AJSLP

Research Article

Application of the Communication Complexity Scale in Peer and Adult Assessment Contexts for Preschoolers With Autism Spectrum Disorders

Kathy S. Thiemann-Bourque,[a] Nancy Brady,[b] and Lesa Hoffman[c]

Purpose: The purpose of this study was to measure changes in communication of preschoolers with autism using the Communication Complexity Scale (CCS; Brady et al., 2012) and to examine the utility of the CCS in measuring pretreatment and posttreatment changes within peer and adult assessment contexts.
Method: The CCS was used to code preassessment and postassessment for 23 children with autism randomly assigned to a treatment that incorporated a peer-mediated approach and a speech-generating device and 22 assigned to a business-as-usual condition with untrained peers. Children were assessed in 2 structured 30-min contexts—1 with an adult examiner and 1 with a peer partner coached by an adult.
Results: Children in both groups showed significant changes in communication complexity CCS scores from pretreatment to posttreatment in the adult and peer contexts. At both occasions, CCS scores were higher with adult partners yet showed greater improvements over time with peer partners.
Conclusions: Results showed that the CCS was sensitive to change over time but did not discriminate changes in communication complexity associated with maturation versus treatment. It did show some differences based on interactions with peer versus adult partners. Outcomes provide preliminary support for using this scale to measure communication changes in different contexts.
Supplemental Material: https://doi.org/10.23641/asha.7408856

Understanding the nature of peer-related social competencies for children with autism spectrum disorder (ASD) and implementation of effective intervention approaches require identification of individual strengths and weaknesses in these early communication skills. Currently, there is no standardized assessment or formal assessment protocol available to examine intentional communication between children with ASD and peers without disabilities during routine social interactions. The Communication Complexity Scale (CCS) was developed by Brady and colleagues (2012, 2018) as a way to measure the development of preintentional and intentional expressive communication in individuals with developmental disabilities and minimal verbal skills. The scale has been applied to various assessment contexts with adult examiners and measures communication through eye gaze, body orientation, and communication with spoken words, signs, or symbols.

Peer-mediated interventions are a widely replicated approach for teaching social communication skills to children with ASD (Goldstein, Lackey, & Schneider, 2014; Watkins et al., 2015). For young children with ASD learning to use augmentative and alternative communication, targeting social communication is of upmost importance given their significant communication deficits that lead to reduced opportunities for social participation (Light & McNaughton, 2012). Furthermore, the extent to which children with ASD learn to interact with peers is related to core deficits in early foundational skills of prelinguistic (e.g., joint attention [JA], gestures, and vocalizations) and intentional communication skills (Freeman, Gulsrud, & Kasari, 2015; Sigman et al., 1999).

[a]Juniper Gardens Children's Project, The University of Kansas, Kansas City
[b]Department of Speech-Language-Hearing: Sciences & Disorders, The University of Kansas, Lawrence
[c]Schiefelbusch Institute for Life Span Studies, The University of Kansas, Lawrence

Correspondence to Kathy S. Thiemann-Bourque: thiemann@ku.edu

Editor-in-Chief: Julie Barkmeier-Kraemer
Editor: Erinn Finke

Received March 20, 2018
Revision received June 10, 2018
Accepted July 2, 2018
https://doi.org/10.1044/2018_AJSLP-18-0054

Disclosure: The authors have declared that no competing interests existed at the time of publication.

The two main aims of the current study were to determine if the CCS could identify changes in communication after implementation of a speech-generating device (SGD) intervention for preschoolers with ASD that incorporated peer-mediated strategies (i.e., taught peers without disabilities to use the same SGD system) and to describe changes in communication based on pre–post CCS scores with peer and adult partners. Ultimately, a reliable scale that can assess early communication and prelinguistic skills with peer partners could be used as part of a multimethod assessment approach (Brown & Odom, 1996; McConnell & Odom, 1999) to obtain a more comprehensive picture of early social communication competencies, to examine child progress and intervention effectiveness, and to provide benchmarks of skill development.

Importance of Assessing Prelinguistic Skills

Researchers have reported a strong correlation between early prelinguistic or nonverbal communication skills, such as JA, and later language and social communication skills (Kasari, Gulsrud, Freeman, Paparella, & Hellemann, 2012; Kasari, Paparella, Freeman, & Jahromi, 2008). In a seminal longitudinal study, Sigman and colleagues (1999) repeatedly assessed language and social skills of children with autism and Down syndrome and typically developing children starting at 2–6 years old ($n = 70$) up to 10–13 years old ($n = 51$). For the children with autism, early nonverbal communication and play skills predicted the extent of peer engagement at 10–13 years old. Given the pivotal role JA plays in early development (Charman, 2003), it has become a key target of early interventions for young children with ASD and minimal verbal skills. Whereas previous interventions have reported improved JA and early communication skills with adult partners (Kasari et al., 2012; Romski et al., 2010), assessment of improvements with peer partners has yet to be studied. Such assessments may help establish goals and treatment approaches within peer-oriented social environments.

Assessing Minimally Verbal Children With ASD

Kasari, Brady, Lord, and Tager-Flusberg (2013) summarized the challenges and gaps in the literature regarding assessment of the minimally verbal child. They reviewed a number of assessments related to core characteristics of ASD, including language, social behavior, and early developmental skills, and recommended multiple assessment methods including standardized testing and experimental measures to address children's specific needs. Drawbacks of standardized measures include difficulty in complying with directions, lack of attention to alternative communication modalities children may use (e.g., sign language or other augmentative and alternative communication), and floor effects or failure to achieve a basal score (Brady et al., 2012). Within semistructured and more natural contexts, children may demonstrate competencies that do not show up on standardized tests.

Gathering information from multiple measures and sources to assess children's early communication skills has been widely recommended (Brown & Odom, 1996; McConnell & Odom, 1999). The most common assessment practices for children with ASD and minimal verbal skills are direct observational methods or experimenter-developed tools (Kasari et al., 2012). Existing direct observation measures tend to focus on dyadic contexts between child and adult partners; there is a gap in tools that can be used to measure social communication between children with ASD and peer partners in authentic social environments. This gap can hinder efforts by early childhood educators and service providers to learn more about the nature of children's peer interaction skills and social competencies. On the basis of previous findings of poor generalization across communication partners (Kent-Walsh & McNaughton, 2005) and observations of different contextual effects of language sampling (Kover, McDuffie, Abbeduto, & Brown, 2012), it is important to also measure communication with peers.

Direct observational coding methods have been used in intervention research focused on improving communication and social interactions of children with ASD (Goldstein, Schneider, & Thiemann, 2007; Sterrett, Shire, & Kasari, 2017; White, Keonig, & Scahill, 2007). Observations in classroom environments provide rich data about children's authentic interactions. However, collecting detailed data about the forms and functions of communication in preschool classrooms requires considerable time and resources. In addition, child communication is directly related to the type and amount of communication opportunities presented, which can vary based on different contextual variables such as the type of adult supervision, the type of activities and materials, and the group size (Downer, Booren, Lima, Luckner, & Pianta, 2010).

To gain a fuller appreciation of communication capabilities, it is necessary to observe how a child communicates when presented specific scaffolded opportunities such as those used in structured probes or temptation tasks, for example, Early Social Communication Scales (ESCS; Mundy et al., 2003) or Communication and Symbolic Behavior Scales (CSBS; Wetherby & Prizant, 2002). Providing consistent opportunities for communication enables a comparison of abilities within these contexts across children and within children over time. For example, Kasari, Freeman, and Paparella (2006) and Yoder and Stone (2006) found that communication frequency during the ESCS increased after intervention. Wetherby and colleagues (2014) found significant changes in CSBS social composite standard scores associated with an intervention. These findings indicate improvements in the structured probes with adults.

