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Research Article

Incorporating a Peer-Mediated Approach Into Speech-Generating Device Intervention: Effects on Communication of Preschoolers With Autism Spectrum Disorder

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Purpose: This study examined the effects of incorporating a peer-mediated approach into a speech-generating device (SGD) intervention on communication of 45 nonverbal and minimally verbal preschoolers with autism spectrum disorder (ASD) and 95 peers without disabilities. The SGD was an iPad 2 (Apple) with voice output app.
Method: Effects were evaluated using a multivariate randomized control trial design with repeated measures for 4 cohorts across baseline, intervention, generalization, and maintenance phases. Children were randomly assigned to an experimental treatment that trained peers on use of the SGD or a business-as-usual comparison condition with untrained peers. Communication outcomes were measured for both children with ASD and peers.
Results: Children receiving the treatment demonstrated significant increases in rates of communication and more balanced responses and initiations (a measure of reciprocity) than children in the comparison group. They were able to generalize improvements and maintain communication gains. Treatment fidelity was high for school staff and peer implementation.
Conclusions: Results support positive effects on communication of teaching young children with ASD and peers without disabilities to use the same SGD system in typical preschool activities. SGD interventions that utilize peer-mediated approaches may improve core deficits in communication and reciprocity and allow for greater classroom social participation and interactions with peers.

Young children with autism spectrum disorder (ASD) who are nonverbal or minimally verbal often rely on a speech-generating device (SGD) to augment their communication. This type of augmentative and alternative communication (AAC) system has much empirical support on improving communication (Ganz et al., 2012; Millar, Light, & Schlosser, 2006; Romski, Sevcik, Barton-Hulsey, & Whitmore, 2015; van der Meer & Rispoli, 2010). To date, SGD intervention research has focused mainly on elementary school–age children; there is much less research with younger children (Schlosser & Koul, 2015). Studies on older students report that many use AAC systems to interact primarily with adults in their environments (Chung, Carter, & Sisco, 2012a). Recent research supports SGD interventions that teach peers without disabilities to be responsive communication partners within routine preschool activities (Thiemann-Bourque, Brady, McGuff, Stump, & Naylor, 2016; Thiemann-Bourque, McGuff, & Goldstein, 2017). Interventions that increase augmented communication with peers have a number of potential benefits, including greater participation in educational environments, learning skills to develop friendships, and improved attitudes of others toward children who use AAC (McCarthy & Light, 2005).

SGD Interventions to Increase Communication

There is evidence to support the positive effects of SGD instruction on communication skills of children with complex communication needs, including those with ASD (Ganz et al., 2012; Millar et al., 2006). In a recent review, Schlosser and Koul (2015) summarized 26 studies that included speech output technology as part of an intervention package with a total of 116 individuals with autism (ages 3–21 years). In 62% of these studies, outcomes were interpreted as providing suggestive or better evidence of positive effects on the basis of quality design indicators. For

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preschool children with ASD, different strategies have been examined in combination with SGD instruction to improve communication, such as enhanced milieu teaching (EMT; e.g., following child's lead, arranging the environment; Olive et al., 2007) and naturalistic teaching procedures (i.e., natural consequences and environments; Schepis, Reid, Behrmann, & Sutton, 1998). These two studies reported increased child communication and interactions with adult partners. In the one randomized group study examining added benefits of an SGD, Kasari et al. (2014) assigned 61 children with autism (5–8 years) to two interventions: one that added SGD use to a blended Joint Attention Symbolic Play and EMT intervention and a comparison condition that included Joint Attention Symbolic Play and EMT without an SGD. Results showed greater spontaneous communicative utterances for children who started the intervention with the SGD. Interestingly, the children were not taught how to use the SGD; adults provided modeled input for 50% of their own utterances. Providing direct SGD instruction may have led to even greater child communication improvements.

Communication Outcomes of SGD Interventions

There is evidence of the benefits of SGD interventions to increase expressive speech and spoken words, social interactions, and receptive vocabulary (Kasari et al., 2014; Light & McNaughton, 2014; Schepis et al., 1998). Schlosser and Koul (2015) noted the need to intensify future research on the impact that speech output technologies may have on other communication skills using more rigorous comparative designs. In the comparative SGD study by Kasari et al. (2014), the intervention focused on building play routines to increase joint engagement between the adult and child, a critical component to help young children with autism develop language. Positive outcomes were noted in requests, comments, and number of different words. To date, there are a lack of intervention studies examining characteristics of exchanges between child and adult partners in a social context, such as proportion of child-initiated exchanges and reciprocal communication (DiStefano, Shih, Kaiser, Landa, & Kasari, 2016). DiStefano et al. analyzed these variables for 55 children from the Kasari et al. (2014) study and found that children in both treatment conditions increased their proportion of initiations (INs) over time and that children with the added SGD component showed greater growth in number of exchanges with adults. Although recent studies have documented a positive impact of SGD technology on a wider range of communication skills, there is limited research on intervention contexts with peer partners.

AAC Interventions and Peer Partners

Children with ASD learning to use AAC are severely restricted in participation in educational and social environments (Light & McNaughton, 2012). These restrictions reduce opportunities to interact in settings where peers should be the expected social partner. Research on strategies to teach peers to be communication partners for individuals with developmental disabilities learning to use AAC is growing for elementary and secondary students (Chung, Carter, & Sisco, 2012b). Therrien, Light, and Pope (2016) reported that, of 19 AAC studies designed to improve peer interactions, only 30% included participants with autism and that six of these were preschool children with complex communication needs (within two single-subject design studies). Overall, the authors reported higher gain scores on peer interaction skills in studies that combined approaches, such as peer training (e.g., peers taught to model or prompt AAC use), child-specific instruction on AAC use, and arranging the environment.

Systematic reviews have concluded that peer-mediated interventions (PMIs) are evidence based and improve core deficits in social communication skills for children with ASD (Goldstein, Lackey, & Schneider, 2014; Watkins et al., 2015). In one of two single-subject studies that combined SGD instruction and peer training, Cosbey and Johnston (2006) prompted young children with autism to use a single-message switch (i.e., "That looks fun. Can I play?") to ask peers for items. Results showed increased spontaneous switch use for all children; however, limitations include a lack of peer data collected during baseline and no details on how peers were trained or fidelity. AAC research on PMIs should provide details on skills peers are trained on and length of training, procedures, and intervention fidelity so that findings can be interpreted and replicated. The second single-case study by Trembath, Balandin, Togher, and Stancliffe (2009) addressed some of these limitations in an investigation of a PMI for two preschoolers with autism by describing the length of training (i.e., two 20-min sessions), specific steps (i.e., how to *show, wait,* and *tell*), and how skills were taught. Peers learned how to help children with autism select pictures on a ZYGO-USA Talara-32. Two children demonstrated greater communication in sessions that included the SGD and the PMI compared with sessions that did not include the SGD. The authors reported that many prompts were needed for peer SGD models during meaningful interactions and stated the need for research on instructional supports to help young peers be successful.

Two recent studies demonstrate the viability of teaching peers without disabilities to be responsive AAC partners (Thiemann-Bourque et al., 2016; 2017). The PMI was a modified version of an empirically supported preschool program called *Stay-Play-Talk* (SPT; English, Goldstein, Shafer, & Kaczmarek, 1997; Goldstein, English, Shafer, & Kaczmarek, 1997). The main adjustment was teaching peers how to use an AAC system during the *Talk* phase. Thiemann-Bourque et al. (2016) combined SPT with a Picture Exchange Communication System (Bondy & Frost, 1994). After peer training, four children with autism (3;0–5;1 [years; months]) and five peers without disabilities (3;4–4;11) showed increased communication in centers, with greater increases in communication and engagement for two children in snack. The authors reported a lack of balanced initiations (INs) and responses (RSs), in that the children with autism used more than twice the number of INs compared with peers and that peer RSs were higher than INs. This finding contrasts with reports that, historically, PMIs have a greater impact on child RSs than child INs (Rogers, 2000). Perhaps it was the nature of the Picture Exchange Communication System in that children selected a symbol to request objects and the peers responded in turn. In the second study, Thiemann-Bourque et al. (2017) combined SPT with a Go Talk4+ (Attainment Company, 2012) to examine effects on communication for three children with autism (4;5–4;7) and three peers (4;5–4;6). This PMI included one change to SPT—peers were taught *More Ways to Be a Good Buddy* (i.e., Get buddy's attention and hold and wait). Outcomes revealed a functional relationship between the start of treatment and higher rates of communication for the children with autism with moderate effect sizes (Tau-U range of 0.50–0.67) and larger effects for communication increases for the three peers (Tau-U range of 0.88–1.00; Parker, Vannest, Davis, & Sauber, 2011). One of three child–peer dyads showed more balanced INs and RSs.

