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ORIGINAL ARTICLE

Social-Communication Intervention for Toddlers with Autism Spectrum Disorder: Effects on Initiating Joint Attention and Interactions with Mother

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Abstract From infancy, children who later receive a diagnosis of autism spectrum disorder (ASD) show impairments in eye gaze within both joint attention and requesting contexts and, most notably, when initiating interactions. These impairments correlate with later social, communication, and play development. To adequately address the social-communication impairments that characterize ASD, early intervention must address each of these areas. We examined a brief social-communication intervention teaching eye gaze in select social-communication contexts while examining generalization to initiating joint attention and interactions with participants' mothers. Three toddlers with ASD participated in intervention involving prompting, prompt fading, and reinforcement. Two toddlers showed generalization from requesting to joint attention with the interventionist; all three showed generalization to interactions with their mothers in a semi-structured play interaction. Findings are discussed in terms of generalization and efficiency of intervention.

Keywords Autism · Gaze shift · Joint attention · Requesting · Mother toddler interaction

Within the first year of life infants demonstrate a foundation for competent social-communicative interactions. One of the earliest forms of social-communication is the use of eye gaze. Before they speak or even point, typically developing infants direct

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their eye gaze to engage their caregivers (Butterworth and Cochran 1980) by looking at an object/event and then shifting their gaze to look at their caregiver's eyes, making eye contact (Morisette et al. 1995). Infants make requests and engage in joint attention (JA) just by shifting their gaze to look at others (referred to as a gaze shift). Eye gaze, requesting, and JA are all related to language, social, and cognitive development in later life (Meltzoff and Brooks 2008; Morales et al. 2005; Mundy et al. 2007).

Unlike typically developing infants, the foundation for competent social-communicative interactions is significantly impaired in infants who go on to receive a diagnosis of autism spectrum disorder (ASD) (Zwaigenbaum et al. 2005). Differences in eye gaze are evident in the social-communicative contexts of requesting as well as JA within the first year of life in children who later receive a diagnosis of ASD compared to children who do not later receive a diagnosis of ASD (Ibañez et al. 2013; Rozga et al. 2011; Zwaigenbaum et al. 2005; Zwaigenbaum et al. 2013). By the preschool and kindergarten years, children with ASD show more significant differences in JA than in requesting (Mundy et al. 1986). In children with ASD, poor eye gaze in requesting and JA contexts is related to later delays in expressive language (Charman et al. 2003; Loveland and Landry 1986; Mundy et al. 1990; Paparella et al. 2011). The absence of eye gaze may result in missed interactions and breakdowns in interaction (e.g., when a social partner does not recognize a child's response as being directed at him/her because the child was looking elsewhere). Impairment in eye gaze in children with autism from a young age suggests eye gaze within both requesting and joint attention situations should be a priority targeted for intervention at an early age.

As a result of findings about early differences in toddlers with ASD and their typically developing peers, a number of studies have investigated interventions addressing these social-communicative behaviors in children with ASD. In the context of requesting or manding, there exists a relatively extensive literature demonstrating the effectiveness of intervention involving modeling, prompting, and reinforcement (e.g., Buffington et al. 1998; King et al. 2014; Sigafoos et al. 2013; Thomas et al. 2010; Wert and Neisworth 2003). Some studies have measured collateral changes in children's gaze behavior after teaching requesting using PECS, mand training, or discrete trial teaching (e.g., Charlop-Christy et al. 2002; Jennett et al. 2008; Plavnick and Ferreri 2012). We only identified one study that specified teaching gaze shift as part of the response form for requesting (Thomas et al. 2010). In contrast to the requesting literature, in the JA literature, many studies have focused on gaze shift as a response form. Interventions involving prompting and reinforcement are generally effective in improving JA (see Meindl and Cannella-Malone 2011 and White et al. 2011 for reviews).

Only a few studies have focused on teaching both requesting and JA (e.g., Dawson et al. 2010; Warren et al. 1993; Yoder and Stone 2006), which would seem to be necessary to adequately address the social-communication needs of young children with ASD. Instead of directly teaching both requesting and JA, in other studies interventionists taught a response in one context or function and then examined generalization to others. Although some studies do not find evidence of generalization (e.g., Hall and Sundberg 1987; Lamarre and Holland 1985), others do (e.g., Carroll and Hesse 1987; Greenberg et al. 2014; Petursdottir et al. 2005; Sigafoos et al. 1989). This suggests that carefully choosing a response form relevant across contexts and teaching in certain contexts may be one of the ways to increase social-communicative behavior across multiple social-communicative contexts without directly teaching in each and

every context. If every context does not require direct intervention, this would certainly improve the efficiency of intervention.

In a recent study, Krstovska-Guerrero and Jones (2016) examined a social-communication interaction intervention involving prompting and reinforcement to teach eye gaze in the context of both requesting and JA. They taught gaze shift (GS) within two social communicative contexts to 4 toddlers (ages, 20 months to 29 months) with ASD. After teaching children to respond to the interventionist's request to clean up and initiate joint attention (IJA) about an activated toy (e.g., remote control car), Krstovska-Guerrero and Jones (2016) observed generalization to other requesting and JA contexts, specifically those in which the toddlers initiated interaction. However, children showed inconsistent generalization to responding to joint attention (RJA); some toddlers responded to the interventionist's bid for JA in the form of a head turn, point, and vocalizations, but none responded when the interventionist just turned her head. Toddlers also showed generalization to highly structured interactions with their mothers that mirrored the intervention situation with the interventionist. Generalization across social-communicative contexts along with generalization to a structured situation with children's mothers was all achieved within a relatively brief intervention lasting from 3 to 9 weeks across all 4 children.