CCS

The CCS was developed by Brady and colleagues (2012) as a means to measure expressive communication in individuals with minimal verbal skills. The CCS assesses communication through gestures, eye gaze, and body movements as well as symbolic communication with spoken words, signs, or symbols. It is appropriate for individuals who communicate nonverbally or with a few words, signs, or symbols. The CCS is not an assessment, but rather a 12-point scale that encompasses environmental awareness through combining two words, signs, or symbols in a meaningful phrase (see Table 3).

The CCS has been used with several different populations and different assessment contexts. For example, Brady and colleagues (2012) used the CCS to measure expressive communication during two different scripted protocol assessments—one designed to promote initiated communication acts in children and adults with intellectual or developmental disabilities and the other designed for infants and toddlers with motor impairments. Brady et al. (2018) demonstrated that CCS scores could be derived from communication recorded by young children with autism participating in the ESCS (Mundy et al., 2003). Hahn, Brady, McCary, Rague, and Roberts (2017) used the CCS to describe communication in 61 infants between 7.5 and 14.5 months of age who either had fragile X syndrome, were infant siblings of children with autism, or were typically developing infants, based on interactions during the Autism Observation Scale for Infants (Bryson, Zwaigenbaum, McDermott, Rombough, & Brian, 2008). Like the previously described contexts, the Autism Observation Scale for Infants is a 15- to 20-min semistructured, play-based measure that provides opportunities for social communication with an adult.

In each of these applications, experimenters watched videos of the interactive assessment protocols and described communication acts using the 12-point scale on the CCS. For example, one task in the Brady et al. (2012, 2018) protocol involves handing a difficult-to-open container with snack foods to the participant. The experimenter waits for the participant to initiate a request for help or to comment on the stuck container. The participant response, whether it be a gesture, word, or sustained focus on the container, is scored for communication level and function according to the CCS. Function refers to the purpose of the participant's communication—behavior regulation (BR; requests and protests) or JA (comments). Responses to each task in the assessment protocol are similarly scored, and the results can be summarized in various ways. For example, Brady and colleagues (2012, 2018) obtained the average of the best three scores from the assessment protocol and described this as the "optimal" score. Furthermore, the best three responses that were classified as BR communication acts and the best three responses that were classified as JA were described as optimal BR and optimal JA scores, respectively. Similar summary scores were derived in the study by Hahn and colleagues (2017).

The CCS has excellent reliability and validity (Brady et al., 2018). Overall kappa scores between independently scored assessments was .83, and 85% of the scores were identical. The correlations between initial scores and retests completed within 2 weeks was .84. Concurrent validity was demonstrated by comparing CCS scores with scores from two other measures of early communication. The correlation between optimal CCS scores and the Communication Matrix (Rowland, 2011) was .35; the correlation between the CCS and Vineland Adaptive Behavior Scales II expressive communication scale (Sparrow, Cicchetti, & Balla, 2005) was .47. These significant and moderate correlations suggest that the CCS reflects the same underlying communication construct yet provides information that is not redundant with these existing measures.

In summary, the CCS is a reliable and valid measure of communication between a child and an adult communicative partner. However, we have not used the CCS to measure interactions between peers and individuals with ASD or other developmental disabilities. Gathering information on peer-related communication competencies within similar structured assessment contexts is important to (a) assist in monitoring sensitivity to change after treatment, (b) determine if modifications in intervention approaches are needed to better target these early foundational skills that are relevant to language acquisition and peer social competencies, and (c) help establish benchmarks of prelinguistic and symbolic communication behaviors as observed with peer partners. These benchmarks may be compared with benchmarks with adult communication partners.

The goal of this study was to evaluate the utility of the CCS as a premeasure and postmeasure in peer and adult assessment contexts and as a tool to measure changes in prelinguistic and intentional symbolic communication for children with ASD who participated in an SGD intervention with trained or untrained typically developing peer partners. All children participated in two structured communication samples—one with a peer (guided by the examiner) and one with an adult examiner only. There were three general research questions:

1. To what extent can the CCS capture changes in communication complexity from pretreatment to posttreatment for preschool children with ASD? We predicted children would improve over time in both the peer and adult assessment contexts.
2. Are there differences in change in communication complexity for preschool children with ASD who participated in an SGD intervention that utilized peer-mediated approaches as compared with an SGD business-as-usual group with untrained peers? We predicted a greater change for the SGD intervention group within the peer assessment context.
3. Are there differences in change in communication complexity as a function of whether the communication partner was a peer or an adult? We hypothesized that all children would show greater communication complexity in the adult assessment contexts than during the peer partner assessments. We also hypothesized higher overall communication complexity and complexity of both JA and BR with adults. This hypothesis was based on the prediction that, in a 1:1 setting with an adult communication partner, there would

be increased opportunities for the children with ASD to have communication success.

Method

Participants

Participants were 45 preschool children with ASD, 36 boys and nine girls (aged 2;11–5;0 years;months). The children attended full or partial inclusion programs or self-contained classrooms serving children with ASD and other developmental disabilities in the Kansas City metro area. Children were included in two ways. One was if they had an educational determination of ASD, and the other was if they had a diagnosis of ASD by a community-based developmental pediatrician or child psychologist, confirmed by educational records and parent report, and if they met the following criteria: (a) 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), (b) nonverbal or minimally verbal (i.e., using less than 20 spontaneous words), (c) recommended by the school team as a candidate for or already using an SGD system, (d) access to typically developing peers, (e) English as the primary language, and (f) limited peer interaction skills based on teacher and parent reports. Children were excluded if they lacked upper body or hand motor skills to select SGD symbols or had a severe cognitive disability as determined by educational records. At the start of the year, all children were administered the Preschool Language Scale–Fifth Edition (Zimmerman, Steiner, & Evatt Pond, 2007), the Mullen Scales of Early Learning (Mullen, 1995), and the Childhood Autism Rating Scale–Second Edition in their home (see Table 1 for demographics). Parents were in attendance, and the first author or trained research assistants (RAs) administered the assessments.

Table 1. Participant characteristics.

	Treatment (*n* = 23)		Control (*n* = 22)	
Demographics	**Mean**	**Range**	**Mean**	**Range**
Age	48	37–60	46	35–58
MSEL ELC (SS)	49	49–51	50	49–63
PLS-5 TLS (SS)	54	50–74	54	50–76
PLS-5 AC	58	50–68	60	50–72
PLS-5 EC	53	50–67	54	50–73
CARS-2	41.8	35–50	41.5	34–53
Male/female	16/7		20/2	
Race/ethnicity				
White	12		13	
African American	8		7	
Hispanic	0		1	
Asian	0		0	
Other	3		1	

Note. MSEL = Mullen Scales of Early Learning (Mullen, 1995); ELC = Early Learning Composite; SS = standard score; PLS-5 = Preschool Language Scale–Fifth Edition (Zimmerman et al., 2007); TLS = total language score; AC = Auditory Comprehension; EC = Expressive Communication; CARS-2 = Childhood Autism Rating Scale–Second Edition (Schopler et al., 2010).

All participants were part of a study examining the effectiveness of an SGD intervention that incorporated a peer-mediated treatment within typical preschool activities (Thiemann-Bourque, Feldmiller, Hoffman, & Johner, 2018). In that study, 23 children were randomly assigned to an SGD intervention utilizing a peer-mediated approach (SGD-PM treatment group) that taught peers responsive social skills, and 22 were assigned to a comparison condition that included play activities with the SGD and untrained peers. The intervention was implemented for one school year, with a range of one to three sessions per week. School staff were recruited to provide the treatment or guide the "business-as-usual" child–peer play activities, with 21 staff assigned to the treatment group and 21 assigned to the comparison group. Effects on rates of communication and child–peer communication reciprocity (i.e., balance of initiations and responses) were evaluated using repeated measures of child and peer behaviors across baseline, intervention, generalization, and maintenance phases. The current article describes results of the CCS used to score pretreatment and posttreatment structured communication samples collected within child–adult and child–peer assessment contexts. In the current study, one peer was assigned to one child with ASD as the communication partner in the preintervention and postintervention assessments. The first author or an RA was the adult partner in the child adult sample. The 45 peer participants without disabilities included 29 boys and 16 girls (aged 3;4–5;1) and were in the same classroom or building as the child with ASD.

