, intervention, and maintenance. Phase changes occurred based upon visual analysis of skill accuracy data for researcher-delivered probes, with phase changes made following demonstration of data stability for at least two participants. Data were analyzed via visual analysis of level, trend, variability, consistency across similar phases, overlap, and immediacy of effect (Kratochwill et al. 2010) for both skill accuracy and cumulative novel responses.

Results

Cumulative Novel Responses

During baseline, Mick demonstrated no novel responses for the Two-way Conversation and Finding Similar Interest skills

during both researcher- and parent-delivered probes (Fig. 1). One novel response to a researcher-delivered probe was observed for the Starting a Conversation skill. Following implementation of the intervention, rapid increases in the cumulative number of novel responses provided were observed for Two-way Conversation, Finding Similar Interests, and Starting a Conversation across both researcher- (9, 5, and 7 novel responses, respectively) and parent-delivered probes (7, 5, and 6 novel responses, respectively). Data collected during maintenance indicated smaller improvements in cumulative novel responses for both researcher- and parent-delivered probes.

With the exception of one novel response to a researcher-delivered probe, Christine demonstrated zero novel responses across skills during baseline (Fig. 2). Following the introduction of intervention, rapid increases in novel responses were observed for all skills during both researcher- (7, 6, and 5 novel responses, respectively) and parent-delivered probes (5, 4, and 5 novel responses, respectively). For researcher-delivered probes of Two-way Conversation, cumulative novel responses continued to increase during maintenance. For Finding Similar Interests, minimal increases in the cumulative novel responses were observed during maintenance.