The present study replicated and extended Krstovska-Guerrero and Jones (2016). The present study examined a brief social-communication interaction intervention involving prompting, prompt fading, and reinforcement. We specifically targeted GS in a small sample of social-communicative contexts to ensure we addressed both requesting and JA, including RJA, because Krstovska-Geurrero and Jones did not observe consistent generalization to this context. Since we added RJA as a target for intervention, we instead examined generalization to IJA, perhaps the most significant area of social-communicative impairment in toddlers with ASD. We began intervention with two requesting contexts because the natural consequences for requests, receipt of the item requested, could be more readily identified as likely reinforcers. By teaching children to shift gaze in a requesting situation first, looking at the interventionist's eyes was paired with reinforcement. Finally, we explored generalization with toddlers' mothers in a semi-structured play interaction and examined the duration of intervention.

Method

Participants

Three 2–3 year old toddlers diagnosed with an ASD participated. Each toddler's parent completed a pre-assessment questionnaire to provide background information about the toddler and his/her pre-existing skills. To be eligible to participate, toddlers must have been between 2 and 3 years of age, have a diagnosis of ASD as reported by the toddler's parent and confirmed through review of toddler's evaluations, and, based upon parent responses on the pre-assessment questionnaire, be able to track a desired item to at least four different positions, reach/look at a desired item, respond when someone points to an item by looking at the item, clean up in response to the direction to clean up, and sit while playing with toys for at least 5 min. These inclusion criteria were similar to Krstovska-Guerrero and Jones (2016) and identified because the

prompts used for teaching GS required the toddler to follow the interventionist's point and the contexts required the child to engage with the toys, play with the toys for a few minutes, and understand the direction to clean up. Toddlers were diagnosed by professionals not associated with this research. Each toddler's early intervention team (school psychologist, speech therapist, psychiatrist, etc.) had conducted an initial evaluation as part of the toddler's involvement in early intervention services, 3–4 months prior to the start of this research. Information from those evaluations is provided next to describe each toddler.

Tom, a 2 year 8 month old boy, was diagnosed with pervasive developmental disorder-not otherwise specified (PDD-NOS; American Psychiatric Association 2000). Tom showed a 25 % delay in visual receptive, fine motor, and receptive and expressive language on the *Mullen Scales of Early Learning* (Mullen 1995). On the *Preschool Language Scale- 4th edition* (PLS-4; Zimmerman et al. 2002), Tom's expressive language age equivalent was 18–21 months.

Adam, a 2 year 4 month old boy, was also diagnosed with PDD-NOS. On the *Hawaii Early Learning Profile* (HELP; Parks 1997), Adam showed more than a 33 % delay in cognitive functioning, but average functioning in both gross and fine motor skills. On the *Rossetti Infant-Toddler Language Scale* (Rossetti 2006), Adam performed at the 9–12 month range for social interaction and pragmatics and at the 12–15 month range on the play, receptive, and expressive language subtests.

Lea, a 2 year 6 month old girl, was diagnosed with autism. On the HELP, Lea showed a 33 % delay in both cognitive and communication development. She showed a 25 % delay in social emotional and fine/gross motor skills. On the *Developmental Assessment of Young Children* (DAYC; Voress and Maddox 1998), she showed below average performance in social, language, and gross and fine motor skills.

Setting and Interventionist

All sessions were conducted in each toddler's home in the toddler's regular play area. There was limited access to toys and very few distractions (e.g., the television remained off during sessions and parents or other caregivers refrained from talking in the room). Sessions occurred 3–4 days per week with 2–3 sessions per day. The first author served as the interventionist. She was enrolled in a Master's Program in Applied Behavior Analysis. She had worked as a teacher's assistant with children with autism for more than 2 years.

Materials

Materials included 27 age appropriate preferred toys used as the toys for requesting and JA opportunities. The interventionist used a video camera to record a portion of the sessions for the purpose of examining intervention integrity and interobserver agreement.

Dependent Variable

The response form taught during both JA and requesting contexts was GS, which was defined as the toddler looking at the toy for at least 1 s and then shifting his/her

gaze to the interventionist's eyes for at least 1 s. GS needed to begin within 4 s of the instruction.

The interventionist recorded the toddlers' responses as either correct (prompted or independent) or incorrect. Each toddler's performance is reported as a percentage of independent correct responses per session during baseline, time delay, follow up, and generalization conditions and percentage of correct responses (prompted) per session during prompting conditions.

Experimental Design

We used a concurrent multiple baseline probe design across participants to examine the effectiveness of most to least prompting, time delay, and reinforcement to teach GS to request and engage in JA. Intervention began with GS in the context of responding to a request (RR); we conducted additional baseline probes to monitor the toddler's performance of GS during initiating a request (IR) and RJA during the time delay condition for RR. After mastery of GS in the context of RR, if performance of GS in the context of IR did not reach mastery criteria, we introduced intervention for GS in the context of IR. Then we monitored RJA performance during time delay for IR. After mastery of IR, if performance of RJA did not reach mastery criteria during time delay for IR, we introduced intervention for RJA. Probes of IJA performance were also conducted during time delay for RR, IR, and RJA for each toddler. If a toddler met mastery criteria within a context before intervention was introduced, we did not introduce intervention.