Although both INs and RSs are required for reciprocity, most PMI studies to date report total rates of these behaviors and not proportions of each within social exchanges. Early PMI studies documented the effects of peer-IN strategies (e.g., initiate joint play, establish focus of joint attention) on increasing child RSs to peers (Goldstein & Wickstrom, 1986; Strain & Odom, 1986), and later research explored teaching peers strategies, such as pivotal RS training, to increase more complex social IN behaviors (Pierce & Schreibman, 1995). Goldstein and Kaczmarek (1992) reported that balance in the number of children's utterances can discriminate quality of interaction better than a measure of total utterances. Interventions that report outcomes on both rates and the balance of INs and RSs for children with ASD and trained peers would make an important contribution to the literature and guide instructional strategies to target core deficits in reciprocal communication.

In summary, the current study was conducted to advance what we know about effective interventions for preschool children with ASD and complex communication needs. The study includes a larger number of children and examines the benefits of a mobile technology that has had a marked upsurge in recent years, iPads (iPad 2, Apple) with voice output apps. The general hypothesis was that an SGD (iPad) intervention that incorporates a peer-mediated approach would lead to better communication outcomes and more balanced exchanges for children with ASD and peer partners compared with a business-as-usual group with untrained peers. Thus, we tested this hypothesis in terms of differences in

1. growth in children's rate and reciprocity of communication,
2. generalization of communication to novel settings and untrained peers,
3. maintenance of gains in communication over time,
4. impact on standardized language measures, and
5. social validity perceptions of changes in quantity and quality of child social behaviors.

Method

Participants

Participants included 45 children with ASD, 36 boys and nine girls between the ages of 2;11 and 5;0, with 23 in the treatment group and 22 in the comparison group. At the start of each school year, 11 to 12 children were recruited for a total of four cohorts (see Table 1 for demographics). Children were recruited from 14 preschools within 10 districts in the Kansas City metro area. All children attended preschool 3 hr per day, 4 days per week, with the exception of five children who attended full-day preschool (two in treatment; three in comparison). Programs ranged from full or partial inclusion to self-contained classrooms serving children with ASD and other developmental disabilities. All children received in-class and pullout services. Individualized Education Programs revealed that children in the treatment group received an average of 77 min/week (range = 30–120 min) of speech-language therapy and 36 min/week (range = 0–120 min) of occupational therapy, and four children received physical therapy (range = 30–60 min/week); two children received applied behavior analysis (ABA) services at another facility for half days. In the comparison group, children received an average of 68 min/week (range = 30–90 min) of speech-language therapy and 44 min/week (range = 0–75 min) of occupational therapy, and two children received physical therapy (range = 20–30 min/week); two children received ABA services at another facility.

Children were included in two ways: one, if they had an educational determination of ASD; and two, if they met the following criteria: (a) a diagnosis of ASD by a community-based developmental pediatrician or child psychologist, confirmed by educational records and parent report; (b) scores on the Childhood Autism Rating Scale–Second Edition (Schopler, Van Bourgondien, Wellman, & Love, 2010) above 30 (i.e., mild to severe symptoms of ASD); (c) nonverbal or minimally verbal (i.e., less than 20 spontaneous words); (d) recommended by the school as a candidate for or already using an SGD; (e) access to typically developing peers; (f) English as the primary language; and (g) limited peer interaction skills based on teacher and parent report using a Social Impression Rating Scale (SIRS; Odom et al., 1997). Exclusionary criteria included lack of upper body and/or hand motor skills to select SGD symbols and severe cognitive disability as determined by educational records. The Preschool Language Scale–Fifth Edition (PLS-5; Zimmerman, Steiner, & Evatt Pond, 2007) and the Mullen Scales of Early Learning (MSEL; Mullen, 1995) were administered at the start and at the end of the year, and the Childhood Autism Rating Scale–Second Edition was administered at the start of the year. Assessments were completed at home by the first author, and the second and fourth authors trained on administration.

Table 1. Demographics of children with autism spectrum disorder at the start of the study.

Group	Age (months)	CARS-2	MSEL	PLS-5		
			ELC	TLS	AC	EC
			(*SS*)	(*SS*)	(*SS*)	(*SS*)
Treatment group (*n* = 23)[a]						
M	48	41.8	49.1	53.5	57.8	53.4
Range	37–60	34.5–50.0	49–51	50–74	50–68	50–67
Comparison group (*n* = 22)[b]						
M	46	41.5	50.0	53.7	59.7	54.2
Range	35–58	34.0–52.5	49–63	50–76	50–72	50–73

Note. CARS-2 = Childhood Autism Rating Scale–Second Edition; MSEL = Mullen Scales of Early Learning; PLS-5 = Preschool Language Scale–Fifth Edition; ELC = Early Learning Composite; TLS = total language score; AC = auditory comprehension; EC = expressive communication; SS = standard score.

[a]Gender and ethnicity: 16 boys, seven girls; 12 White, eight African American, zero Hispanic, zero Asian, three other/mixed. [b]Gender and ethnicity: 20 boys, two girls; 13 White, seven African American, one Hispanic, zero Asian, one other/mixed.

The 95 peers without disabilities included 45 boys and 50 girls between the ages of 3;4 and 5;1. Peers were recommended by the classroom teacher on the basis of (a) age-appropriate social skills, (b) consistent school attendance, and (c) a willingness to participate. They attended the same classroom or were located in a classroom in the same building. Up to four peers for each child with ASD were recruited to participate for one school year and took turns participating in a dyad (one child with ASD:one peer).

A total of 42 special education team members participated: 21 in the treatment group and 21 in the comparison group. School staff in the treatment group had an average of 12 years of teaching experience, and the comparison group had 8 years, with education levels ranging from high school to master's degrees for both groups. School staff trained to implement the treatment included speech-language pathologists (*n* = 10), early childhood special education teachers (*n* = 7), and paraprofessionals (*n* = 4). School staff in the comparison group included speech-language pathologists (*n* = 8), early childhood special education teachers (*n* = 9), paraprofessionals (*n* = 3), and one behavior therapist. Given similar education levels and service providers across groups, the difference in years of experience was not expected to influence child outcomes. Approval for this study was granted by the Human Subjects Committee at the University of Kansas, and all ethical considerations for protection of participants were followed. Parental consent was obtained for all children, and consent was secured for all school staff.

Settings

All sessions took place in the child's classroom, hallway, or a nearby empty room. A child was seen out of the classroom if the staff deemed that this would be more beneficial due to other distractions. Each classroom was staffed by one lead teacher and one to three aides, depending on class size and student educational needs. Participating school staff selected activities depending on what they had available and/or based on child preferences. Activities varied for each session and, in general, were represented within these four common preschool activities: (a) puzzles and matching activities (e.g., Uno Moo; shape sorters), (b) simple games (e.g., Pop the Pig, Pop-Up Pirate, Zingo), (c) sensory activities (e.g., car racer, spinning toys, ball and hammer run), and (d) manipulatives (e.g., Potato Head, play dough, peg boards). A setting for generalization probes with trained peers was in a different location; this setting could have included snack, play on the floor, or motor activities (e.g., therapy swing). If snack was the generalization setting, it occurred with the rest of the class.