Fig. 1 Cumulative novel responses of Mick

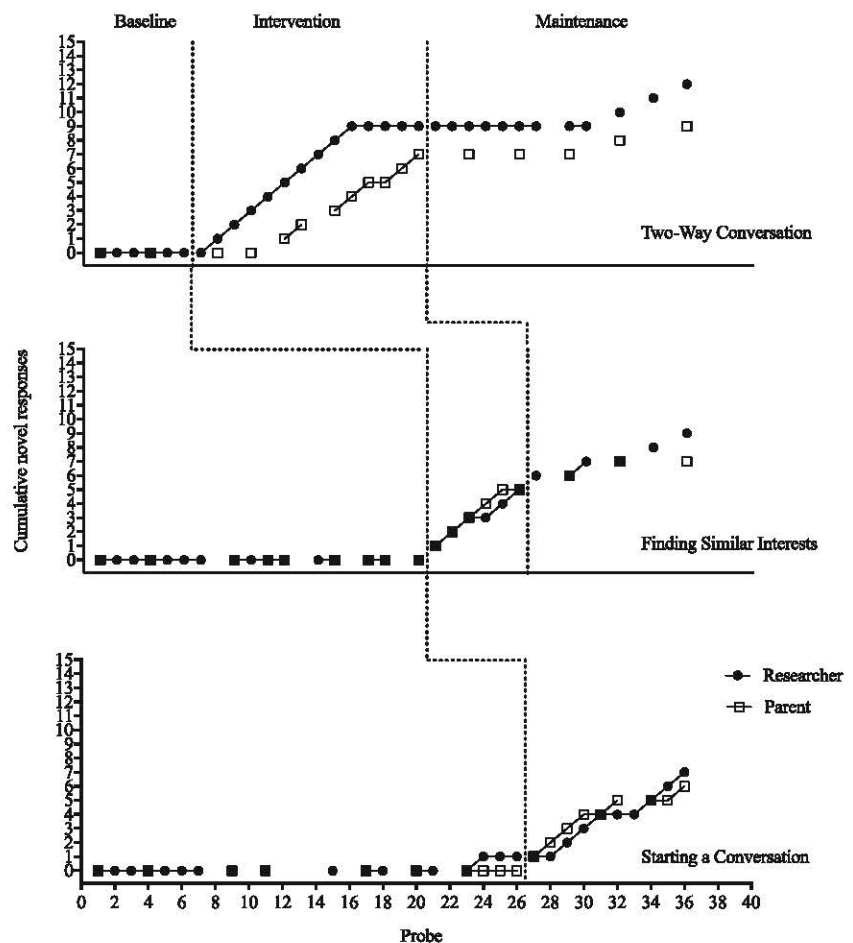
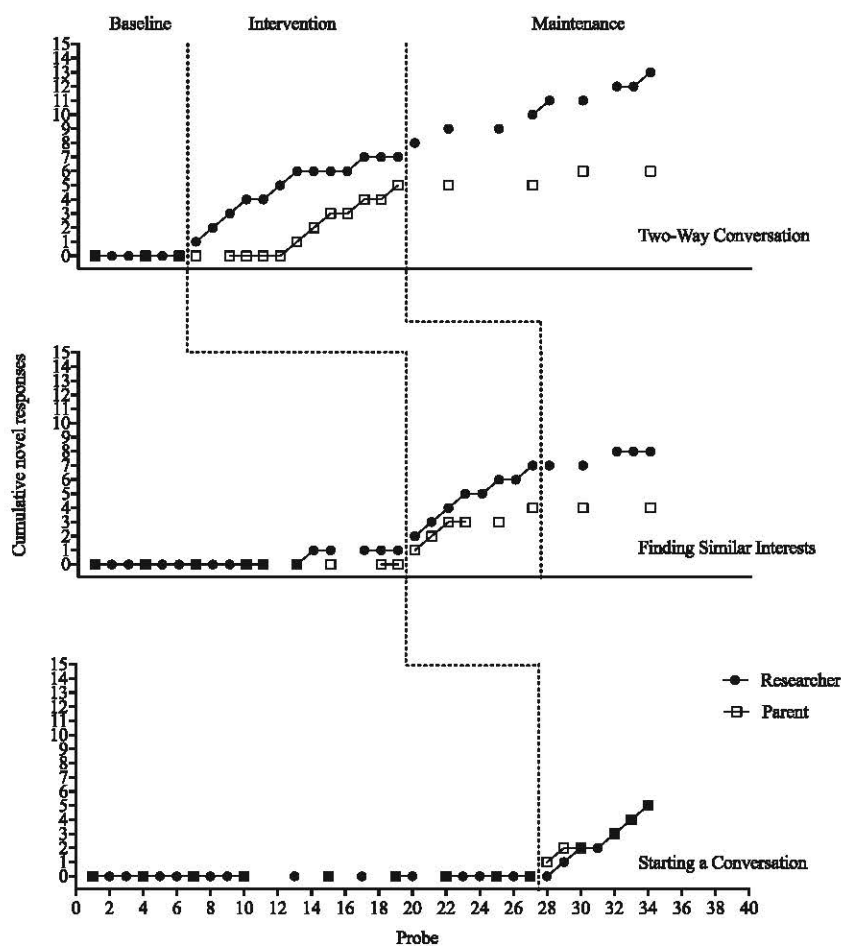


Fig. 2 Cumulative novel responses of Christine



During baseline, Christine demonstrated low to moderate and variable levels of skill acquisition for all target probes during researcher- and parent-delivered probes (Fig. 5).

During intervention, immediate increases in skill accuracy were observed across all skills for researcher-delivered probes, with some variability observed for the Starting a