Procedure

Identification of Toys To identify preferred toys to use for JA and requesting opportunities, the interventionist conducted a multiple stimulus without replacement preference assessment (MSWO; DeLeon and Iwata 1996). The interventionist identified 45 age appropriate toys and grouped them into 9 groups of 5 similar toys (e.g., all cars were grouped together and all dolls were grouped together). Each group of 5 similar toys was used in separate MSWO conducted two times on two different days. The three most preferred toys in each group of five toys were chosen for JA and requesting. Across the 9 groups this resulted in 27 toys total. Two toys with multiple pieces (e.g., puzzles, blocks) were assigned to teach RR because this involved cleaning up and multiple piece toys provided multiple opportunities. The third multiple piece toy was used for teaching either IR (if it did not make any sounds or light up) or IJA (if it made sounds/lit up). Five toys were assigned to IJA opportunities; these five were chosen because they made noise, lit up, and/or moved. The remaining toys were divided with 10 assigned each to IR and RJA.

To identify small toys (e.g., stuffed toys, farm animals) to use as reinforcers during RJA instruction, the interventionist asked parents to identify five preferred small toys at the beginning of each RJA session for use during that session. Small toys varied from session to session depending on parent identification of preference. The interventionist conducted a mini preference assessment in which she presented three of the parent identified toys at the beginning of a session; the first toy the toddler chose was used as the reinforcer during that session.

Baseline The toddler and the interventionist sat on the floor/at the table facing each other. The interventionist provided five opportunities for each of the target responses, but no prompting during baseline sessions. If the toddler shifted gaze correctly, the interventionist provided only generalized social reinforcers (i.e., smile, social praise) and natural consequences. At least five baseline sessions were conducted before any intervention began. Once intervention began with the first toddler, baseline probe sessions continued with the second and third toddlers. Detailed baseline procedures for each requesting and JA situation are discussed next.

Responding to a request (RR). RR was examined in the context of the toddler and the interventionist cleaning up toys together. The interventionist asked the toddler to clean up (the request), but held a container slightly out of the toddler's reach while he/she cleaned up pieces of a toy. In this way the toddler had to acknowledge the interventionist's request (in this case by shifting gaze) as he/she complied by placing the toys in the container. While seated next to someone cleaning up, children will naturally shift gaze as they complete the activity.

At the beginning of RR sessions, the interventionist presented the two toys identified for teaching RR in front of the toddler. The first toy the toddler chose was used for the entire session. The interventionist engaged the toddler with the toy (e.g., putting a puzzle together, building with blocks). At the completion of the activity, the interventionist spoke the instruction, "Clean up," and held a container slightly out of the toddler's reach. After the first opportunity, on subsequent opportunities within a session, the interventionist held the container slightly out of the toddler's reach, but did not say anything. Consistent with parent report on the pre-assessment questionnaire, on every RR opportunity, the toddlers independently reached to put the toy in the container. If the toddler tried to put the toy in the container without shifting gaze, the interventionist terminated the opportunity after 4 s by gently removing the toy from the toddler's hand. If the toddler shifted his/her gaze to the interventionist's eyes, the interventionist moved the container within the toddler's reach so the toddler could place the toy in the container (natural consequences). Opportunities continued with the remaining pieces of the toy activity.

Initiating a request (IR). At the beginning of each opportunity, the interventionist presented three of the preferred toys assigned to teach IR in front of the toddler. The first toy the toddler chose was used for that opportunity. On subsequent opportunities, the interventionist presented the two toys not chosen from the previous opportunity, along with a new toy the toddler had not yet chosen and allowed the toddler to choose one toy to use for that opportunity. The interventionist placed the toy slightly out of the toddler's reach on the table in front of the toddler. If the toddler shifted his/her gaze to the interventionist's eyes within 4 s of the toy being placed on the table, the interventionist gave the toddler access to the preferred toy for 10 s. If the toddler did not engage in GS within 4 s of the toy being placed on the table, the interventionist removed the toy from the table.

Responding to JA (RJA). RJA opportunities began the same way as IR opportunities; the toddler picked one toy from an array of three preferred toys from those assigned to teach RJA. Sampling of the toys was the same as for IR. The interventionist placed the chosen toy on the floor/table (within 180 degrees of the toddler) within the toddler's reach, obtained the toddler's eye contact (either by pointing to the interventionist's eyes or calling the toddler's name), and then turned her head and pointed to the

toy (without touching the toy). She provided no vocal instructions. If the toddler looked at the toy and shifted his/her gaze from the toy back to the interventionist's eyes, the interventionist smiled and commented on the toy (natural consequences). If the toddler did not shift his/her gaze within 4 s, the interventionist terminated the opportunity by removing the toy.

Initiating JA (IJA). To assess IJA, the toddler and interventionist sat on the floor/at a table facing each other. The interventionist gave one of the IJA toys to the toddler. While the toy was in the toddler's hands, the interventionist or toddler activated the toy so the toy lit up, moved, and/or made sounds/music. A correct response occurred if the toddler shifted his/her gaze within 4 s of activation of the toy. After 4 s, if the toddler did not shift gaze, the interventionist terminated the opportunity by removing the toy. The interventionist presented a different toy on each opportunity.

Intervention During intervention, the interventionist presented 10 opportunities during each session in the same way as in baseline, but introduced most to least prompting, time delay, and reinforcement. Prompt fading followed a most to least prompt fading procedure with a time delay. Mastery criteria for each prompt level was 80 % or above correct responding for three consecutive sessions or 90 % or above correct responding for two consecutive sessions. For IJA, which we probed during intervention for RR, IR, and RJA, if the toddler's independent correct responding was 80 % or above during the last baseline session before intervention was to begin for IJA, we considered IJA mastered.

Responding to a request (RR). Intervention began as in baseline; the toddler chose a toy, played with it, and then the interventionist asked the child to clean up (the request), but held a container slightly out of the child's reach while they cleaned up pieces of a toy. As the toddler stretched his/her arm toward the container, the interventionist immediately (0 s delay) moved the container to her eye level (full prompt) to prompt the toddler to shift his/her gaze to make eye contact. When the toddler shifted gaze to RR, the interventionist provided consequences in the form of social praise and brought the container closer for the toddler to put the toy in the container.