Experimental Design

A multivariate randomized control trial was used to address the research questions (Shadish, Cook, & Campbell, 2002). The comparison condition consisted of business-as-usual communication activities set up for a focus child and an untrained peer partner, and school staff were told to use the SGD as they deemed appropriate. The experimental treatment included SGD instruction delivered within a PMI based on the authors' earlier research. To increase sample size, the experiment was repeated four times, once each in 4 years, and combined for a single analysis. Collectively, the four cohorts consisted of 45 focus children with ASD and 95 peer partners. To establish equivalent groups on key variables at start, matching and randomization were used. Participants with ASD in each cohort year were matched on the Early Learning Composite raw score of the MSEL (Mullen, 1995) administered at the start of the year. Each child's score was rank ordered highest to lowest to locate comparable adjacent scores. Children were paired up, and one child from each matched pair was then randomly assigned to either treatment or comparison groups by a random draw from a box. Between-groups tests indicated no significant differences on any preintervention cognitive or language scores.

Within the treatment group, experimental conditions addressing the rate of communication research questions were manipulated as follows: ABCDE, where A = baseline, B = intervention, C = generalization to a trained or nontrained peer, D = generalization to an unfamiliar peer, and E = maintenance (see Table 2). To examine differences in changes in proportion of RSs (vs. INs), experimental conditions ABC were of interest and met quality indicator recommendations for measuring change across multiple phases (Kratochwill et al., 2010). Children in the comparison group participated in the same experimental conditions, ABCDE, with the exception that Phase B consisted of one weekly child–peer activity.

Preparation and Training Procedures

Implementation of the study is discussed in two sections below. First was the training of staff, focus children, and peers regarding use of the SGD. Second was the implementation of the measurement and experimental conditions (i.e., Phases ABCDE; see Table 2 for sequence).

SGD Setup and Training

Following pretest on the standardized language and cognitive measures, training of school staff and child participants occurred. All children were provided with an iPad and voice output app that was installed, the SGD. The first year, SoMuch2Say (Close 2 Home Apps, 2011) was installed. Based on teacher feedback at the end of that year (e.g., limited flexibility, slow button release time), a different app, Touch Chat HD (Silver Kite, 2017), was installed for Years 2–4. Two children were familiar with Proloquo2Go (Assistiveware, 2009); thus they continued to use this app. At the start of each year, the average number of symbols per page for children in the treatment group was six (range of two to 20), and four children could scroll between multiple pages. In the comparison group, the average number of symbols per page was seven (range of two to 20), and two children could scroll between pages. This difference reflects the growth in popularity of iPads in classroom settings and the range in child SGD experience over the 4-year study. Decisions for vocabulary programmed on the iPad were made by school staff and were individualized based on child competencies and Individualized Education Program objectives. The range in number of symbols and in programmed vocabulary (e.g., objects, actions, adjectives, names and pictures of children) were expected given the heterogeneity in communication consistent with this population.

All Staff Training

All participating school staff attended a 2-hr in-service focused on (a) study timeline and expectations, (b) programming symbols and pages on the iPad, (c) peer recruitment, and (d) directions for four 15-min one-on-one SGD treatment sessions with an adult partner. This latter component was included to ensure that all children had the ability to discriminate between a minimum of two symbols to request items at the start of the study. School staff were encouraged to add vocabulary for new activities and as needed on the basis of communication growth.

Additional Staff Implementer Training

Following baseline, school staff was notified of group assignment, and if assigned to treatment, they participated in an additional 1-hr training on (a) procedures for training peers, (b) identifying preferred activities, and (c) guiding and prompting child–peer communication using the SGD. This last component included giving ideas on how to set up social activities with many communication opportunities and how to encourage communication for different reasons. Three children had two adults assigned who shared responsibilities, and four participants attended the same classroom with a different staff assigned to each child (i.e., two treatments and two comparisons). Specific instructions were given to staff in the treatment group on the importance of keeping the comparison staff blind to treatment procedures and not to schedule sessions when the other staff was in the room. The implementers were introduced to the treatment in a stepwise manner (Kratochwill et al., 2010).

SGD Peer-Mediated Training

The selected peers were provided SGD training. Children with ASD did not attend these sessions. The first or second author provided the training, and school staff assisted in modeling skills and guiding practice. Sessions took place in an empty room. Peers were taught to be responsive play and communication partners using a modified version of SPT (Goldstein et al., 1997). Training consisted of the following: Day 1, (a) sensitivity training by viewing videos on ways children communicate and (b) steps to *Stay* with your friend (i.e., Sit close; If buddy moves you move.); Day 2, (a) review of *Stay*, (b) steps to *Play* with your friend (i.e., Share toys; Take turns), and (c) steps to *Talk* with your friend (i.e., Look and Listen—look at buddy, listen to words; and Push and Talk—push picture, say words out loud); and Day 3, (a) review of *Stay*, *Play*, and *Talk* steps and (b) introduce two additional strategies: (a) *Get Attention* and (b) *Hold and Wait*. These two strategies were taught to help the peer elicit communication from the focus child; the peer was not taught to elicit specific pragmatic functions. Programmed SGD vocabulary depicted a range of symbols for different communication purposes; the peer was encouraged to use any symbol that matched the social context. Training followed a standard protocol of (a) giving a Buddy Book with illustrated steps, (b) adult–child practice, (c) child–child practice, (d) and corrective feedback/reinforcement. Total training time was approximately 80 min over 2–3 days (less time with fewer peers). The start of training was staggered across the six matched pairs of children with ASD, with the peers of two pairs beginning training the same week; this was repeated until all peers in a cohort were trained.

Table 2. Timeline for sequence of training and phases across groups.

Procedures and phases	Pretest	All staff training	Baseline (A)	Additional implementer training	SGD peer-mediated training	SGD instruction-trained peer (B)	GEN novel activity (C)	GEN unfamiliar peer (D)	MAINT (E)	Posttest
Experimental condition										
Treatment group	X	X	X	X	X	X	X	X	X	X
						BAU untrained peer (B)				
Comparison group	X	X	X			X	X	X	X	X
Range of weeks	1 to 2	1	2 to 8	1	1 to 2	9 to 19	2 to 8	1 to 2	1 to 3	1 to 2

Note. SGD = speech-generating device; GEN = generalization; MAINT = maintenance; BAU = business-as-usual; ABCDE = all experimental conditions.

Implementation of Experimental Conditions

Pretesting

The PLS-5 (Zimmerman et al., 2007) and the MSEL (Mullen, 1995) were administered to all children with ASD at the start of each year during the initial home visit.

Baseline

Baseline data collection occurred following the first training for all school staff and prior to additional staff implementer training for children assigned to treatment. Staff were not aware of group assignment at this time. Each child–peer pair engaged in a 10-min activity two to three times per week, with the iPad programmed to match the play context. The iPad was placed between the children on a stand, and they were instructed to stay together and play nicely. The adult did not sit at the table, and no prompts were provided. During the SGD and peer-mediated training period, weekly observations for the matched pair in the comparison group were suspended, and baseline data continued for the other four pairs who remained in baseline.

SGD Instruction With Trained Peer (Treatment Group)

After the SGD peer-mediated training, trained peers took turns interacting with the child they were assigned to and met for 15 min, two to three times per week. Trained school staff guided the groups, and research staff provided coaching as needed. For the first 5 min, the school implementer (a) showed a sign of SPT and reviewed steps, (b) reviewed *Gain Attention* and *Hold and Wait* steps, (c) prompted child–peer SGD communication with at least one IN and one RS, and (d) showed the children other symbols they could use. The activity then continued for 10 min, and all dependent variables were coded during this time. The implementer was instructed to sit back and watch, then prompt once every 30 s (approximately) if no communication was observed. If the peer was unsuccessful in eliciting communication, the adult prompted in a least-to-most hierarchy, for example, (a) tells focus child "It's (peer's) turn," (b) points to symbol and says, "Give (peer) a turn and say, 'Here you go,'" and (c) hand-over-hand to push the symbol Here you go" and give object. Children received the intervention over a period of nine to 19 weeks (range of 17–31 sessions).

Communication Activities With an Untrained Peer (Comparison Group)

Following baseline, children assigned to participate in the comparison group did not receive peer training, and staff was directed to (a) have one peer present, (b) program the iPad with symbols that match the communication context and on the basis of child's skill level, (c) have activity last for 10 min, and (d) do what they would normally do with the SGD in the selected activity. Research staff assisted with questions about programming the iPad; however, no coaching was given for child–peer communication or interactions. Children participated in one weekly 15-min activity over a period of nine to 19 weeks (range of nine to 14 sessions). Due to the number of repeated measures collected, the once-weekly observations were deemed sufficient to measure change for children in the comparison group and less socially demanding given there was no social instruction.