Approval for this study was granted by the human subjects committee at the University of Kansas, and all ethical considerations for the protection of participants were followed. Parental consent was obtained for all children, and consent was secured for all school staff.

Setting

For both the adult and peer contexts, the structured communication sample was administered at the child's school in a quiet room with a table and two chairs. The SGD was an iPad with a voice output app (i.e., TouchChat HD [Silver Kite, 2017]; Proloquo2Go [Assistiveware, 2009]) and was available for both pretest and posttest. It was positioned on a stand and placed in front of the child with ASD. One vocabulary page was created to represent each of the 12 communication opportunities in the assessment and programmed to include four symbols: one representing the task-specific item (e.g., snack container in the snack task), one for "I want," one comment (e.g., "Wow!"), and one foil (e.g., tissue box). The order of administration with the adult or peer was based on the child's schedule, peer availability, and teacher preferences; because of the differences in schedules, counterbalancing the order of adult or peer assessments was not possible. However, preliminary analysis revealed no order effects or significant differences by time or condition.

Peer Partner Communication Sample

One of the same peers who engaged with the focus child with ASD during the weekly treatment sessions or play observations (comparison group) was selected to participate as the communication partner during each preintervention and postintervention structured assessment. The focus child was seated between the examiner and the peer. This positioning allowed coders to more clearly identify who the child was directing their attention to (peer or adult), which was important for coding peer-directed communication. Peers were given instructions and coached to administer all 12 items in the communication sample (see Table 2); the examiner was there to scaffold the interaction. An in-depth outline of directions that were provided to the peer before each task and the administration protocol for the 12 tasks are provided in the Supplemental Material S1.

At the start of each session, the examiner told the peer, "We are going to do this as a team. I'm going to teach you how to be my helper with the toys. I will show you how to play with the toy and then you will show (focus child; FC) how it works. Some of his/her toys will be broken or stuck on purpose because I want to see if he/she will tell you things or ask for help. Wait to see if (FC) asks for help or tells you something. I will tell you what to say and help you remember as we go. Each page on this iPad has pictures on it that (FC) can choose to push. I'm going to set it by (FC) so he/she can use it if he/she wants to talk. Are you ready?" After these directions, the peer and the examiner joined the focus child at a table. The examiner pushed the first task symbol on the iPad with the instruction, "Let's play ___ (e.g., windup toys)" and then followed up with the following steps, depending on child response. First, the examiner coached the peer to be a helper and show how the item worked (e.g., wind up a toy, blow bubbles, or play an instrument), then look expectantly, and wait 7–10 s for the focus child to communicate. If the child communicated intentionally (i.e., a score of 6 or higher), the peer was coached to respond and the examiner transitioned to the next task. If the child did not communicate intentionally to ask for help or show a toy/comment on an action, the second step was coaching the peer to repeat the demonstration and offer help while holding out a hand. If necessary, after waiting another 7–10 s, the peer was directed to give the toy to the child to take one more turn, and then the examiner transitioned to the next activity. For example, in the bubbles task, one bottle had a lid that would open and one was glued shut. The peer was coached to open the bubbles and show the child how to blow them. Then, the "working" bottle of bubbles was put off to the side, and the peer was asked to give the child the bubbles with the lid glued shut and instructed to "wait to see if he/she will ask you for help with his/her bubbles." If the child asked the peer for help (e.g., through gestures, triadic orientation, words, or SGD use), the adult gave the peer the working bottle; took away the nonworking bottle and said, "Those bubbles aren't working, blow these ones"; and then transitioned to the next task. If, for example, the child

Table 2. 12 Tasks to elicit child responses in the peer and adult partner communication samples.

Task	Function	Sample of directions provide to peer
1. Two windup toys, one broken and one working	BR	"Wind it up to show ___ how it works then wait to see if ___ will ask you for help."
2. Stretchy lizard toy in a plastic container with 10–12 small blocks	JA	"Hold the jar, I put a stretchy lizard inside but don't say anything about it. Let's see if ___ notices it. Tell him to pick a block."
3. Food item/sensory toy in a container with a tight lid	BR	"Give the container to ___ then wait and see if he/she asks you for help to open the snack."
4. Musical instruments (rain stick, xylophone and stick, two maracas)	JA	"I want you to be my helper and hold the bag, let's see if ___ takes an instrument to show you or tell you about."
5. Two hammer toys that make noise, one with batteries and one without	BR	"I want you to show ___ how your hammer works. Then, I want you to wait and see if ____ will ask you for help."
6. Plastic carrot in a marker box and two pieces of paper (to elicit JA)	JA	"I put in a pretend carrot in the box but don't say anything about it. Let's see if ___ notices it. Hold it up and tell ___ to pick a marker."
7. Train tracks, three toy trains in a bag	BR	"Let's see if ___will ask for tracks or trains. Hold the bag back but where ____ can see it."
8. Two books, one normal and one with altered pages (e.g., cut up, scribbled on)	JA	"I made some funny marks on this book, let's see if ___ notices and tells you about it. Don't tell ___ what's wrong with the pages."
9. Two bottles of bubbles, one sealed and one open	BR	"Show ___ how to blow bubbles. Then, wait and see if ____ will ask you for help."
10. Musical ball run toy, five small balls and one large ball that doesn't fit	JA	"Give this one to ___ and wait to see if ___ notices that it is too big. Show ___ where to put it."
11. Two bumble balls, a working cow and a broken pig	BR	"Show ___ how your cow works. Wait and see if ___ will ask you for help with the pig."
12. Switch-activated fan or light toy that moves or lights up	JA	"Push that button under the table with your foot, then look at __ to see if he/she notices the fan moving."

Note. BR = behavior regulation; JA = joint attention.

stared at the bubbles or asked the adult for help and did not show intentional communication to the peer within 7–10 s, the task was repeated and the peer was coached to hold out his or her hand and say, "I can help." After another 7–10 s, regardless of the focus child's response, the task was removed and the examiner moved on to the next task.

Each activity took approximately 2–3 min to administer, for a total assessment time of 30 min. One activity was presented at a time and then removed before presentation of the next one until all 12 tasks were administered. Six activities were set up to elicit JA, and six were set up to elicit BR. One task, the switch-activated fan, was set up ahead of time—in the child's line of vision but out of reach. This task was designed to elicit JA; thus, it was initiated (e.g., switch was activated by the peer) as soon as the focus child noticed it at any time during the assessment. As described, each task was presented up to two times based on the demonstration of intentional communication (i.e., a score of 6 or higher on CCS) directed to the peer partner. At any time during the assessment, if the focus child directed communication to the examiner, he or she would point to the peer and say, "Look," and turn her attention away. If the peer offered to help before the focus child demonstrated intentional communication, the examiner prompted the peer to wait. If a child showed any signs of distress by the type of toy presented, that toy was substituted out for a similar toy that would serve the same purpose. For example, some children were distressed when the cow or pig bumble ball was turned on or when the fan toy was activated. Thus, we substituted two remote control cars for the bumble balls and a switch-activated light toy that did not move.

Adult Partner Communication Sample

All activities and procedures in the adult communication samples were the same as in the peer partner samples, with the exception of the following. The examiner engaged with the focus child throughout the assessment, presenting each of the 12 tasks in sequence. After the presentation of each task, the examiner waited 7–10 s, and if the focus child initiated intentional communication (i.e., scored as 6 or higher on CCS), he or she responded to the child's communication and then moved on to present the next task. If after 7–10 s the child did not engage in intentional communication (i.e., scored a 5 or lower on CCS), the examiner repeated the task to provide a second opportunity for intentional communication. The examiner then waited another 7–10 s and responded to any communication attempt before presenting the next task.