Upon meeting mastery criterion in the presence of the full prompt and a 0 s time delay, the interventionist faded to a partial gestural prompt in which she only moved the container half way along the path between the original position of the container and her eye level. Upon mastery in the presence of the partial prompt, the interventionist introduced a time delay by waiting 4 s after presenting the container for the toddler to shift gaze. If the toddler did not respond at the end of the 4 s delay, the interventionist provided the partial gestural prompt.

Initiating a request (IR). Intervention began as in baseline with a preferred toy slightly out of the toddler's reach. Consistent with parent report on the pre-assessment questionnaire, every toddler reached for/looked at the toy, at which point the interventionist provided a prompt similar to teaching RR, in which she moved the toy to her eye level (full prompt) for the child to shift his/her gaze. When the toddler looked at the interventionist, she provided consequences for IR consisting of social praise and giving the toddler access to the toy for which he/she was reaching. The interventionist faded the prompt in the same way she did when teaching RR.

Responding to JA (RJA). After the toddler chose a toy, the interventionist placed the toy on the floor/table, within the toddler's reach, obtained the toddler's eye contact

either by pointing to the interventionist's eyes or calling the toddler's name, and then turned her head and pointed to the toy (without touching the toy). She provided no vocal instructions. Once the interventionist pointed to the toy with her index finger and the toddler looked at the toy, the interventionist immediately (0 s time delay) used a full gestural prompt by moving her index finger from the toy to her eyes. Prompt fading proceeded as in teaching RR and IR with the interventionist moving her finger only halfway between the toy and her eyes and then delaying the prompt.

The natural consequences for RJA are a smile and comment about the RJA toy. Such social responses do not generally function as reinforcers for children with ASD. During intervention, the interventionist paired these natural consequences with access to a small preferred toy (identified by each toddler's parent) and social praise (e.g., the interventionist said, "Good job looking!"). Intervention began with a continuous schedule of reinforcement consisting of the interventionist smiling, commenting on the toy (natural consequences), providing social praise, and giving the toddler access to the small preferred toy. When the toddler mastered GS to RJA with a 4 s time delay, the interventionist thinned the schedule of reinforcement from continuous reinforcement to an FR-2, in which she continued to provide natural consequences and social praise on every opportunity (continuous), but access to a preferred toy was provided every two opportunities. Once the toddler showed 80 % or higher *independent* correct responding during one session for the new intermittent schedule, the interventionist moved to an FR-5 schedule on the next session and then FR-10. Natural consequences and social praise were provided on a continuous schedule, only the preferred toy was faded. The toddler mastered RJA when he/she showed 80 % or higher *independent* correct responding for 3 consecutive days or 90 % or higher *independent* correct responding for 2 consecutive days on an FR-10 schedule.

Follow up To examine maintenance of GS, the interventionist conducted a one month follow up probe after mastery of GS for RJA for Tom and Adam (at which point they had also reached mastery criteria for IJA). For Lea, maintenance of GS was conducted one month following mastery of GS for IJA. The interventionist conducted follow up sessions in the same way as baseline sessions.

Generalization The interventionist examined generalization of GS to an IJA context. Generalization of GS was also examined in all contexts with each toddler's mother in a structured session and in a semi-structured play interaction.

Initiating JA (IJA). To assess generalization of GS to IJA, the interventionist presented five opportunities during each generalization session. One generalization session was conducted during baseline, after mastery of GS in each context (RR, IR, and RJA), and at follow up.

To assess IJA, the toddler and interventionist sat on the floor/at a table facing each other. Toys for IJA were identified through the preference assessment conducted prior to baseline and were not used for requesting or RJA. The interventionist gave one of the toys to the child. While the toy was in the toddler's hands, the interventionist or toddler activated the toy so the toy lit up, moved, and/or made sounds/music. A correct response occurred if the toddler shifted his/her gaze within 4 s of activation of the toy. After 4 s, if the toddler did not shift gaze, the interventionist terminated the opportunity by removing the toy. The interventionist presented a different toy on each

opportunity. Mastery criterion for IJA was 80 % or higher *independent* correct responding on one session.

Because Lea did not show generalization of GS to IJA at mastery level of 80 % or higher independent correct responding during generalization sessions, the interventionist introduced intervention to teach GS in this context. As soon as the toy activated, the interventionist immediately (0 s time delay) presented a full gestural prompt by moving her index finger from the toy to her eye level. Prompt fading was the same as in teaching RJA. The interventionist provided only natural consequences for IJA (i.e., a smile and comment about the IJA toy).

Structured sessions with each toddler's mother. Generalization of GS across each social-communicative context was examined with each toddler's mother during structured sessions conducted in the same way as the interventionist conducted baseline sessions. Each mother conducted one generalization session for each context during baseline, after mastery of GS in each context, and at follow up.

To ensure mothers presented opportunities as intended, the interventionist taught each mother how to do so prior to the collection of baseline data. The interventionist described the baseline procedure. Then the interventionist and mother practiced with the interventionist acting as the mother and the mother acting as her toddler and then switching roles. Practice continued until the mother correctly presented five opportunities for each target skill.

Play interactions with each toddler's mother. To examine generalization to a more natural context in which children play with their mothers, each toddler and mother also engaged in a semi-structured play interaction adapted from Loveland and Landry (1986). The play interaction was a more natural play context in which toddlers would typically engage in GS for the purposes of requesting and JA. This situation was designed to examine generalization across settings and people. Play interactions occurred once pre-intervention (before collecting baseline data) and again post-intervention (after mastery of RJA and generalization to IJA for Tom and Adam and after mastery of IJA for Lea and before 1 month follow up). Each mother and toddler played for 15 min in a room in the house in which the toddler regularly played and the toddler had free access to his/her toys.