Generalization Novel Activity

Child and peer communication in a novel setting or activity were collected with a trained peer (treatment group) or untrained peer (comparison group). Data were collected during a novel 10-min activity (e.g., snack, centers, or free-play) selected by the school staff midway through each year (i.e., January–March). A range of three to six sessions were collected per child. Staff were asked to conduct the sessions as they typically would with the iPad and peer present.

Generalization Unfamiliar Peer

This phase began after all generalization data were completed in the novel activity. A peer who had not participated in the study was observed interacting with the focus child and the SGD in a 10-min activity similar to those used in the weekly interactions. Data were collected for all children over a period of 1 to 2 weeks (range of three to six sessions per child). Staff were instructed to conduct the sessions as they typically would.

Maintenance

Maintenance data were collected 4 to 8 weeks after the last SGD instruction session with the focus child and a trained peer or an untrained peer during similar activities as the weekly dyad interactions. There was a range of one to three probes collected for children in the comparison group, and three probes were collected for each child in the treatment group.

Posttesting

The PLS-5 (Zimmerman et al., 2007) and the MSEL (Mullen, 1995) were administered to all children with ASD at the end of each year during a final home visit.

Data Collection and Dependent Variables

To address the research questions, several measures were collected. These included two observational measures of focus and peer children's communication—rate and reciprocity; standardized, norm-referenced measures of communication skills; social validity; and treatment fidelity. All child and peer communication data were collected for 10 min within the structured activity within all five experimental phases. One exception was only 5 min of data collected in generalization in novel settings for Cohorts 1 and 2. Collecting more generalization data was possible later in the study due to an increase in staff and a desire for more comparable observation times across phases. All sessions were videotaped using a Flip Mino Video Camera (1st generation, Flip Video) or Sony HDR-CX260 Handycam set up on a tripod. Coding was completed by trained assistants on personal digital assistants (PDAs) using Noldus Observer XT 9.0 (Noldus Information Technology, 2009). Behavior codes were created within Noldus Observer on a desktop computer and then downloaded to a PDA using Noldus Mobile Module software. The primary coder collected data live with the PDA. The video was available for a second viewing by the primary coder, and then uploaded to an external hard drive for secondary coding by a blind reliability coder.

In an effort to track differences between groups in exposure to and partner use of the SGD outside of the direct play contexts, we collected data on five environmental variables: (a) proximity to the SGD (within 2 ft), (b) prompts to use the SGD (either by peer or adult), (c) spontaneous focus child SGD use, (d) peer SGD use (any peer), and (e) adult SGD use (modeled input). Observations were completed once per week, and each occurrence of the five variables was coded per minute for a 15-min interval across a range of naturalistic settings (e.g., one-on-one therapies, centers, snack, large or small group). Across the four cohorts, the total number of naturalistic observations was 343 (86 hr) for the comparison group and 355 (88 hr) for the treatment group.

Focus and Peer Children's Communication—Rate and Reciprocity

Focus Children's Communication

All focus child communication acts directed to peers were coded using event recording or total frequency of acts for a 10-min interval, except the 5-min generalization sessions for Cohorts 1 and 2. Due to this difference in interval length across cohorts, total acts were converted into a rate per minute to serve as the outcome. Intentional communication was defined by clear direction through gaining attention, eye contact, or body orientation to a peer. Each communication act was first coded as an IN or an RS. An IN was coded if the focus child started communicating first and/or a minimum of 3 s passed (coded on count of 4) since the last communication act (by either child). An RS was coded if the act followed within 3 s of a previous IN or a previous RS (see Table 3); thus, multiple INs were coded if there was at least a 3-s pause between acts, and multiple RSs were coded if the act was within 3 s of the last communication act and the other partner had taken at least one turn (e.g., Focus IN + Peer RS + Focus RS + Focus RS). Coding of INs and RSs allowed for analyses of the proportion of each type of act as a measure of reciprocity and if communication exchanges were balanced between the two partners. Communication acts were coded if the child used speech, SGD, a combination of speech + SGD, gestures, or vocalizations. For speech and SGD acts, an IN or RS could have included requests (e.g., for objects, actions, or information), comments, and secures for attention. Verbal imitative acts were coded as vocalizations, and SGD imitative acts were coded as SGD RSs; thus, they occurred within 3 s of a peer model or act. It was important to give credit for imitating a peer given that vocal and SGD imitations could serve a functional role in language learning. Communication to adults was not coded.

Peer Social Communication

All peer communication directed to the focus child was coded using event recording or total frequency of acts during the same 10-min coding interval using the same operational definitions of behaviors (and converted to a rate per minute). That is, total rates of communication acts and rates of INs and RSs directed to the focus child were coded for each peer partner. Peer speech directed to adults was not coded.

Interobserver Agreement

Interobserver agreement (IOA) was completed for total communication acts, INs, and RSs for focus children and peers. A minimum of 20% of sessions were blind coded by a research assistant (RA) unfamiliar with the research goals and group assignment. Fewer videotaped sessions were possible for generalization sessions with unfamiliar peers; thus, IOA data were completed for 15% (comparison) and 17% (treatment) sessions when two coders were available to code live. Five RAs were blind coders and trained to code primary dependent measures to a criterion level of 80% reliability over three videotaped sessions prior to coding independently. They were trained using videos of dyadic interactions from the first author's prior studies. A Note Corder-DP-201 (Olympus) with a 15-s interval recording was next to the camera microphone to assist with reliability coding back in the lab. Point-by-point reliability was used. An agreement was coded if both the primary and reliability observer agreed on occurrence and nonoccurrence of a communication act, and then if the act was an IN or an RS. The total number of agreements was then divided by the total number of agreements plus disagreements in each session and multiplied by 100. For total acts for focus children in the treatment condition, mean IOA was 94% for baseline, 83% for treatment, 84% for generalization, 81% for generalization with unfamiliar peer, and 82% for maintenance. For the comparison group, mean IOA for total acts for the focus children was 87% for baseline, 89% for weekly SGD instruction, 88% for generalization, 98% for generalization with unfamiliar peer, and 89% for maintenance. Mean IOA for total acts for peers in the treatment condition was 91% for baseline, 84% for treatment and generalization, 81% for generalization with unfamiliar peers, and 85% for maintenance. For peers in the comparison group, mean IOA for total acts was 95% for baseline, 89% for weekly SGD instruction, 90% for generalization, 82% for generalization unfamiliar peer, and 89% for maintenance. See Table 4 for details on mean IOA and ranges across groups and phases. Low reliability agreements were due to low occurrence (e.g., one act counted by one coder, two counted by second coder = 50%).

Table 3. Definitions of coded communication acts.

Act	Definition
Communication acts	
Focus child	Any intentional communication act directed to the peer through body orientation or eye gaze using speech, speech-generating device (SGD), gestures, vocalizations, or a combination of speech + SGD. Speech: minimum requirements: (a) one consonant and one vowel combination and (b) approximation of a word includes one consonant matching placement in the intended word; may include requests, comments, or acts to gain attention. SGD: intentional push of button(s) on SGD to communicate to peer. Gesture: use of conventional gesture (e.g., gives, points, or waves) to communicate. Vocalization: must contain a recognizable vowel; may contain a consonant sound; does not include cries, lip smacks, humming, or whining; repeats the last word (or phrase) of the peer's utterance (i.e., immediate echolalia); and unintelligible speech.
Peer	Any intentional communication act directed to the child with autism spectrum disorder through body orientation or eye gaze using speech, the iPad as SGD, gestures, vocalizations, or a combination of speech and SGD use (as defined above).
Initiation and response acts	
Initiation (FI or PI)	Child initiates by communicating using speech, SGD, gestures, or vocalizations as described above. A new initiation is coded if a minimum of 3 s passed after the last communication act (by child or peer). Thus, multiple FIs or PIs can be coded when a minimum of 3 s separates each initiation.
Response (FR or PR)	Child responds to another child's initiation or a child's response by communicating using speech, SGD, gestures, or vocalizations within 3 s of a previous initiation. Multiple FR or PR acts may occur if within 3 s of previous focus child or peer act.
Other (OT)	Verbal or physical behaviors that disrupt the interaction (e.g., yelling, crying, or throwing toys); noninteractive, delayed echolalia that does not relate to the immediate context; perseverative behaviors deemed to be self-stimulatory (e.g., constant humming or scripts) and that take peer's attention away from the activity.