Fig. 3 Cumulative novel responses of John

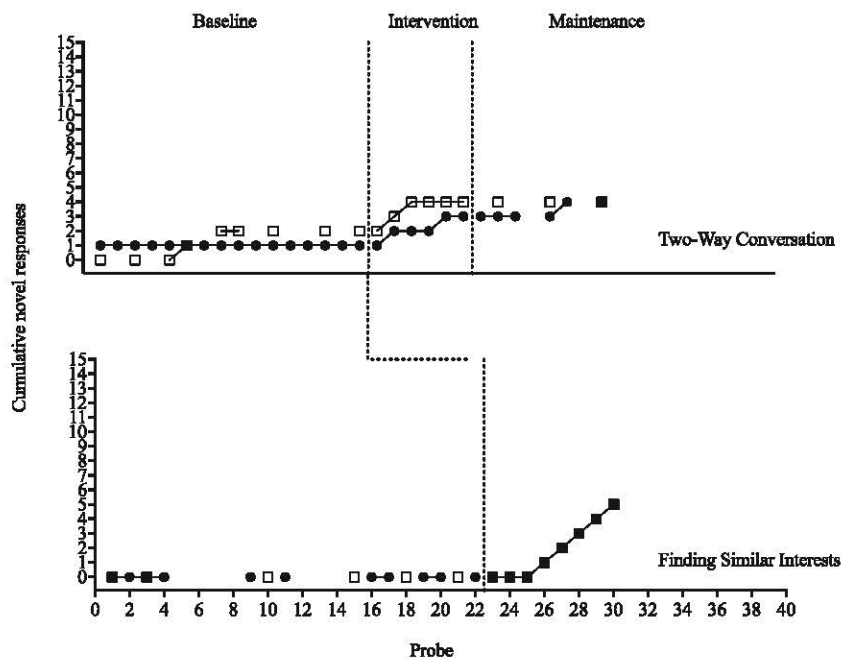
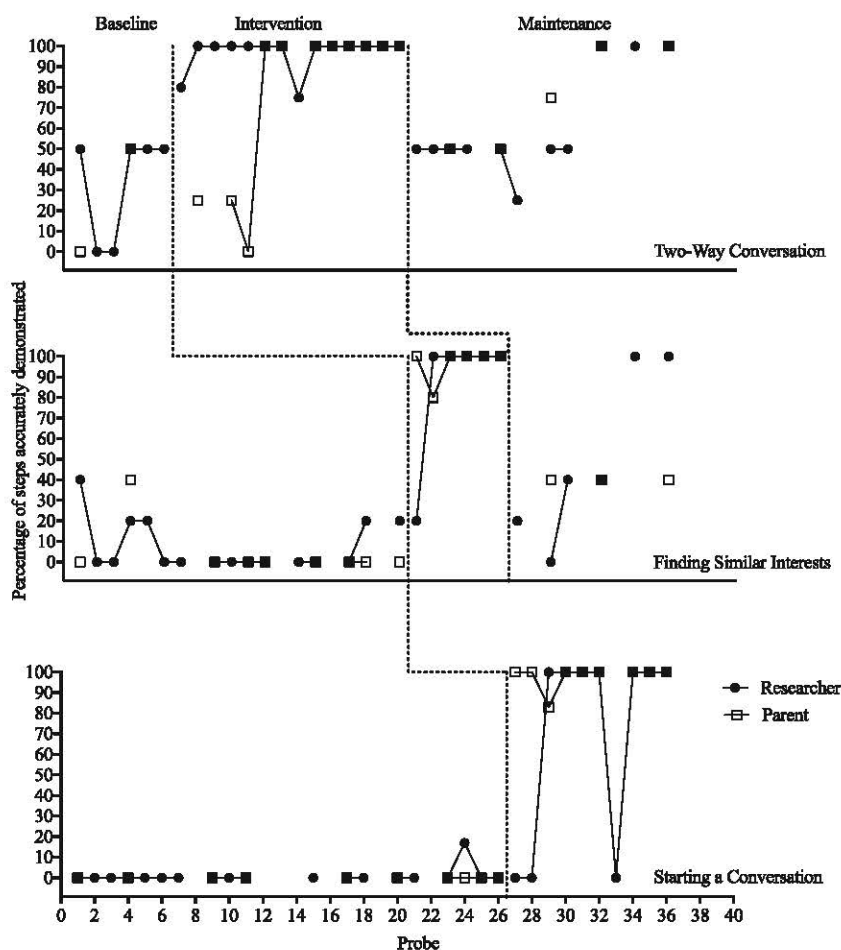


Fig. 4 Social skill accuracy of Mick



Conversation skill. Generalization data revealed improved skill accuracy over baseline levels. High levels of variability were noted in the maintenance phase for both training and generalization, with the high levels of accuracy observed during the intervention phase not being maintained.