During the play interaction, the toddler's mother embedded opportunities for requesting and JA. For IR opportunities, the mother presented a preferred toy slightly out of the toddler's reach. To present RJA opportunities, the mother pointed to pictures hung on the walls of the room. To present IJA opportunities, the mother engaged the toddler in an unexpected activity with a toy of which the toddler had possession (e.g., while the toddler was holding a toy-box, the mother pressed the lever so the cat would pop out of the box). RR opportunities naturally occurred at the end of the play interaction, but, due to investigator error, no data were collected. During the play interaction, mothers only provided natural consequences; they did not prompt GS. To ensure the mothers presented opportunities as intended, the interventionist taught each mother how to do so prior to the play interaction and provided continuous feedback during the play interaction. To teach mothers how to present opportunities during play, the interventionist described the procedure for the 15 min of play. Then the interventionist and mother practiced with the interventionist acting as the mother and the mother acting as her toddler and then switching roles. Practice continued until the mother correctly presented five opportunities.

During the mother toddler play interaction, the mother recorded the frequency of her toddler's GS for IR, RJA, IJA and other occurrences of eye contact. During IR, RJA, and IJA opportunities, GS was defined in the same way as described previously. Eye contact was defined as the toddler looking at the mother's eyes for 1 s, but not GS during IR, RJA, and IJA opportunities that were specifically planned by the mother. For example, the mother counted an occurrence of eye contact if the toddler made eye contact when his/her mother sang a song or said the toddler's name.

Social Validity Social validity was examined through a questionnaire about the appropriateness, acceptability, and effectiveness of the intervention. Mothers completed the questionnaire at the 1-month follow up session. Each toddler's mother rated questions about the intervention on a three point scale ranging from 0 to 2 on which 0 indicates a negative response, 1 indicates a neutral response, and 2 indicates a positive response.

Interobserver Agreement

A trained undergraduate student independently observed video recordings of a portion of all sessions for all the participants. Approximately every third session across baseline and intervention was video recorded. Agreements occurred when the observer and the interventionist scored the participant's response on an opportunity in the same way. Disagreements occurred when the observer and the interventionist scored the participant's response differently on an opportunity. Trial by trial IOA was calculated by dividing the number of agreements by the total number of response opportunities and multiplying by 100.

For Tom, the independent observer scored 40 % of baseline and 36 % of intervention sessions. Mean IOA was 100 % for baseline and 96 % (range, 90 %–100 %) for intervention. For Adam, the independent observer scored 27 % of baseline and 29 % of intervention sessions. Mean IOA was 100 % for baseline and 98 % (range, 95 %–100 %) for intervention. For Lea, the independent observer scored 38 % of the baseline and 30 % of intervention sessions. Mean IOA was 95 % (range, 95 %–100 %) for baseline and 98 % (range, 93 %–100 %) for intervention. During the mother toddler play interaction, the mother recorded her toddler's responses and the interventionist acted as the observer to collect IOA data. For all participants, IOA was 100 %.

Intervention Integrity

Intervention integrity was assessed by the same independent observer who examined IOA. The observer used an intervention integrity data sheet to examine the correct implementation of each component of intervention (presenting opportunities, prompts, and consequences). The percentage of correct implementation of each intervention component was calculated separately, by dividing the number of times the interventionist correctly carried out the intervention component by the total number of opportunities, multiplied by 100.

For Tom, mean intervention integrity for presenting opportunities, prompts, and consequences was 100 %, 98 % (range, 94 %–100 %), and 100 %, respectively. For

Adam, mean intervention integrity for presenting opportunities, prompts, and consequences was 100 %, 95 % (range, 90 %–100 %), and 98 % (range, 95 %–100 %), respectively. For Lea, intervention integrity was 100 % for presentation of GS opportunities, prompts, and consequences.

Results

Performance of RR, IR, and RJA with the Interventionist

Figure 1 shows toddlers' performance of GS for RR, IR, RJA, and IJA with the interventionist and each toddler's mother. Filled circles depict RR performance, unfilled