Note. FI = focus initiation, PI = peer initiation, FR = focus response, PR = peer response.

Standardized, Norm-Referenced Test

The PLS-5 (Zimmerman et al., 2007) and the MSEL (Mullen, 1995) were administered to all children at the start and at the end of each study year to examine treatment effects on receptive and expressive language skills. The Auditory Comprehension and Expressive Communication subtests of the PLS-5 provide a comprehensive measure of a child's developmental language, including preverbal and verbal skills. The MSEL measures children's cognitive abilities based on four subtests: Visual Reception, Fine Motor, Expressive Language, and Receptive Language.

Social Validity Assessment

Two measures of social validity were used to capture staff and parent perceptions of changes in interactions for treatment and comparison children and to gauge satisfaction

Table 4. Interobserver agreement percent averages (ranges) across groups and phases.

Phase	Baseline	Treatment group	Comparison group	Gen trained/nontrained	Gen unfamiliar	Maint
Treatment group behaviors						
Focus acts	94 (63–100)	83 (70–100)		84 (71–88)	81 (71–100)	82 (72–100)
Focus IN	97 (83–100)	92 (67–100)		95 (80–100)	86 (67–100)	91 (63–100)
Focus RESP	91 (67–100)	91 (63–100)		88 (50–100)	88 (67–100)	90 (76–100)
Peer acts	91 (67–100)	84 (68–100)		88 (70–100)	80 (70–100)	85 (70–98)
Peer IN	99 (89–100)	95 (75–100)		96 (50–100)	88 (60–91)	94 (86–100)
Peer RESP	92 (50–100)	86 (65–100)		91 (76–100)	92 (75–100)	90 (67–100)
Comparison group behaviors						
Focus acts	87 (60–100)		89 (67–100)	88 (70–100)	98 (79–100)	89 (67–100)
Focus IN	100 (100–100)		99 (80–100)	99.8 (50–100)	100 (100–100)	95 (75–100)
Focus RESP	100 (100–100)		95 (50–100)	98 (78–100)	100 (100–100)	92 (50–100)
Peer acts	95 (75–100)		89 (70–100)	90 (70–100)	82 (67–100)	89 (67–100)
Peer IN	99 (93–100)		99 (80–100)	99 (71–100)	94 (50–100)	97 (80–100)
Peer RESP	83 (50–100)		89 (50–100)	98 (67–100)	91 (75–100)	98 (75–100)

Note. Gen trained/familiar = generalization condition with a trained peer (treatment group) or a nontrained peer (comparison group); Gen unfamiliar = generalization setting with an unfamiliar (new) peer; Maint = maintenance; IN = initiations; RESP = responses.

with the program. First, an SIRS (adapted from Odom et al., 1997) was administered at the start and at the end of each year to gain perceptions of (a) staff ratings of peers, (b) staff ratings of focus children, and (c) parent ratings of their children. Items consisted of (a) approaches others to play, (b) responds by giving objects, (c) uses appropriate social behaviors to get attention, (d) takes turns playing for at least 10–15 min, (e) starts talking using the SGD or words, (f) appears to be having fun, and (g) uses the SGD to communicate in a functional way. Staff and parents rated items on a 1-to-5 (*never* to *frequently*) Likert scale. Second, all staff completed a questionnaire at the end of the year to rate 14 items on the feasibility and acceptability of the program, with a range from 1 to 5 (*strongly disagree* to *strongly agree*).

Treatment Fidelity

Research staff completed a 12-item checklist to monitor fidelity of implementation of the treatment. Items on the checklist related to session setup, reminding peers of SPT steps, child–peer practice with the iPad, and prompting. The checklist was completed for a total of 195 treatments (36%) of all sessions across the four cohorts, with an average fidelity of 89% (range = 67% to 100%). Fidelity of peer implementation of strategies was also collected through completing a 10-item checklist that included steps related to staying close, playing with the same materials, giving toys, gaining attention, listening and responding, and using the SGD to communicate. The peer fidelity checklist was completed for a total of 235 (44%) of all treatment sessions, with an average of 80% across all peers (range of 50% to 100%). If a peer was at 50% fidelity or below over two sessions, a 20-min refresher peer training session was provided.

Statistical Analysis

To address the first three group differences on the hypothesized changes in children's communication, we examined individual growth over time. Because multiple observations were collected during each phase and each child participated in multiple phases, the data had a multilevel structure. Further, the children were assessed on different occasions, and not all children had the same number of assessments per phase. To account for this sampling pattern, we estimated multivariate, multilevel models via residual maximum likelihood using SAS MIXED (SAS Institute Inc., 2016).

More specifically, our design warranted a multivariate two-level model in which time was Level 1 and children were Level 2. The time-specific outcomes were treated as separate dependent variables by intervention phase, such that each phase had its own Level 2 random intercept variance (to capture the correlation of outcomes from the same phase by allowing children mean differences) and its own Level 1 residual variance (for the remaining variation within each phase). Covariances were estimated among the Level 2 random intercepts for phases from the same child. Given the small sample of 45 children, fixed effects were tested using Kenward–Roger denominator degrees of freedom, whereas random effects were evaluated using likelihood ratio tests (i.e., the difference in −2*log-likelihood given the difference in the number of parameters between nested models).

To examine group differences, experimental group, coded as comparison = 0; treatment = 1, was included as a moderator of all phase intercepts and within-phase slopes. Note that the phase mean intercepts refer to the model-predicted outcome at the beginning of each phase, whereas the within-phase time slopes refer to the rate of change per occasions per week during each phase. Fixed linear time slopes were included for each phase—as well as fixed quadratic time slopes when they were significant—during the intervention phase for both focus child and peer rates of total communication. A model adding random linear time slopes during the intervention phase (i.e., for individual differences in within-phase change) did not converge for focus child or peer rates of total communication but did have significantly better fit for focus child and peer proportion of RSs and was thus retained for these latter two outcomes. Effect sizes for time and group were calculated as total R^2: the square of the correlation between the outcome predicted by the fixed effects and the observed outcome (Hoffman, 2015).

To address the effects of treatment on gains on standardized language measures (Question 4), multivariate single-level models were estimated using residual maximum likelihood for each subtest administered at the start and at the end of study participation. Each model included separate residual variances by occasion and a covariance between occasions. To address social validity (Question 5), similarly specified multivariate single-level models were used to test (a) differences between groups on three completed SIRS questionnaires and (b) naïve judge perceptions of changes in social communication for children in the treatment group. Mean ratings per child were used as the outcome variable in each model. Using similarly specified multivariate single-level models as for the standardized language measures, we examined group differences in change from the start to end of study for the five SGD environmental variables.

Results

The first three questions regarding differences in experimental group's initial growth with intervention, generalization, and maintenance of communication skills were addressed in the multilevel analysis for focus children first and for peers second. For focus children and peers, results were presented first for change in rate of total communication, then by proportion of responding. Based on results shown in Tables 5 and 6 and Figures 1 and 2, it appears that the groups were equivalent in their rate of communication and proportion of RSs in baseline, but thereafter, the focus children and peers in the treatment group outperformed those in the comparison group across conditions. Empirical support for these trends is provided below.

Table 5. Results for rates per minute of total spontaneous communication acts.