Scoring and Coding Using the CCS

All assessments were captured on video using a Flip Mino Video Camera (first generation, Flip Video) or Sony HDR-CX260 Handycam positioned on a tripod near the table. Videos were uploaded to a desktop computer for later coding in the laboratory by primary and secondary coders. The peer partner communication sample and the adult partner communication sample were each coded using the 12-point scale on the CCS (see Table 3). There

Table 3. Levels, scores, and example behaviors on the Communication Complexity Scale.

Level	Scale score/definition	Example
	0 = no response	Child looks away; child is disengaged.
	1 = Alerting: a change in behavior; stops doing a behavior	Bumble ball stops vibrating; child stops moving.
Preintentional	2 = Single orientation only: on an object, event, or person; can be communicated through vision, body orientation, or other means	Child focuses attention on one object, watches a toy move, or stares at the partner.
	3 = Single orientation only + 1 PCB	Child watches a toy move and vocalizes.
	4 = Single orientation only + more than 1 PCB	Child stares at the fan, vocalizes, and reaches for it.
	5 = Dual orientation: shift in focus between a person and an object, between a person and an event using vision, body orientation, and so forth (without PCB)	Child bangs a hammer and then looks to the partner.
Intentional nonsymbolic	6 = Triadic orientation (e.g., eye gaze or touch from an object to a person and back)	Child looks at the snack container, then to the partner, and then back to the container.
	7 = Dual orientation + 1 PCB (e.g., dual focus + gesture)	Child picks up train, then looks to the peer/adult, and holds it out to show.
	8 = Dual orientation + more than 1 PCB (e.g., dual focus + gesture + vocalization)	Child looks at carrot in marker box, then looks to the partner, shakes head "no," and vocalizes.
	9 = Triadic orientation + 1 PCB (e.g., triadic + vocalization)	Child looks at the partner, then looks at a lizard in blocks, then looks back to the partner, and points to the lizard.
	10 = Triadic orientation plus more than 1 PCB (e.g., triadic plus vocalization and gesture)	Child looks at a book, looks at the partner, then looks back to the book, and points and vocalizes.
Intentional symbolic	11 = One-word verbalization, sign, or augmentative and alternative communication symbol selection	Child says "ball" or pushes ball symbol, gazes at peer, and waits (to request ball).
	12 = Multiword verbalization, sign, or augmentative and alternative communication symbol selection	Child says "see bubbles" or pushes two symbols—one for "see" and one for "bubbles"—to share attention.

Note. PCB = potentially communicative behavior (e.g., gestures, eye gaze, vocalizations) that appear purposeful, viewed as an individual trying to communicate. Copyright 2018 by the University of Kansas. Reprinted with permission.

were two parts to coding the CCS from the videos. The first was to identify start and stop times based on a 5-s interval that encompassed the child's highest level of communication demonstrated during the entire task, from the time the task was placed on the table up to the time it was removed. This was completed for each of the 12 tasks, with the start–stop times written at the top of the coding form.

The primary coder then proceeded to code the highest identified behavior with the CCS (i.e., a scale of 0–12) for each communication sample. Scores of 0–5 reflect a range of behaviors from no response to alerting and preintentional communication behaviors. Scores of 6–10 reflect intentional nonsymbolic communication behaviors, and scores of 11 and 12 reflect intentional symbolic communication. Any score of 6 or higher was an intentional communication act, and thus, the function of each act, to communicate either JA or BR, was also coded. Scores of 5 or lower were preintentional acts, and thus, the communicative function of the act could not be determined. Within the peer assessment context, intentional communication was only coded if the act was directed to a peer and based on the following three criteria: (a) The act was a gesture, vocalization, speech, sign, or SGD use; (b) the act was directed toward the peer, as demonstrated through eye gaze, body orientation, or gestures; and (c) the act served a communicative function, such as regulating the peer's behavior, attracting the peer's attention to the child, or directing peer's attention to the activity. If the peer held out his or her hand or said "I can help" and the focus child responded, these acts were coded as defined on the scale (and as BR). During the child–peer assessment, intentional communication directed to the adult was not coded. For the child–adult assessment, all acts were coded using the same 12-point scale and coding criteria. Any task with a score of 6 or higher (i.e., intentional communication) was also coded for the communicative function of JA or BR. The adult examiner was instructed not to provide prompts. If they did, any child communication act that directly followed an adult prompt, verbal utterance, or action on an object was not coded. This differed from the child–peer assessment context, in that if a peer held out a hand to ask the focus child if he or she wanted help, then the child's response was coded. The decision not to code responses to adult prompts was consistent with coding of the CCS with adult partners in previous research (Brady et al., 2018; Hahn et al., 2017).

Once each task was scored based on the participant's response, an average of the three highest scores from the 12 tasks was calculated to index overall optimal communication complexity. Likewise, the three highest scores of all intentional communication acts that were coded as JA or BR communication acts were averaged to indicate optimal JA or optimal BR, respectively. If fewer than three scores were coded as JA or BR, the optimal score was created by averaging the two scores if available or using a single score if only one JA or BR was expressed.

Interobserver Agreement: Peer Partner

The first author and one trained RA scored and coded the CCS from the child–peer partner assessments. The RA was trained on scoring and coding the CCS by the second author's research team and by the first author for variations in coding with peer partners. Once trained, the RA coded three previously recorded videos of adult–child structured communication assessment contexts, and each score or coding decision was discussed. Then, the RA coded videos of child–peer structured assessments until she reached a criterion of three consecutive tapes at 80% or greater agreement with the first author based on point-by-point agreement for scoring of each of the 12 tasks and for coding intentional communication acts as BR or JA. The first author and the trained RA served as both primary and secondary coders. At preintervention, children had not yet been assigned to any condition; therefore, the two coders were blind to treatment condition. Because the RA was a treatment coach for school staff, she was not blind to treatment condition at postintervention.

Interobserver agreement (IOA) was calculated for 25% of all preintervention and postintervention videos with peer communication partners, with equal numbers randomly selected for each testing period. Point-by-point reliability was used. An agreement was coded if both the primary and reliability observers agreed on the score given for each of the 12 tasks and if they agreed on the type of communicative function for JA or BR for tasks with a score of 6 or higher. The total number of agreements was then divided by the total number of agreements plus disagreements in each session and multiplied by 100. For both treatment and comparison groups, the mean IOA was 82% (range of 67%–92%) for scores across the 12 tasks coded from preintervention and postintervention peer assessment contexts. For the communicative functions of JA and BR, the mean IOA was 91% (range of 60%–100%) for both groups. Low percentage of IOA on functions was due to fewer intentional communication acts coded for some children (i.e., a total of five intentional acts coded, with agreement on three acts = 60%).

IOA: Adult Partner

A second trained RA was the primary CCS coder of all adult–child assessments, and three graduate RAs who were naive to the research questions and trained in CCS scoring and coding completed the reliability coding. The RA was considered reliable when 80% point-by-point agreement was reached for each of the 12 tasks across three consecutive videos, including 80% agreement on coding of communication acts as BR or JA. In the adult assessment contexts, IOA was calculated in the same manner as in the peer samples for 25% of the videos randomly selected. Mean IOA on the CCS with adults at preintervention and postintervention was 86% (range of 75%–100%) for agreement on scores across the 12 tasks and 88% (range of 73%–100%) for communicative functions. Similar to IOA within the peer–child assessment, the low end of the range for functions was due to fewer intentional acts coded. For any IOA outcomes of both peer– and adult–child assessments that fell below 75%, the first author met with the RAs to discuss disagreements and then added examples of coding situations to the manual to improve accuracy for future coding.