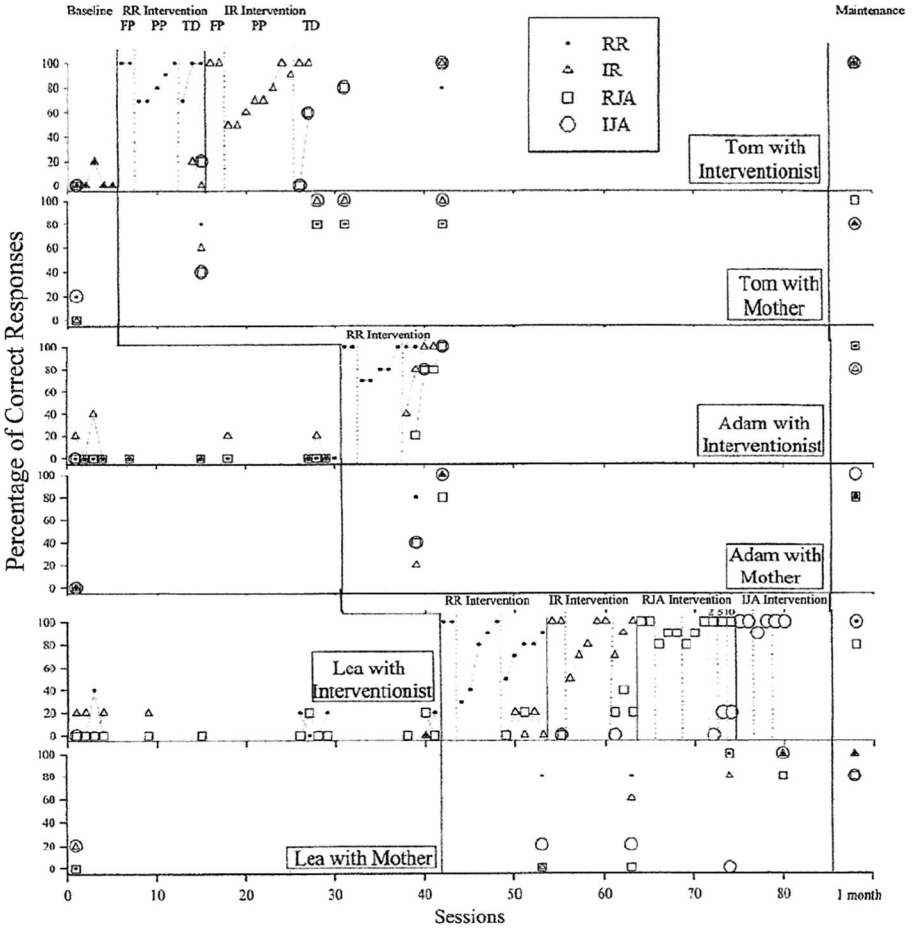

Fig. 1 Performance of RR, IR, RJA and IJA for each toddler with the interventionist and toddler's mother. Each pair of panels shows a child's performance with the interventionist and his/her mother. The numbers 2, 5, and 10 on panel 5 represent Lea's performance during FR2, FR5, and FR10 schedules of reinforcement during RJA intervention. During baseline, time delay, follow up, and generalization conditions, performance reflects independent correct responses; during full and partial prompt conditions, performance reflects prompted and independent correct responses

triangles depict IR performance, unfilled squares depict RJA performance, and unfilled circles depict IJA performance. Each pair of panels show performance for one of the participants (the first two panels show Tom's performance, the middle two panels show Adam's performance, and the final two panels show Lea's performance). In each pair of panels, the first panel shows performance with the interventionist and the second panel shows generalization performance with the toddler's mother. During baseline, time delay, follow up, and generalization conditions, performance reflects *independent* correct responses; during full and partial prompt conditions, performance reflects prompted and independent correct responses.

The first panel of Fig. 1 shows Tom's performance with the interventionist. During baseline, the mean percentage of correct responses for RR was 4 % (range, 0 %–20 %). Once intervention began for RR, he mastered RR in 10 sessions. During the initial baseline sessions for IR (prior to any intervention for any context), the mean percentage of correct responses was 4 % (range, 0 %–20 %). Performance remained low for IR (range, 0 %–20 %) during time delay for RR. Once intervention began for IR, Tom mastered IR in 12 sessions. During initial baseline sessions for RJA (prior to any intervention for any context), mean percentage of correct responses was 4 % (range, 0 %–20 %). RJA performance remained low during RR intervention (range, 0 %–20 %), but, during time delay for IR, RJA performance increased to 60 % and then 80 %. Due to error, the interventionist thought Tom had met mastery criterion (which he had not) and another session was not conducted before ending intervention. A session conducted shortly thereafter showed Tom's performance of RJA continued to improve, reaching 100 %, exceeding minimum mastery level. Tom's performance of RR, IR, and RJA maintained at follow up.

The third panel of Fig. 1 shows Adam's performance with the interventionist. During baseline, the mean percentage of correct responses for RR was 0 %. Once intervention began for RR, he mastered RR in 9 sessions. During initial baseline for IR, the mean percentage of correct responses for IR was 10 % (range, 0 %–40 %). During initial baseline for RJA, the mean percentage of correct responses was 0 %. During time delay for RR, Adam's performance of GS to both IR and RJA increased, reaching mastery without the introduction of intervention in either context. Adam's performance of RR, IR, and RJA maintained at follow up.

The fifth panel of Fig. 1 shows Lea's performance with the interventionist. During baseline, mean percentage of correct responses for RR was 8 % (range, 0 %–40 %). Once intervention began for RR, she mastered RR in 12 sessions. During initial baseline, mean percentage of correct responses for IR was 8 % (range, 0 %–20 %). Performance remained low for IR during intervention for RR (mean 8 %, range 0 %–20 %). Once intervention began for IR, she mastered IR in 10 sessions. During initial baseline, mean percentage of correct responses for RJA was 3 % (range, 0 %–20 %). RJA performance remained low during intervention for RR (mean10%, range 0 %–20 %), increasing slightly to a mean of 27 % (range, 20 %–40 %) during time delay for IR. Once intervention began for RJA, she mastered RJA in 11 sessions. Lea's performance of RR, IR, and RJA maintained at follow up.

Duration of Intervention

Tom, Adam, and Lea completed RR, IR, and RJA intervention in 12, 6, and 15 days respectively reflecting 2–4 weeks of intervention. For Lea, duration of intervention

including the time required to also teach IJA was 5 weeks. Teaching IJA required only an additional 3 days of intervention. For each participant and each target response, the full prompt condition was mastered within 2 sessions and the time delay (TD) condition within 2–3 sessions (with one exception, for RR, Lea required 5 sessions in time delay). Toddlers required a few more than the minimum number of sessions to mastery (5–8 sessions) in the partial prompt condition. Overall, on average, each toddler mastered each response in approximately 9 sessions; not much more than the minimum number of sessions (6) in which it would have been possible to master a response given mastery criterion.