Rate per minute of total communication	Comparison group			Treatment group			Group difference		
	EST	*SE*	*p* <	EST	*SE*	*p* <	EST	*SE*	*p* <
Focus child intercept									
Baseline	0.17	0.05	.01	0.30	0.05	.01	0.13	0.07	.06
Intervention	0.20	0.16	.22	1.44	0.13	.01	**1.25**	0.20	.01
Generalization	0.28	0.14	.05	1.10	0.13	.01	**0.82**	0.19	.01
Unfamiliar peers	0.25	0.16	.12	2.06	0.15	.01	**1.81**	0.22	.01
Maintenance	0.31	0.14	.03	2.38	0.13	.01	**2.07**	0.19	.01
Focus child time slopes									
Baseline linear	−0.02	0.02	.22	−0.04	0.02	.01	−0.02	0.02	.29
Intervention linear	0.02	0.03	.58	**0.15**	0.02	.01	**0.14**	0.04	.01
Intervention quadratic	0.00	0.00	.71	**−0.01**	0.00	.01	**0.00**	0.00	.03
Generalization linear	0.00	0.02	.89	**0.10**	0.02	.01	**0.10**	0.03	.01
Unfamiliar peers linear	0.02	0.10	.83	**−0.26**	0.12	.02	−0.29	0.16	.07
Maintenance linear	0.02	0.13	.85	0.05	0.16	.74	0.03	0.20	.88
Peer intercept									
Baseline	0.39	0.10	.01	0.63	0.10	.01	0.24	0.14	.09
Intervention	0.36	0.16	.02	1.77	0.12	.01	**1.41**	0.20	.01
Generalization	0.42	0.15	.01	1.10	0.14	.01	**0.68**	0.20	.01
Unfamiliar peers	0.49	0.20	.02	2.19	0.20	.01	**1.70**	0.28	.01
Maintenance	0.81	0.20	.00	3.03	0.20	.01	**2.22**	0.28	.01
Peer time slopes									
Baseline linear	−0.03	0.03	.41	**−0.09**	0.03	.01	−0.06	0.04	.17
Intervention linear	0.03	0.04	.35	**0.16**	0.03	.01	**0.12**	0.04	.01
Intervention quadratic	0.00	0.00	.62	**−0.01**	0.00	.01	0.00	0.00	.05
Generalization linear	0.00	0.03	.92	**0.17**	0.02	.01	**0.17**	0.04	.01
Unfamiliar peers linear	0.02	0.12	.89	−0.13	0.14	.32	−0.15	0.18	.41
Maintenance linear	−0.15	0.16	.35	0.09	0.20	.65	0.23	0.25	.35

Note. Bold values indicate slopes with $p < .05$. EST = estimate.

Focus Children Effects

Group Differences in Rate of Total Communication

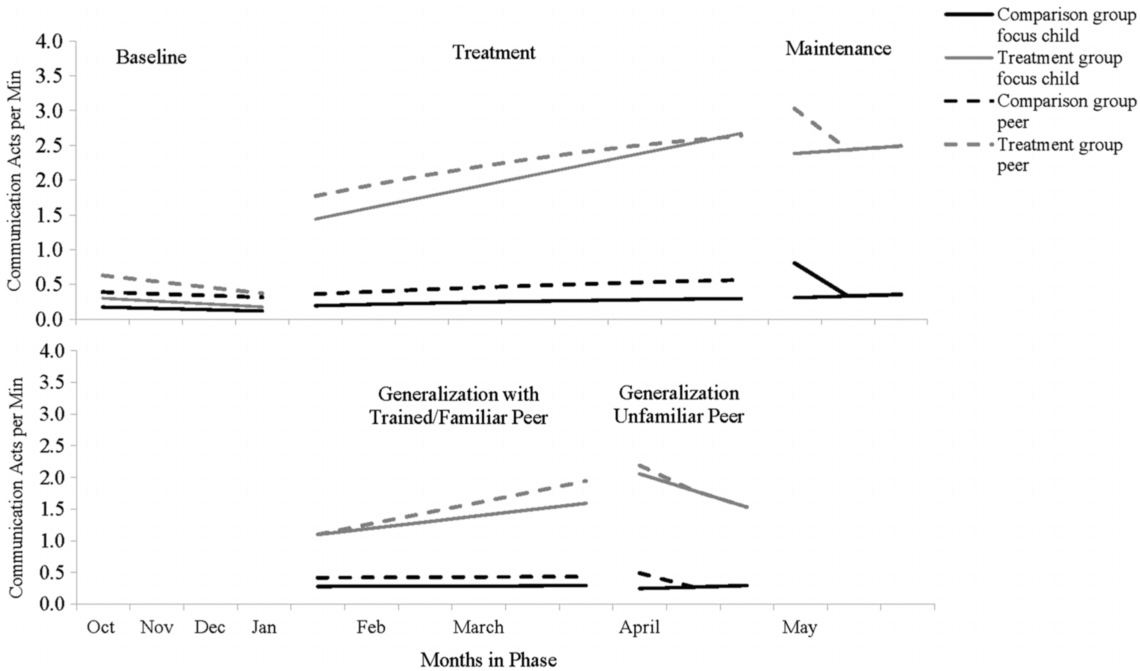
The phase intercepts (for differences in communication mean level between phases) had a significant interaction with group, $F(4, 91) = 22.53$, $p < .001$: significantly higher intercepts were found for treatment than for comparison groups at all phases except baseline (i.e., prior to differentiating the groups; see top of Table 5 and solid lines in Figure 1, in which black = comparison, gray = treatment). The comparison group intercepts did not differ by phase, whereas the treatment group intercepts increased significantly across phases, $F(4, 82) = 51.84$, $p < .001$; all

Table 6. Results for proportion of responses (vs. initiations) for focus children and peers.

Proportion of responses (vs. initiations)	Comparison group			Treatment group			Group difference		
	EST	*SE*	*p* <	EST	*SE*	*p* <	EST	*SE*	*p* <
Focus child intercept									
Baseline	0.22	0.06	.01	0.22	0.05	.01	0.01	0.08	.93
Intervention	0.31	0.05	.01	0.51	0.04	.01	**0.20**	0.06	.01
Generalization	0.25	0.06	.01	0.49	0.05	.01	**0.24**	0.08	.01
Focus child linear time									
Baseline	−0.02	0.02	.50	−0.02	0.03	.55	0.00	0.04	.98
Intervention	0.00	0.00	.80	**0.01**	0.00	.01	**0.01**	0.00	.04
Generalization	0.01	0.02	.40	0.00	0.01	.84	−0.01	0.02	.57
Peer intercept									
Baseline	0.13	0.04	.01	0.22	0.04	.01	0.09	0.06	.13
Intervention	0.23	0.05	.01	0.60	0.04	.01	**0.36**	0.06	.01
Generalization	0.45	0.07	.01	0.43	0.05	.01	−0.03	0.08	.74
Peer linear time									
Baseline	−0.02	0.02	.45	**−0.04**	0.02	.04	−0.02	0.03	.45
Intervention	0.00	0.00	.38	0.00	0.00	.82	0.00	0.00	.41
Generalization	**−0.04**	0.02	.02	0.00	0.01	.94	0.04	0.02	.05

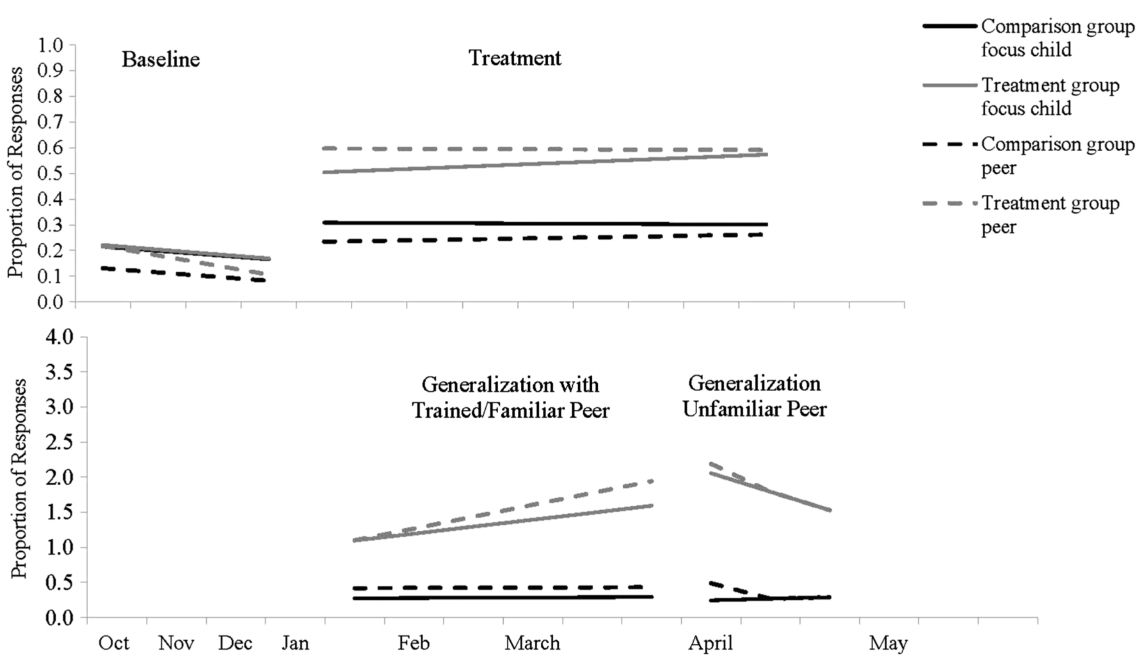
Note. Bold values indicate slopes with $p < .05$. EST = estimate.