John demonstrated low to moderate levels of accuracy for both researcher- and parent-delivered probes for Two-way Conversation during baseline (Fig. 6). Due to substantial variability, additional baseline probes were conducted. Data for Finding Similar Interests demonstrated generally low levels throughout the baseline phase for both researcher- and parent-delivered probes. Due to participant absence and subsequent lack of intervention phase data, data for the Starting a Conversation are not presented. John was also absent for one intervention session for Two-way Conversation, resulting in fewer data points collected for this skill in comparison to other participants. During intervention, substantial overlap in data was observed for Two-way Conversation. For Finding Similar Interests, delayed improvements in skill accuracy were observed. Maintenance phase data indicate generally low levels of skill accuracy across both researcher- and parent-delivered probes. Due to absence, no maintenance data were collected for Finding Similar Interests.

Autism Spectrum Rating Scale

Pre- and post-intervention parent ratings on the ASRS are presented in Table 4. With the exception of Christine for the Peer Socialization subscale, all scores across participants were observed to decrease from pre- to post-intervention. In order to quantify changes from pre- to post-intervention, paired sample *t* tests were conducted. Significant changes were observed in the DSM-5 scale, $t(2) = 4.500$, $p = 0.046$, and the Atypical Language subscale, $t(2) = 5.166$, $p = 0.035$. Although mean improvements were observed in other scales of interest, statistical significance was not obtained.

Discussion

The purpose of the present study was to evaluate the effect of the PEERS curriculum, modified to incorporate lag schedules of reinforcement, on discrete skill acquisition and novel responding in children with ASD. Across all participants, implementation of the modified curriculum was associated with increases in the number of exemplars of appropriate and novel responses demonstrated by participants following

Table 4 Pre- and post-intervention ASRS scores

	ASRS total		DSM-5		Atypical language		Behavioral rigidity		Peer socialization		Adult socialization	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Mick	71***	65*	74***	67**	71***	60*	79***	75***	67**	61*	62*	60*
Christine	70***	59	69**	62*	62*	44	61*	47	74***	75***	62*	49
John	79***	64*	77***	64*	78***	68**	75***	67**	71***	61*	74***	66**

***Scores are very elevated

**Scores are elevated

*Scores are slightly elevated

consistent with previous research, finding lag schedules of reinforcement to be a useful strategy for addressing restricted and repetitive behaviors in individuals with ASD (e.g., Lepper et al. 2017; Susa and Schlinger 2012).

Whereas findings of improved novel responding to researcher-delivered probes are important, findings regarding increased novel responding to parent-delivered probes are particularly noteworthy. A growing body of research indicates the utility of lag schedules in increasing variable responding (e.g., Adami et al. 2017); however, few studies have evaluated generalization across persons (Wolfe et al. 2014). Of those studies evaluating generalized effects of lag schedules (Argott 2010; Lee and Sturme 2014; Lee et al. 2002), mixed results have been obtained. Although additional research is necessary to determine those elements that may promote generalization of variable behaviors, the current study provides encouraging support regarding the potential for social skill curricula incorporating lag schedules of reinforcement to result in generalized improvements in both skill accuracy and novel responding.

Results of the study also indicated that implementation of the intervention resulted in improvements in skill accuracy across all participants and skills, except for the Two-way Conversation for John. Skill accuracy data collected via direct observation support previous research finding parent, teacher, and self-ratings of social functioning and related skills to improve following participation in the PEERS (Laugeson et al. 2014; Mandelberg et al. 2014; Schohl et al. 2014). Also supporting previous research indicating improved social skill use under non-training conditions, data collected during probes with parents indicate improvements in skill accuracy with adults not involved in training. These findings are important, as generalization has been reported to be a particularly challenging aspect of social skill training with individuals with ASD (Barry et al. 2003).

It should be noted that novel responding slowed and skill accuracy decreased from intervention phase levels during maintenance phases in which reinforcement for demonstrating all target skill steps was no longer provided. As an additive analysis of PEERS and reinforcement strategies was not

conducted because it is difficult to evaluate the relative contribution of each component of intervention to the observed outcomes. However, the decrease in novel responses and skill accuracy during maintenance suggests that provision of reinforcement may have an important effect on the outcomes of the current study. Future researchers may consider a more gradual thinning of the schedule of reinforcement as a means of maintaining high levels of accuracy and novel responding following termination of intervention procedures.