Analytic Method

We addressed our research questions regarding group and peer–adult context differences in communication complexity by predicting each outcome in doubly multivariate general linear models (i.e., including each child's scores for the adult and peer contexts at both occasions). Although conceptually equivalent to multivariate repeated-measures analysis of variance, in these models, the use of full-information residual maximum likelihood estimation (as implemented in SAS MIXED) eliminates the need for listwise deletion of participants with incomplete responses and thus makes use of all available outcomes under an assumption of missing at random (i.e., that missing responses are conditionally random after controlling for all other data in the model). Separate residual variances were estimated for each response, and all residual covariances were included. In addition, separate residual variances and covariances by treatment group were modeled for the overall and BR complexity outcomes, as warranted by significant likelihood ratio tests for the improvement in model fit in doing so.

Results

Table 4 provides descriptive statistics for the three optimal communication complexity outcomes—overall, BR, and JA—at each occasion (preintervention or postintervention) for each group (SGD with peer-mediated approach, business-as-usual comparison). Outcomes for each context (peer or adult interaction) are also presented. As shown, far fewer children in both groups had any communication acts that were coded as JA than were coded as BR. This was expected based on the communication phenotype of children with autism (Dawson et al., 2004). The CCS reflected improvements over time in each of the three outcomes in the peer and adult assessment contexts for both groups. The treatment group also had markedly less variance in each of the three outcomes at postintervention than the comparison group in both contexts.

Full model results are shown in Tables 5–7. The first section of each table provides the effects within the peer context for change over time overall and within each group, followed by treatment group differences in change over time (i.e., a Group × Time interaction) and at each occasion (pretest, posttest). The second section of each table provides the same effects for the adult context. The third section of each table provides the differences between the peer and adult contexts in each effect. As expected, given random assignment to the treatment or comparison groups, there were no significant treatment group differences in scores at pretest. The treatment and control groups differed in their mean change over time similarly across the peer and adult contexts—that is, there was a nonsignificant three-way interaction of Occasion (preintervention or postintervention) × Group (treatment or comparison) × Context (peer or adult) for each outcome (as reported in the fourth row of the Peer–Adult Difference section of each table). Accordingly, in Tables 5–7, we also report effects of pooling over groups to increase power.

Results for Overall Communication Complexity

Results of CCS scores reflecting overall communication complexity in the peer and adult assessment contexts, as well as differences in communication complexity between the peer and adult assessment contexts (peer–adult difference), are shown in Table 5.

Peer Assessment Context

Consistent with our first hypothesis, there was significant mean growth from pretest to posttest ($d = 1.71$) in

Table 4. Communication complexity outcome descriptive statistics by context, group, and time.

			Preintervention					Postintervention				
Outcome	Context	Group	*N*	*M*	*SD*	Min	Max	*N*	*M*	*SD*	Min	Max
Optimal overall	Adult	Comparison	22	10.45	1.28	7.00	12.00	22	11.08	1.13	7.33	12.00
		Treatment	23	10.59	1.30	7.33	12.00	23	11.49	0.39	11.00	12.00
	Peer	Comparison	22	9.29	2.11	4.00	11.33	22	10.48	1.23	7.33	11.67
		Treatment	23	8.99	2.13	5.33	12.00	23	11.23	0.45	10.00	12.00
Optimal behavior regulation	Adult	Comparison	22	10.49	1.28	7.00	12.00	22	11.17	0.99	8.00	12.00
		Treatment	23	10.73	1.25	7.33	12.00	20	11.43	0.38	11.00	12.00
	Peer	Comparison	18	9.90	1.45	6.50	11.00	20	10.45	1.39	7.00	12.00
		Treatment	22	9.83	1.56	6.00	12.00	22	11.17	0.43	10.00	12.00
Optimal joint attention	Adult	Comparison	12	11.08	0.79	9.00	12.00	11	10.73	1.19	9.00	12.00
		Treatment	12	10.75	1.22	7.00	12.00	9	11.78	0.44	11.00	12.00
	Peer	Comparison	11	9.30	1.61	7.00	11.50	8	9.94	1.82	7.00	11.00
		Treatment	14	9.96	1.91	6.00	12.00	7	11.71	0.49	11.00	12.00

Note. *N* = Total number of observations; Min = minimum complexity score; Max = maximum complexity score.

Table 5. Model results for overall optimal communication complexity.

Context	Effect	Est	*SE*	*df*	*p*	*d*
Peer	Change across both groups	1.83	0.33	41.7	< **.01**	1.71
	Change for comparison group	1.41	0.50	21.0	< **.01**	1.22
	Change for treatment group	2.25	0.43	22.0	< **.01**	2.23
	Group difference in change	0.84	0.66	41.7	< .21	0.39
	Group difference at pretest	−0.09	0.65	42.7	< .89	0.04
	Group difference at posttest	0.75	0.28	26.4	< **.01**	1.04
Adult	Change across both groups	0.78	0.19	40.9	< **.01**	1.28
	Change for comparison group	0.67	0.30	21.0	< **.04**	0.98
	Change for treatment group	0.90	0.24	22.0	< **.01**	1.59
	Group difference in change	0.23	0.38	40.9	< .55	0.19
	Group difference at pretest	0.19	0.38	43.0	< .63	0.15
	Group difference at posttest	0.42	0.25	25.7	< .11	0.65
Peer–adult difference	Change across both groups	−1.05	0.27	42.6	< **.01**	1.21
	Change for comparison group	−0.74	0.39	21.0	< .07	0.84
	Change for treatment group	−1.35	0.36	22.0	< **.01**	1.59
	Group difference in change	−0.61	0.53	42.6	< .26	0.35
	Pretest across both groups	1.47	0.25	42.9	< **.01**	1.78
	Pretest for comparison group	1.33	0.35	21.0	< **.01**	1.68
	Pretest for treatment group	1.61	0.37	22.0	< **.01**	1.86
	Posttest across both groups	0.43	0.10	26.4	< **.01**	1.62
	Posttest for comparison group	0.59	0.19	21.0	< **.01**	1.34
	Posttest for treatment group	0.26	0.07	22.0	< **.01**	1.60

Note. Bold values indicate *p* < .05. Est = estimate; *SE* = standard error; *df* = denominator degrees of freedom; *d* = Cohen's standardized mean difference.

overall communication complexity in the peer context. Contrary to our second hypothesis, there was no significant group difference in change over time—although children in the treatment group (*d* = 2.23) did grow more than children in the comparison group (*d* = 1.22).

Adult Assessment Context

Similar results for overall communication complexity were found in the adult context—although there was significant mean growth from pretest to posttest (*d* = 1.28) and although children in the treatment group (*d* = 1.59) grew

Table 6. Model results for communication complexity coded as optimal behavior regulation.

Context	Effect	Est	*SE*	*DF*	*p*	*d*
Peer	Change across both groups	1.16	0.26	38.2	< **.01**	1.45
	Change for comparison group	0.83	0.38	20.8	< **.04**	0.95
	Change for treatment group	1.48	0.35	17.5	< **.01**	2.04
	Group difference in change	0.65	0.52	38.2	< .21	0.41
	Group difference at pretest	−0.04	0.50	35.8	< .93	0.03
	Group difference at posttest	0.61	0.32	23.8	< .07	0.78
Adult	Change across both groups	0.72	0.20	42.4	< **.01**	1.11
	Change for comparison group	0.73	0.30	21.0	< **.02**	1.07
	Change for treatment group	0.72	0.27	22.1	< **.01**	1.15
	Group difference in change	−0.01	0.40	42.4	< .99	0.00
	Group difference at pretest	0.28	0.38	42.8	< .45	0.23
	Group difference at posttest	0.28	0.23	27.7	< .23	0.46
Peer–adult difference	Change across both groups	−0.43	0.19	36.1	< **.03**	0.74
	Change for comparison group	−0.10	0.29	16.8	< .73	0.17
	Change for treatment group	−0.76	0.25	21.4	< **.01**	1.30
	Group difference in change	−0.66	0.39	36.1	< .10	0.57
	Pretest across both groups	0.88	0.20	37.8	< **.01**	1.41
	Pretest for comparison group	0.71	0.32	19.5	< **.04**	1.01
	Pretest for treatment group	1.04	0.25	21.0	< **.01**	1.82
	Posttest across both groups	0.45	0.13	24.9	< **.01**	1.33
	Posttest for comparison group	0.61	0.25	20.2	< **.03**	1.07
	Posttest for treatment group	0.28	0.09	18.5	< **.01**	1.49

Note. Bold values indicate *p* < .05. Est = estimate; *SE* = standard error; *df* = denominator degrees of freedom; *d* = Cohen's standardized mean difference.