Figure 1. Predicted rates of total communication acts of children with autism spectrum disorder and peers over time.



pairwise differences were significant. The within-phase time slopes had a significant three-way Phase × Group interaction, $F(4, 429) = 5.37$, $p < .001$. The comparison group did not improve during any phase, whereas the within-phase change for the treatment group differed by phase, $F(4, 420) = 16.73$, $p < .001$: the treatment group improved significantly during the intervention and generalization with familiar peers phases, showed no change

Figure 2. Predicted proportion of responses (vs. initiations) of children with autism spectrum disorder and peer partners over time.



during maintenance phase, and declined during baseline and generalization with unfamiliar peers phases. Collectively, for focus child rates of total communication, change over time (between and within phases) accounted for 17% of the variance, and group differences (as elaborated above) accounted for another 41% of the variance, bringing the total R^2 to 58%.

Group Differences in Proportion of RSs (vs. INs)

The phase intercepts for focus children had a significant interaction with group, $F(2, 72) = 3.20$, $p = .047$; significantly higher intercepts were found for treatment than for comparison at intervention and at generalization with familiar peers but not at baseline (see top of Table 6 and solid lines in Figure 2, in which black = comparison, gray = treatment). The comparison group intercepts did not differ by phase, whereas the treatment group's intercepts differed significantly by phase, $F(2, 51) = 13.67$, $p < .001$. The treatment group's intercept increased from baseline to intervention, achieving balanced levels of RSs versus INs (~50%) and remained constant during generalization phase with trained peers. In regard to within-phase time slopes, the treatment group improved during intervention, and the comparison group did not improve during any phase. For focus child proportion of RSs, total R^2 values were 13% (time), 13% (+ group), and 26% (both).

Peer Effects

Group Differences in Rate of Total Communication

The phase intercepts for peers had a significant interaction with group, $F(4, 87) = 11.21$, $p < .001$; significantly higher mean intercepts were found for treatment than for comparison at all phases except baseline (see bottom of Table 6 and the dashed lines in Figure 2, in which black = comparison, gray = treatment). The comparison group intercepts did not differ by phase, whereas the treatment group intercepts increased significantly across phases, $F(4, 80) = 30.94$, $p < .001$; all pairwise differences were significant. The within-phase time slopes had a significant interaction with group, $F(4, 392) = 4.70$, $p < .001$. The comparison group did not improve during any phase, whereas the within-phase change for the treatment group differed by phase, $F(4, 381) = 12.98$, $p < .001$: In the treatment group, trained peer communication rates to focus children improved significantly during intervention and generalization and declined during baseline and maintenance. Unfamiliar peers decreased in communication rates to focus children during this generalization setting; however, their predicted mean rates were significantly higher than unfamiliar peers of children with ASD in the comparison group. Collectively, for peer rates of total communication, these total R^2 values were 18% (time), 37% (+ group), and 55% (both).

Group Differences in Proportion of RSs (vs. INs)

The phase intercepts for peers had a significant interaction with group, $F(2, 59) = 8.96$, $p < .001$: Significantly higher intercepts were found for treatment than for comparison at intervention but not at baseline or generalization with trained or familiar peers (see bottom of Table 6 and dashed lines in Figure 2 in which black = comparison, gray = treatment). The comparison group's intercepts differed by phase, $F(2, 74) = 8.47$, $p < .001$, such that they increased significantly between intervention and generalization. The treatment group's intercepts also differed by phase, $F(2, 44) = 25.93$, $p < .001$. Trained peers' (treatment group) proportion of RSs increased significantly between baseline and intervention, in which they achieved near-balanced levels of RSs and INs. Although this balance decreased slightly from treatment to generalization, it was maintained during treatment and generalization. Peers in the comparison group showed a significant increase in proportion of RSs as well from intervention to novel generalization settings (from 23% to 45%). Lastly, with respect to the within-phase time slopes, proportion of RSs for peers in the treatment group declined significantly during baseline and for peers in the comparison group during generalization. Finally, for peer proportion RSs, total R^2 values were 19% (time), 15% (+ group), and 33% (both).

Impact on Standardized Tests

Both groups improved significantly from preintervention to postintervention (all p's < .001; time total R^2 values ranging from .10 to .20) equally so in every standardized subtest measure except for the Expressive Language subtest of the MSEL, for which the treatment group improved significantly more ($p = .04$, interaction total $R^2 = .03$).

Social Validity Outcomes

Children in both treatment and comparison groups improved significantly from preintervention to postintervention on the SIRS questionnaire as reported by teachers for peers ($p < .001$; time total $R^2 = .22$), teachers for focus children ($p < .001$; time total $R^2 = .46$), and parents ($p < .001$; time total $R^2 = .10$). For the latter two reports, there were marginally significant Group × Time interaction, such that the treatment group ratings grew more over time for teachers' ratings of focus children (M = 1.4 to 3.1 preintervention to postintervention) than the comparison group (M = 1.3 to 2.6 preintervention to postintervention; $p = .06$, interaction total $R^2 = .03$) and for ratings by parents of their children (M = 1.9 to 2.7 preintervention to postintervention) than comparison group parents (M = 1.8 to 2.2 preintervention to postintervention; $p = .09$, interaction total $R^2 = .04$). School staff ratings on the acceptability of the program were high, ranging from *agree* to *strongly agree* (range of 4.0 to 5.0) across all survey questions. The highest ratings related to research staff providing necessary assistance, comfort level in giving feedback for changes or improvements, and the appropriateness of the voice output app.

Naturalistic SGD Environmental Variables

There were no significant differences between groups at either occasion or changes over time within groups across any of the five naturalistic SGD environmental variables.

Discussion

The results of this study extend AAC intervention research by demonstrating that an SGD intervention that taught peers without disabilities to be responsive communication and play partners can positively impact communication of preschoolers with ASD. Significant increases in intentional communication were observed for both communication partners, and the children were able to generalize and maintain these skills compared with children in a comparison group that did not have trained peers. Large effects were found for children with ASD and trained peers without disabilities (e.g., total R^2 for group ranging from .13 to .41). Changes were also observed in more balanced proportion of RSs and INs for children who received the treatment, meaning each partner contributed more equally to communication exchanges. Improvements in social communicative behaviors reported by teachers and parents for the children were encouraging, and a poststudy survey revealed a high degree of satisfaction by the school staff.

Recent reviews on AAC intervention studies report limitations related to the need for (a) a larger number of children and randomized group designs, (b) measuring outcomes with different communication partners, and (c) reporting generalization across settings and partners and if progress is maintained (Therrien et al., 2016; van der Meer & Rispoli, 2010). In the PMI literature, there is a need for research on (a) preschool-age children, (b) a larger number of participants, (c) generalization and maintenance measures, (d) treatment fidelity data for peer behaviors, and (e) social validity outcomes (Zagona & Mastergeorge, 2016). The current study addresses limitations from both AAC and PMI literature and has several methodological strengths. First, great care was taken with matching and randomization to construct equivalent groups (ruling out selection bias) in the four multiyear cohorts. Second, given the intensity of the intervention, we included a relatively large sample of children with ASD over the 4-year period. A third strength was high fidelity documenting the integrity of the treatment condition for both adult implementers and trained peer partners. Further, children who received treatment communicated more frequently to each other during two generalization settings: novel activities and with new partners. New peers (not a part of the weekly groups) also communicated more often to children with ASD who received the treatment compared with new peers of children who did not. Outcomes also add to the literature by reporting maintenance of improvements 1–2 months after coaching ended. Finally, the design and multilevel growth analyses that accounted for the organizational structure in the data enabled intercept and slope comparisons made simultaneously between experimental groups and treatment phases over time.