Generalization to IJA

On Fig. 1, the first panel for each toddler shows his/her performance of IJA with the interventionist (open circles). During baseline, toddler's IJA performance was 0 %. During generalization probes of IJA, Tom's performance (the first panel of Fig. 1) increased, reaching mastery level of 80 % or better independent correct responses in one session. At 1 month follow up, Tom's performance of GS to IJA was 100 %. After mastery of RR, Adam's percentage of correct responding for IJA (the third panel of Fig. 1) increased to 80 % reaching mastery level. After meeting mastery criterion for IR and RJA, performance of IJA increased to 100 %. At 1 month follow up, Adam's performance of GS to IJA was 80 %. During baseline, Lea's percentage of correct responses for IJA (the fifth panel of Fig. 1) remained at 0 % during baseline probes even as intervention began for and she mastered RR and IR. As Lea mastered RJA, her performance of IJA increased slightly to 20 % for two sessions. Because Lea did not reach mastery level for IJA, the interventionist introduced intervention for IJA and Lea mastered IJA in 6 sessions, adding another week to intervention. At 1 month follow up, Lea's performance of GS to IJA was 100 %.

Generalization with Mother

We examined generalization to interactions with each toddler's mother during structured sessions similar to baseline and intervention sessions as well as during semi-structured play interactions between each mother and toddler. In Fig. 1, the second panel of each toddler's performance shows generalization with each toddler's mother during the structured sessions. The second panel of Fig. 1 shows Tom's performance with his mother. During baseline, percentage of correct responses for RR, IR, RJA, and IJA was low (range, 0 %–20 %). During time delay for IR with the interventionist, when Tom mastered GS with the interventionist in all the contexts, his performance with his mother increased to mastery level (range, 80 %–100 %) and maintained at 1 month follow-up.

The fourth panel of Fig. 1 shows Adam's performance with his mother. During baseline, percentage of correct responses for GS across all contexts was 0 %. After mastery of RR with the interventionist, percentage of correct responses for RR with his mother increased to 80 %, but IR, RJA, and IJA remained low (range, 20 %- 40 %). As the interventionist conducted sessions to assess Adam's performance of IR, RJA and IJA after mastery of RR, he showed mastery of IR and RJA with the interventionist without intervention. At the same time, Adam engaged in GS in all contexts with his mother at mastery level (range, 80 %–100 %) and maintained performance at follow up.

The sixth panel of Fig. 1 shows Lea's performance with her mother. During baseline, percentage of correct responses for RR, IR, RJA, and IJA was low (range, 0 %- 20 %). As Lea mastered GS in each context with the interventionist, she showed improvements in her performance of GS within that context with her mother that maintained at mastery level 1 month after intervention ended.

Semi-Structured Mother Toddler Play Interaction

Each of the three toddlers showed 0 to 1 instance of GS to IR, RJA, and IJA during the pre-intervention mother toddler play interaction. Post-intervention, the frequency of IR, RJA, and IJA ranged from 3 to 5 for each toddler (5 was the maximum possible, because each mother presented 5 opportunities each for IR, RJA, and IJA). All three toddlers also showed increases in the frequency of eye contact at post-intervention. During pre-intervention mother toddler interaction Tom, Adam, and Leah made eye contact 5, 11, and 0 times respectively. During post-intervention mother toddler interaction Tom, Adam, and Leah made eye contact 13, 20, and 6 times respectively.

Social Validity

All three mothers had only positive responses (ratings of 2) indicating that they felt eye contact was very important during interaction, the intervention was very effective in teaching eye contact, the intervention was very successful, the intervention was very appropriate for the participant, eye contact was very important for the participant, and they would recommend this intervention to other children. In response to the open ended questions about other ways to teach the behaviors targeted by this intervention, only one mother indicated any other intervention. She pointed out the use of social stories to teach eye contact, but said that the present intervention was better. No mother suggested a better way to teach GS. When asked to give their opinion about the procedures, mothers expressed satisfaction with the procedures and thought the procedures were child friendly.

Discussion

We examined a brief social-communication interaction intervention involving prompting and reinforcement to teach GS as a common response form across social-communicative contexts. We also explored generalization to IJA, a core deficit that is notoriously difficult to address in intervention, as well as to interactions with the toddlers' mothers. All three toddlers met mastery criteria for GS to RR, IR, and RJA. Two of the three toddlers demonstrated generalization to IJA and all three showed generalization with their mothers. Toddlers maintained performance at 1 month follow up and mothers thought that the procedures were appropriate and effective.

The present study was a replication and extension of Krstovska-Guerrero and Jones (2016). Krstovska-Guerrero and Jones taught RR (cleaning up toys) and IJA (remote controlled activated toy) and found inconsistent generalization to RJA. To ensure the acquisition of RJA, we planned to directly teach GS in RR, IR, and RJA contexts. We probed for generalization as we proceeded with intervention and ended up needing to

teach all contexts for one toddler only. The other two toddlers showed some generalization across the targeted contexts and to IJA. Both of these toddlers showed generalization from requesting to JA. Krstovska-Guerrero and Jones taught IJA in the context of a remote controlled activated toy, instead we taught IJA in the context of the toy in toddler's hands to possibly reduce the ambiguity of requesting the activation of toy shifting gaze. IJA intervention required the minimum number of sessions possible to reach mastery criteria for the only toddler who needed intervention for all three contexts. The duration of the present study was short as in Krstovska-Guerrero and Jones (2016).