Table 7. Model results for communication complexity coded as optimal behavior regulation.

Context	Effect	Est	*SE*	*df*	*p*	*d*
Peer	Change across both groups	0.95	0.52	14.0	< .09	0.99
	Change for comparison group	0.03	0.75	16.2	< .97	0.02
	Change for treatment group	1.87	0.71	11.8	< **.02**	1.55
	Group difference in change	1.85	1.03	14.0	< .09	0.96
	Group difference at pretest	0.13	0.83	20.0	< .88	0.07
	Group difference at posttest	1.98	0.76	13.0	< **.02**	1.45
Adult	Change across both groups	0.52	0.21	9.0	< **.04**	1.64
	Change for comparison group	0.21	0.27	8.8	< .47	0.51
	Change for treatment group	0.84	0.32	9.1	< **.03**	1.72
	Group difference in change	0.63	0.42	9.0	< .17	1.00
	Group difference at pretest	0.14	0.40	26.5	< .72	0.14
	Group difference at posttest	0.77	0.42	23.0	< .08	0.78
Peer–adult difference	Change across both groups	−0.43	0.54	8.5	< .45	0.55
	Change for comparison group	0.18	0.76	8.3	< .82	0.16
	Change for treatment group	−1.04	0.75	8.7	< .20	0.93
	Group difference in change	−1.22	1.07	8.5	< .29	0.78
	Pretest across both groups	1.15	0.39	14.9	< **.01**	1.52
	Pretest for comparison group	1.14	0.59	14.0	< .07	1.04
	Pretest for treatment group	1.16	0.51	16.0	< **.04**	1.12
	Posttest across both groups	0.72	0.36	9.2	< .08	1.31
	Posttest for comparison group	1.32	0.46	9.0	< **.02**	1.92
	Posttest for treatment group	0.12	0.56	9.4	< .84	0.14

Note. Bold values indicate $p < .05$. Est = estimate; *SE* = standard error; *df* = denominator degrees of freedom; *d* = Cohen's standardized mean difference.

more than children in the comparison group ($d = 0.98$), this group difference in change was not significant.

Difference Between Peer and Adult Assessment Contexts

Given the nonsignificant three-way interaction of Context × Group × Time, we examined differences in overall communication complexity between the peer and adult contexts pooling across the treatment and comparison groups. Consistent with our third hypothesis, overall communication complexity was significantly higher in the adult context than in the peer context, both at pretest ($d = 1.78$) and at posttest ($d = 1.62$). In addition, children showed a significantly greater improvement over time in the peer context than in the adult context ($d = 1.21$).

Results for BR

Results for the average of the top three intentional communication acts coded as BR in the peer and adult assessment contexts, as well as differences in BR between the peer and adult assessment contexts (peer–adult difference), are shown in Table 6.

Peer Assessment Context

Consistent with our first hypothesis, there was significant mean growth from pretest to posttest ($d = 1.45$) in BR in the peer context. Contrary to our second hypothesis, there was no group difference in change over time—although children in the treatment group ($d = 2.04$) grew more than children in the comparison group ($d = 0.95$), this difference in change was not statistically significant.

Adult Assessment Context

Similar results for BR were found in the adult context as for the peer context—there was significant mean growth from pretest to posttest ($d = 1.11$) but no significant difference in change between the treatment and comparison groups.

Difference Between Adult and Peer Assessment Contexts

Consistent with our third hypothesis, pooling across groups, mean BR was significantly higher in the adult context than in the peer context, both at pretest ($d = 1.41$) and at posttest ($d = 1.33$). Children also showed a significantly greater improvement over time in the peer context than in the adult context ($d = 0.74$).

Results for JA

Results for the average of the top three intentional communication acts coded as JA in the peer and adult assessment contexts, as well as differences in JA between the peer and adult assessment contexts (peer–adult difference), are shown in Table 7.

Peer Assessment Context

Contrary to our first hypothesis, the mean growth from pretest to posttest ($d = 0.99$) in JA in the peer assessment context was not significant. Also contrary to our second hypothesis, there was also no significant group difference in change over time—although children in the treatment group ($d = 1.55$) grew more than children in the comparison group ($d = 0.02$).

Adult Assessment Context

In contrast to the peer context, significant growth from pretest to posttest (d = 1.64) was found for JA in the adult context. Similar to the peer context, the treatment group (d = 1.72) grew more in JA than children in the comparison group (d = 0.51); however, this difference in change was not statistically significant.

Difference Between Peer and Adult Assessment Contexts

Partially consistent with our third hypothesis, pooling across groups, JA was significantly higher in the adult context than in the peer context at pretest (d = 1.52) but not at posttest (d = 1.31). In addition, children did not grow significantly more in JA in the peer context than in the adult context.

Discussion

We utilized the CCS to measure and compare changes in communication of preschoolers with ASD with minimal to no verbal skills who were randomly assigned to receive SGD treatment with trained peer partners or a business-as-usual SGD comparison group with untrained peers. Differences were examined across two communication samples—one with a peer partner and one with an adult partner—collected approximately 8 months apart at the beginning and end of treatment.

Two important findings were as follows: (a) The CCS captured growth in overall communication complexity and complexity of BR over time for children in both the treatment and comparison groups, and (b) the CCS revealed that children in the peer-mediated SGD treatment group showed more change than children in the comparison group in overall communication complexity, BR, and JA, although the difference in change was not statistically significant. Pooling across the two groups, three additional results were as follows: (a) Communication complexity and BR were higher in the adult context than in the peer context; (b) over time, overall communication complexity and BR showed greater improvements in the peer context than in the adult context; and (c) JA was significantly higher in the adult context than the peer context at the initial assessment, and this context difference disappeared by the end of treatment.

Given that children in both experimental conditions improved in their overall communication complexity and BR over the course of treatment, the CCS did not capture clear effects of the peer-mediated SGD intervention on improving these skills. Thus, the CCS did not discriminate changes associated with maturation versus those related to the peer-mediated SGD treatment, but there are several possible reasons for this. Features of the peer assessment procedures may have contributed to the lack of establishing treatment effects as measured with the CCS in the peer context. That is, the peers for both treatment and comparison conditions were recommended by their classroom teachers to participate in the intervention study. They received brief instructions on how to elicit and prompt child communication just before and during the assessment. Thus, focus child behaviors were somewhat dependent on peer behaviors and their ability to readily comply with adult directions. Although the examiner guided the interaction and provided a structured environment, there were times when managing both peer and child behaviors was a challenge. Future studies evaluating the utility of the CCS or other tools designed to measure changes with peer partners should examine and report on peer training procedures, fidelity of peer administration, and the potential impact of peer behaviors on child assessment outcomes.

An additional factor is that children in both the treatment and comparison conditions were provided with an iPad to use as their SGD for the duration of the school year. The SGD system may have enhanced communication opportunities for the children in both conditions, with greater opportunities to engage with teachers, peers, and others in the classroom. These opportunities may have led to improved communication for both groups. Another reason for similar growth across groups is that all of the children with ASD were participating in early special education programs designed to meet their educational and communication needs; therefore, one would expect changes in intentional communication over one school year. This growth was captured with the CCS—a tool that is sensitive to changes in the complexity of children's intentional communication, including the functions of BR and JA. Outcomes extend available research on the CCS used to describe communication of young children and infants with developmental disabilities (Brady et al., 2018; Hahn et al., 2017) to demonstrating its functionality as a measure of communication change over time and with peers.