At the beginning of each generalization phase, the phase mean intercepts were significantly higher for total communication acts for both the children with ASD and peer partners who received the treatment compared with baseline rates. These generalization outcomes are noteworthy given that children with ASD have significant difficulties in transferring skills outside of original treatment contexts. Trembath et al. (2009) remarked on the importance of encouraging SGD use across classroom activities and partners to improve generalization, and others have emphasized the importance of involving peers in interventions to promote generalization in natural school settings (Bellini, Peters, Benner, & Hopf, 2007). In the current study, positive generalized outcomes in novel settings and with untrained peers may have been due to providing the treatment in natural preschool settings, implementation by indigenous providers, and training multiple peer exemplars. However, within-phase changes showed a decrease in communication within the second generalization phase with an unfamiliar peer. One possible reason could be that there was a novelty effect when the children were first paired up to play together, followed by a decline in communication in the absence of a trained or supportive peer partner and a lack of understanding on the peer's part on how to maintain communication and engagement. Given more time, it would have been interesting to provide these new peers with brief SGD training and then measure effects on communication for both partners.

Another important finding was that the children with ASD and peers who participated in treatment exhibited a more balanced proportion of communicative RSs and INs, which changed to approximately 50:50 for the focus children and 60:40 for the peers. These balanced exchanges continued during novel generalization activities. In contrast, children who did not receive treatment demonstrated consistently uneven proportion of responding, meaning that child INs more often than not went unanswered by the other partner. The positive impact on reciprocal interactions is important for two main reasons. First, the majority of AAC intervention studies report solely on effects for the participants with ASD (Therrien et al., 2016) or measure INs and RSs independently for each partner. Measuring effects on sequential or the back-and-forth nature of exchanges would greatly improve our understanding of how to address deficits in social reciprocity—a core feature of ASD. Second, the outcomes support a transactional model of early child development (Snyder-McLean & McLean, 1978) and extend this model to peers in the environment. This model posits that reciprocal interactions and changes in social environments lead to changes in children's early social communication development. Within a peer social context, children in this study became more competent communicators. It could be conceived that as peers learned to be effective communication partners, children with ASD began to orient, respond, and communicate more in turn.

Successful exchanges then triggered additional communication attempts and practice opportunities with subsequent increases in more balanced exchanges. The outcomes support DiStefano et al.'s (2016) research documenting changes in proportions of INs and exchanges within treatment contexts that encourage joint engagement in play with adults, albeit our outcomes show promising methods to increase reciprocity and exchanges with peers.

There was a significant difference on one standardized language assessment, in that children with ASD who had trained peers showed higher expressive language scores at posttreatment than those with untrained peers. One component of the peer training was to teach peers to "say your words AND push the button," allowing for both modeled verbal and SGD input. In a previous study, we surveyed 71 teachers of preschool children learning to use different forms of AAC and found that peer communication input was associated with increased child language growth (Barker, Akaba, Brady, & Thiemann-Bourque, 2013). The difference between groups in expressive language provides preliminary evidence on the role trained peer partners may play in improving language outcomes for young AAC users. Much more research is needed to examine longer-term outcomes of modeled peer input and other peer-mediated instructional methods within SGD interventions on children's vocabulary and language development.

Clinical Implications

Outcomes from this study suggest that early childhood service providers might consider instructional approaches to improve social communication competencies of peers without disabilities when planning SGD interventions for preschool children with ASD. Young peers can be taught responsive play and SGD communication strategies in a relatively short time, with a high level of fidelity. Peers were taught two strategies that often led to a communication exchange: First, get the child's attention, then hold and wait. At the start of treatment, these strategies often resulted in routines where the child with ASD would primarily initiate to ask for objects. Over time, there was an increase in peer INs to ask for objects, and the child with ASD responded by giving then commenting or requesting an action from the peer. These routines are important as they provide opportunities for practicing new communication skills. A follow-up study on observed changes in communicative functions is forthcoming. It is worth noting that, although staff in the comparison group often encouraged children with ASD to communicate (to them) using the SGD, the majority seldom prompted child- and peer-directed communication. Implications for practice align with recent recommendations for professional development to increase service providers' awareness of the value of PMIs and the need to provide paraprofessional training in AAC interventions that focus on peer interactions (Therrien et al., 2016; Zagona & Mastergeorge, 2016).

Limitations

Although this is the largest examination to date of treatment effects on child and peer communication following an SGD intervention that utilized peer-mediated approaches, a few limitations of the study deserve mention. First, the participants with ASD varied in skill level for symbol selection at the start of each year. Some children could select between two enlarged pictures, whereas some children were selecting from 15 to 20 symbols per page and scrolling pages. These differences were attributed to varied experiences with SGDs and the rapid surge in the use of iPads over the course of the study. However, all participants with ASD were nonverbal or minimally verbal at the start (i.e., no speech or were using less than 20 words). A second limitation was related to collecting data for the comparison group once per week and for the treatment group two to three times per week. We recognize this as a potential confound, in that the treatment group had more exposure to typically developing children and familiarity with the social activities, which could have impacted the outcomes. However, repeated weekly observations of communication rates remained low and relatively stable for the comparison group; thus, there were enough repeated observations that we believe the threat to internal validity was small. Also, one could argue that additional observations may have been punitive for children who did not receive training and often sat silently, unsure what to do. A third limitation of the study was the sample size. Although this number could be considered large for an intervention study of this intensity with a low incidence population, outcomes could be generalized to a wider number of preschoolers with ASD and complex communication needs with more participants. Further, the sample size likely limited the statistical power to detect significant differences between groups on the parent and teacher report social validity measures. Fourth, researchers who administered the postintervention standardized language measures were not blind to group assignment at the end of the year. A second research staff scored each standardized test protocol separately for 25% of all children. Item-by-item reliability across subtests on the two assessments was consistently above 80% for all secondary scorings, limiting the possibility of experimental bias by assessors. Another limitation relates to procedures for coding communication acts. Due to the timing criterion for coding INs and RSs, if a child initiated using speech ("my ball") then 2 s later pushed the SGD to request "ball" and a peer responded, then only the last communication act prior to the peer RS was coded (SGD not speech in this example). Further, if a child pushed multiple buttons in a sequential manner, only one communication act was coded (e.g., pushed symbols for "I want + puzzle piece + Sarah" all coded as one IN using SGD). We also coded child vocal imitations and SGD imitations of peer acts as RSs. Not coding imitative acts would have strengthened the findings in relation to the importance of measuring and reporting changes in spontaneous communication and contextual responding. Finally, we did not code the appropriateness of the communication act in matching the child's actual communicative intent. On occasions when this occurred, the peer responded accordingly to the perceived intent (e.g., "you already have that color, what other one do you want?"). This type of peer feedback is important for children to learn new communication skills (Goldstein et al., 2007). These examples show how our coding system could be improved in future research to better understand outcomes on a number of important child–peer communication variables.

Conclusions

There is a large body of evidence over the past 25 years that has advanced the field and enhanced our understanding of effective AAC interventions for young children; however, these approaches have yet to be fully incorporated into typical school environments and translated into practice (Light & McNaughton, 2014). Our results reveal the positive effects on communication and balanced exchanges that can occur with explicit instruction to peer partners on how to use the same SGD system to initiate, respond, and stay engaged in play. Successful participation across school environments for children with ASD who have complex communication needs is dependent upon ensuring that evidence-based AAC practices are put in place. Communication interventions that ensure others in the environment have skills and knowledge to be able to support individuals learning to use AAC systems can increase opportunities for social participation and possible friendship development (McNaughton & Light, 2013). Much more research is needed that focuses on support and training for early education service providers working with this population in inclusive settings (Romski et al., 2015). Given the recent advances in the use of iPads as SGDs in classrooms and in clinical practice without evidence of effectiveness, it will be essential for future research to incorporate what we already know as effective SGD and peer-mediated instructional strategies to support staff using this technology.

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