The generalized effects of the intervention are further indicated by changes in parent ratings on the ASRS. Of note are the significant changes observed in the Atypical Language subscale, as items on this subscale are directly related to behaviors targeted in the current study (e.g., repetitive and out-of-context speech). As improvements in parent ratings were generally noted and often resulted in participants moving from one descriptive category to another, a failure to obtain significant changes on other scales of interest may be due to the small sample included in the current study—with research suggesting acceptable power may only be reached if effects are very large when using *t* tests with small samples (Winter 2013). Despite limitations associated with the pre–post nature of the ASRS in the current study, these data provide preliminary support for the effect of clinic-based intervention on behavior of participants in more naturalistic settings (e.g., school, community).

Limitations and Future Directions

The results of the current study must be viewed in light of several limitations. First, no additive component analysis was conducted as in Radley et al. (2017a, b). As such, the effect of the PEERS without modification on novel responding is unknown. Although research evaluating programs containing similar practices has demonstrated the utility of lag schedules of reinforcement in promoting variable responding beyond training multiple exemplars (Radley et al. 2017a, b), future researchers should consider conducting an additive component analysis to determine the relative contribution of lag schedules to the results observed. Second, due

to absence, not all participants were exposed to all skills or equal amounts of training in each skill. More specifically, John did not receive training in the Starting a Conversation skill. Relatedly, John's absence precluded collection of maintenance data for the Finding Similar Interests skill. Although data collected for Mick and Catherine meet What Works Clearinghouse Standards for single-case design (Kratochwill et al. 2010), it is not possible to make conclusions regarding functional relationships for John due to the lack of data. As such, it would be beneficial to replicate the procedures of the current study to establish functional control with a larger number of participants. Treatment dosage in relation to response to lag schedules should also be considered in future research, as the participant with the poorest attendance (i.e., John) demonstrated the smallest and most delayed response to intervention.

It should be noted that there was no assessment for skill acquisition deficits or performance deficits (Gresham and Elliott 1987). As such, it is possible that participants did not require training in discrete skill steps in order to demonstrate the improvements in skill accuracy observed during the intervention phase. In such a case, participants may have only required reinforcement in order to demonstrate target skills with a high level of accuracy. Given this limitation, it is imperative that future investigations conduct assessments for skill acquisition and performance deficits in order to determine the necessity of the full intervention program (e.g., Bellini et al. 2007).

Although data collected in the current study indicate participant performance under intervention conditions (e.g., reinforcement contingencies in place), it is unknown whether participants would have demonstrated similar levels of accuracy and novel responding to probes during the intervention phase in which consequences for accurate and novel responses were not in place. In an effort to assess the broader effects of the procedures utilized in the current study, researchers may conduct intervention phase probes under conditions dissimilar to training (e.g., no reinforcement or performance feedback provided).

Finally, generalization data was collected with parents in the training setting. Although findings of generalization are important, stimuli in the training setting may have served as cues for variable skill use. In order to extend the findings of the current study, data should be collected in non-training environments with novel communication partners to better assess the generalized effects of social skill training programs incorporating lag schedules of reinforcement. Future researchers may also consider collecting and assessing other variables that may indicate the social validity of the modified PEERS as implemented in the current study. These data may include duration and frequency of social interactions with peers during unstructured periods, parent reports of skill accuracy and restricted and repetitive behavior, and sociometric data.

Author's Contributions KCR designed the study, supervised execution of the study, conducted data analysis, and wrote the manuscript. KAH assisted with the design of the study, facilitated intervention sessions, collected data, and collaborated in writing of the manuscript. ANM facilitated the intervention sessions, collected data, and collaborated in writing of the manuscript. MGM collected data and collaborated in writing of the manuscript. ELL collected data and collaborated in writing of the manuscript.

Compliance with Ethical Standards

Conflicts of Interest All authors of the study report that they have no conflicts of interest.

Ethical Approval All procedures performed in the current study were in accordance with the ethical standards of the institution and the national research committee and with the 1964 Helsinki Declaration and its later amendments. Prior to conducting the current study, Institutional Review Board approval was obtained from the University of Southern Mississippi.

Informed Consent Informed consent and assent were obtained for all individual participants included in the study.

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