A closer examination and comparison of child–adult and child–peer CCS differences between the two experimental groups revealed some interesting findings. First, children who received the SGD treatment with trained peer partners had significantly higher communication complexity and JA in the peer context at posttest, and the effects were large (i.e., d = 1.04 and d = 1.45, respectively; see Tables 5 and 7). This SGD treatment included teaching peers responsive social skills that can lead to improved interactions, such as taking turns, sharing, and talking to their partner with ASD (Thiemann-Bourque, Brady, McGuff, Stump, & Naylor, 2016; Thiemann-Bourque, McGuff, & Goldstein, 2017). Communication complexity with peer partners in this instance refers to an increase in intentional nonsymbolic communication (i.e., a mean of 8.99, or close to triadic orientation plus one potentially communicative behavior; see Table 1) to intentional symbolic communication (a mean of 11.23, one-word to multiword verbal, sign, or SGD selection). Recall from the coding procedures that any act scored as a 6 or higher can be coded as JA or BR. For example, a child may engage in triadic orientation or push the SGD to make a comment about a surprising event. Differences in intentional peer-directed communication acts with JA grew more for children who received the peer-mediated SGD treatment, with a change in score from 9.96 to 11.71 compared with a change from 9.30 to 9.94 for the comparison group. On the basis of the CCS, these changes translate to a growth in intentional symbolic acts with the function to engage in JA with peers; in contrast, there were no significant changes in intentional symbolic JA acts for children not receiving the treatment. JA deficits are characteristic of young children with ASD, and this early skill plays a pivotal role in early development (Charman, 2003). JA has become a key target of early interventions based on longitudinal studies showing clear associations between improved JA and later language, vocabulary, social communication, and peer interactions (Kasari et al., 2008, 2012; Sigman et al., 1999; Stone & Yoder, 2001). To date, adults have been the communication partners teaching JA primarily in clinic settings; studies measuring JA with peer communication partners in typical preschool environments are lacking. Although much more research is necessary, the usefulness of the CCS in capturing growth in JA with peer partners is especially noteworthy; we are not aware of other measures or scoring systems that can capture these changes.

As predicted, all children with ASD used more complex communication when interacting with adults in the structured assessment context. This finding was not surprising, given the optimal communication context and scaffolding an adult examiner could provide and the characteristic deficits in social interaction and play skills with peers for this population. What is noteworthy is that the CCS described changes or growth in the communication levels of children with severe expressive communication deficits with both adult and peer communication partners. Furthermore, improvements from pretreatment to posttreatment were greater in the peer context than in the adult context. Thus, the CCS showed variability based on the assessment context. This information could be used to supplement scores or assessment data from other early communication assessments such as the ESCS (Mundy et al., 2003) or CSBS (Wetherby & Prizant, 2002) that focus on adult partner communication to obtain a broader picture of communication competencies across different contexts. Changes reflect the ability to engage in higher levels of intentional communication with adult and peer partners and thus augment information provided by frequency counts or rates of behaviors typically reported in communication intervention studies (Kasari et al., 2006; Yoder & Stone, 2006).

Clinical Implications

In clinical settings or schools that provide early intervention services to young children with ASD who have complex communication needs, the CCS may be useful to monitor changes in prelinguistic and symbolic communication behaviors and be a progress monitoring tool for measuring the development of peer communication competencies. These competencies may include initiating to ask for items or preferred toys from a peer, to comment on events, or to gain a peer's attention and responding to a peer's requests, comments, or attempts to gain attention. When the primary intervention goals are to train peers without disabilities to engage and be responsive communication partners to impact the communication development of children with ASD, the CCS may be useful as a formative assessment tool. That is, if treatment changes are not observed, data from the CCS could be used to modify peer-mediated or other social treatment approaches to better target important precursors related to communication and social competencies for children with minimal verbal skills. To date, the authors are not aware of a similar tool or method that would provide such information.

Common assessment practices for children with ASD are direct observational methods (Kasari et al., 2012). Although these observations can provide rich data about behaviors exhibited within natural environments, they may be devoid of opportunities to observe sustained peer interactions given the core deficits in social communication and interactions characteristic of this population. The current assessment was structured and provided opportunities to observe child behaviors in a controlled activity. Ultimately, it will be important to develop measures of communication with peers in natural environments that are not scripted or prompted. Additional research is needed to examine the usefulness of the CCS in both structured and more natural peer assessment contexts and how to involve peers in assessments that can reliably measure a full range of child communication behaviors. Until a standard assessment protocol and procedures with peer partners are developed, clinicians should, at minimum, observe interactions with peer partners in reporting children's communication competencies.

Limitations and Future Directions

Although this is the first study we are aware of that reports on using the CCS to measure differences after treatment in communication of children with ASD during adult or peer partner assessments, a few limitations of the study deserve to be mentioned. First, a larger sample size and thus higher statistical power may have led to detection of significant differences in change over time between groups and the ability to generalize findings to a wider population of preschool children with ASD. For example, far fewer children had any intentional acts coded as JA; thus, these analyses were likely underpowered to detect differences. In addition, trained coders of the child–adult assessments were blind to treatment condition at both preintervention and postintervention; however, coders for the child–peer assessments were not blind at the postintervention. This may have resulted in biased outcomes for children receiving the treatment.

The peer interactions in the current study were highly scripted, as in the adult interactions. This enabled us to examine communication in contexts that varied by partner but were otherwise highly similar. However, the scripted nature of the interaction may be viewed as a limitation because it was not a naturalistic play-based context. Including a peer partner in assessments is a new endeavor—one that will require close attention to the challenges of managing peer and child behaviors together and an understanding of how to interpret child outcomes based on peer responses within the assessment. The second author is currently validating a version of the CCS that can be applied to authentic interactions using a time-sampling method. Hence, in the future, we will be able to examine how to use the CCS to code peer interactions in authentic interactions in the classroom or on the playground.

Conclusion

The outcomes demonstrate that the CCS has the potential to fill a gap in the assessment literature for young children with ASD and complex communication needs by documenting the utility of this measure to identify changes in communication within structured opportunities and with different partners. To date, the interactive assessment contexts for measuring child communication using the CCS or other observational scales have been with adult partners. The findings extend research with peer partners and provide support for using the CCS to gain a more complete picture of early communication skills within peer social environments. This assessment information could be used to establish benchmarks of early skills that are precursors to symbolic communication for children who are minimally verbal—an urgent need noted by Kasari and colleagues (2013). It may also assist early educators in monitoring the effectiveness of social interventions with peers. Given the accepted evidence and recommendations for including peers in interventions designed to teach communication and social interaction skills, an important direction for future research would be to develop adequate assessment tools and child–peer protocols to measure treatment changes and monitor child gains.

Acknowledgments

This research was funded by National Institute on Deafness and Other Communication Disorders Grants R01DC012530 and R01HD076903. We thank the families, children, and preschool staff for their participation and ongoing support in assisting with this study. We gratefully acknowledge the project coordinator Sarah Feldmiller and the research assistant Stacy Johner for their time and effort and all the student research assistants who assisted in collecting data over the course of the project.

References

Assistiveware. (2009). *Proloquo2Go* (Version 1.0) [Mobile application software]. Retrieved from https://www.assistiveware.com

Brady, N. C., Fleming, K., Swinburne Romine, R., Holbrook, A., Muller, K., & Kasari, C. (2018). Concurrent validity and reliability for the Communication Complexity Scale. *American Journal of Speech-Language Pathology, 27*(1), 237–246.

Brady, N. C., Fleming, K., Thiemann-Bourque, K., Olswang, L., Dowden, P., Saunders, M. D., & Marquis, J. (2012). Development of the Communication Complexity Scale. *American Journal of Speech-Language Pathology, 21*(1), 16–28.

Brown, W. H., & Odom, S. (1996). Observational assessment of young children's social behavior with peers. *Early Childhood Research Quarterly, 11,* 19–40.

Bryson, S. E., Zwaigenbaum, L., McDermott, C., Rombough, V., & Brian, J. (2008). The Autism Observation Scale for infants: Scale development and reliability data. *Journal of Autism and Developmental Disorders, 38*(4), 731–738.

Charman, T. (2003). Why is joint attention a pivotal skill in autism? *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 358*(1430), 315–324.

Dawson, G., Toth, K., Abbott, R., Osterling, J., Munson, J., Estes, A., & Liaw, J. (2004). Early social attention impairments in autism: Social orienting, joint attention, and attention to distress. *Developmental Psychology, 40*(2), 271–283.

Downer, J. T., Booren, L. M., Lima, O. K., Luckner, A. E., & Pianta, R. C. (2010). The individualized classroom assessment scoring system (inCLASS): Preliminary reliability and validity of a system for observing preschoolers' competence in classroom interactions. *Early Childhood Research Quarterly, 25*(1), 1–16.

Freeman, S. F., Gulsrud, A., & Kasari, C. (2015). Brief report: Linking early joint attention and play abilities to later reports of friendships for children with ASD. *Journal of Autism and Developmental Disorders, 45*(7), 2259–2266.

Goldstein, H., Lackey, K. C., & Schneider, N. (2014). A new framework for systematic reviews: Application to social skills interventions for preschoolers with autism. *Exceptional Children, 80*(3), 262–286.

Goldstein, H., Schneider, N., & Thiemann, K. (2007). Peer-mediated social communication intervention: When clinical expertise informs treatment development and evaluation. *Topics in Language Disorders, 27*(2), 182–199.

Hahn, L. J., Brady, N. C., McCary, L., Rague, L., & Roberts, J. E. (2017). Early social communication in infants with fragile X syndrome and infant siblings of children with autism spectrum disorder. *Research in Developmental Disabilities, 71,* 169–180.

Kasari, C., Brady, N., Lord, C., & Tager-Flusberg, H. (2013). Assessing minimally verbal school-aged children with autism spectrum disorder. *Autism Research, 6,* 479–493.

Kasari, C., Freeman, S., & Paparella, T. (2006). Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 47*(6), 611–620.

Kasari, C., Gulsrud, A., Freeman, S., Paparella, T., & Hellemann, G. (2012). Longitudinal follow-up of children with autism receiving targeted interventions on joint attention and play. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*(5), 487–495.

Kasari, C., Paparella, T., Freeman, S., & Jahromi, L. B. (2008). Language outcome in autism: Randomized comparison of joint attention and play interventions. *Journal of Consulting and Clinical Psychology, 76*(1), 125–137.

Kent-Walsh, J., & McNaughton, D. (2005). Communication partner instruction in AAC: Present practices and future directions. *Augmentative and Alternative Communication, 21*(3), 195–204.

Kover, S. T., McDuffie, A., Abbeduto, L., & Brown, W. T. (2012). Effects of sampling context on spontaneous expressive language in males with fragile X syndrome or Down syndrome. *Journal of Speech, Language, and Hearing Research, 55*(4), 1022–1038.

Light, J., & McNaughton, D. (2012). The changing face of augmentative and alternative communication: Past, present, and future challenges. *Augmentative and Alternative Communication, 28*(4), 197–204.

McConnell, S. R., & Odom, S. L. (1999). A multimeasure performance-based assessment of social competence in young children with disabilities. *Topics in Early Childhood Special Education, 19*(2), 67–74.

Mullen, E. (1995). *Mullen Scales of Early Learning (MSEL)*. Circle Pines, MN: AGS.

Mundy, P., Delgado, C., Block, J., Venezia, M., Hogan, A., & Seibert, J. (2003). *Early Social Communication Scales (ESCS)*. Coral Gables, FL: University of Miami.

Romski, M., Sevcik, R. A., Adamson, L. B., Cheslock, M., Smith, A., Barker, R. M., & Bakeman, R. (2010). Randomized comparison of augmented and nonaugmented language interventions for toddlers with developmental delays and their parents. *Journal of Speech, Language, and Hearing Research, 53*(2), 350–364.

Rowland, C. (2011). Using the communication matrix to assess expressive skills in early communicators. *Communication Disorders Quarterly, 32*(3), 190–201.

Schopler, E., Van Bourgondien, M. E., Wellman, G. J., & Love, S. R. (2010). *Childhood Autism Rating Scale–Second Edition (CARS-2)*. Torrance, CA: WPS.

Sigman, M., Ruskin, E., Arbelle, S., Corona, R., Dissanayake, C., Espinosa, M., & Robinson, B. (1999). Continuity and change in the social competence of children with autism, Down syndrome, and developmental delays. *Monographs of the Society for Research in Child Development, 64*(1), 1–10.

Silver Kite. (2017). *Touch chat HD* [Mobile application software]. Retrieved from https://itunes.apple.com/us/app/touchchat-hd-aac/id398860728?mt = 8

Sparrow, S. S., Cicchetti, D. V., & Balla, D. A. (2005). *Vineland Adaptive Behavior Scales (Vineland-II)*. Circle Pines, MN: American Guidance Service.

Sterrett, K., Shire, S., & Kasari, C. (2017). Peer relationships among children with ASD: Interventions targeting social acceptance, friendships, and peer networks. In *International review of research in developmental disabilities* (Vol. 52, pp. 37–74). San Diego, CA: Academic Press.

Stone, W. L., & Yoder, P. J. (2001). Predicting spoken language level in children with autism spectrum disorders. *Autism, 5*(4), 341–361.

Thiemann-Bourque, K., Brady, N., McGuff, S., Stump, K., & Naylor, A. (2016). Picture exchange communication system and pals: A peer-mediated augmentative and alternative communication intervention for minimally verbal preschoolers with autism. *Journal of Speech, Language, and Hearing Research, 59*(5), 1133–1145.

Thiemann-Bourque, K., Feldmiller, S., Hoffman, L., & Johner, S. (2018). Incorporating a peer-mediated approach into speech-generating device intervention: Effects on communication of preschoolers with autism spectrum disorder. *Journal of Speech, Language, and Hearing Research, 61*(8), 2045–2061.

Thiemann-Bourque, K., McGuff, S., & Goldstein, H. (2017). Training peer partners to use a speech-generating device with classmates with ASD: Exploring communication outcomes across preschool contexts. *Journal of Speech, Language, and Hearing Research, 60*(9), 2648–2662.

Watkins, L., O'Reilly, M., Kuhn, M., Gevarter, C., Lancioni, G. E., Sigafoos, J., & Lang, R. (2015). A review of peer-mediated social interaction interventions for students with autism in inclusive settings. *Journal of Autism and Developmental Disorders, 45*(4), 1070–1083.

Wetherby, A. M., Guthrie, W., Woods, J., Schatschneider, C., Holland, R. D., Morgan, L., & Lord, C. (2014). Parent-implemented social intervention for toddlers with autism: An RCT. *Pediatrics, 134*(6), 1084–1093.

Wetherby, A. M., & Prizant, B. M. (2002). *Communication and Symbolic Behavior Scales: Developmental Profile (CSBS DP)*. Baltimore, MD: Paul H. Brookes Publishing Co.

White, S. W., Keonig, K., & Scahill, L. (2007). Social skills development in children with autism spectrum disorders: A review of the intervention research. *Journal of Autism and Developmental Disorders, 37*(10), 1858–1868.

Yoder, P., & Stone, W. L. (2006). A randomized comparison of the effect of two prelinguistic communication interventions on the acquisition of spoken communication in preschoolers with ASD. *Journal of Speech, Language, and Hearing Research, 49*(4), 698–711.

Zimmerman, I. L., Steiner, V., & Evatt Pond, R. (2007). *Preschool Language Scale–Fifth Edition (PLS-5)*. San Antonio, TX: The Psychological Corporation.