At least two factors may relate to the toddlers' generalization across contexts. The antecedent stimuli in each context were all very similar, including the presence of an object and minimal verbal directions from the interventionist. These antecedents reflect the situations in which children engage in social-communicative behavior and are often used in assessments of social-communicative behavior (e.g., *Early Social Communication Scales*; Mundy et al. 2003). During intervention for RR, the interventionist only vocalized on the first opportunity (saying, "Clean up"). Thus, her direct action was minimal. The antecedent for RJA consisted of the interventionist turning her head and pointing at the toy; the interventionist did not make any vocalizations. When children initiate interaction, the antecedents do not involve action on the part of the social-communicative partner. Minimizing the salience of the interventionist's clean up request and RJA directive may have facilitated generalization to both initiating contexts. IR (mand) occurs naturally in the presence of a variety of stimuli including, for example, an object out of reach (as in this study) as well as no object, just motivation (e.g., hunger). In the IR situation in this study, the interventionist placed an object in view, but out of reach. Thus, the antecedent stimulus included the presence of the object (and motivation), rather than just a motivating operation. The antecedent stimuli for JA also consisted of the presence of some object. Minimal verbal directions and presence of the object as part of the antecedent stimuli in the requesting context may also explain some of the emergence of JA after teaching requesting.

In addition to similar antecedents, GS as the response form may also be important for generalization. Some literature shows generalization across contexts when a common response form is taught (e.g., Carroll and Hesse 1987; Greenberg et al. 2014; Petursdottir et al. 2005; Sigafoos et al. 1989). During IR intervention, when the toddler shifted gaze, he/she received access to the requested item; shifting gaze resulted in tangible reinforcement. Note that, if GS was not part of the response requirement (e.g., if the toddler was taught to vocalize only to request), then the toddler's gaze would have remained fixed on the object of request while receiving reinforcement; this is a pattern of responding often seen in children with ASD. In contrast, by teaching GS, the social stimuli associated with the interventionist's eyes and face were paired with the tangible reinforcer associated with the toddler's request. Having this history with GS in a requesting situation may explain the continued demonstration of GS in a JA situation, when the only available consequences were social interaction, which typically has low motivational value for children with ASD. Because of the previous pairing with other tangible reinforcers, natural JA consequences may have become more reinforcing.

We carefully chose the antecedents and consequences to reflect some of those that are characteristic of social-communicative interactions in young children and assessments of social-communication in young typically developing children and those with

ASD. The nonverbal antecedents used in this study may have facilitated generalization, but do not reflect the range of antecedent stimuli to which children respond or initiate interaction. For example, during an RJA opportunity, a parent might point, turn, and look at a tiger at the zoo, while also saying, "Oh, wow, that tiger is bigger than any I've ever seen!" Children also respond to RJA directives that do not involve even a head turn, but just the partner looking at an object. Similarly, during IJA opportunities, we only sampled a context in which the object was in the child's hands. Other examples of stimuli about which children IJA might include unusually placed items in novel settings (Taylor and Hoch 2008) or turn taking (e.g., Isaksen and Holth 2009; Jones 2009). Since IJA, in particular, and initiations, in general, are significantly impaired in children with autism, identifying additional contexts will be important to determine the impact of this intervention on overall social-communication and initiation of interaction.

Unlike the generalization observed for the first two toddlers, one toddler, Lea, required intervention to address GS in each social-communicative context, including IJA. In terms of measures of overall cognitive functioning and communication provided from each toddler's most recent evaluation, the three toddlers were not very different. However, Lea was diagnosed with autism; Tom and Adam were diagnosed with PDD-NOS. Younger children with mild autism show better outcomes to intervention in general (e.g., Eaves and Ho 2004). Presumably, Lea showed more significant impairments that warranted the autism diagnosis, however, a limitation is that we do not have a standardized measure of symptomatology for each toddler to provide a comparison. This is something to consider in future research. In addition, Tom and Adam both received home based intervention services and, thus, had been exposed to instruction including prompting and reinforcement, as used in this study. Lea was not yet receiving any services and so had less experience with such a structured teaching situation. Continuing to examine this intervention and patterns of acquisition and generalization in relation to child characteristics such as symptomatology and intervention history will yield important information about for which children with ASD this may be an effective intervention. The criteria for participation in this study could certainly exclude some children with ASD and it remains for future research to determine whether these are necessary criteria or prerequisites.

Krstovska-Guerrero and Jones (2016) demonstrated generalization to interactions with toddler's mothers in a structured intervention situation. We used the same structured intervention situation along with a semi-structured observation of mother toddler play interaction based on Loveland and Landry's (1986) procedure. The more natural play interaction is one in which we see typically developing young children engaging in requesting and JA with their mothers. This is an important initial step in ensuring that changes following intervention impact children with ASD in their natural environments and everyday interactions. A limitation is that, during the play interaction, we embedded opportunities to engage in requesting and JA to ensure a more comparable situation across the participants and that opportunities were provided for each context. In doing so, this play interaction was not as naturalistic and unstructured as it could have been. Future investigations of this intervention may include this semi structured as well as even more naturalistic play situations (e.g., Kasari et al. 2010).

In this study, we targeted just three contexts for intervention, found generalization to IJA, a core deficit in children with ASD, and generalization to play interactions with toddler's mothers. This all occurred within a relatively brief intervention, lasting a total

of 24–39 sessions, occurring on 6–15 days across 2–4 weeks. The interventionist conducted 2–3 sessions per day 3–4 times per week. Each session took between 5 and 10 min. Overall, intervention duration was even shorter as compared to Krstovska-Guerrero and Jones (2016). This is likely due to the fact that the toddlers participated in more sessions on more days each week as compared to Krstovska-Guerrero and Jones (2016). Even with such a brief intervention, increasing the intensity by conducting more sessions on more days each week, resulted in more rapid acquisition in terms of the number of weeks of intervention. In Krstovska-Guerrero and Jones, toddlers acquired target responses in 3–9 weeks which is a longer than the duration of the present study. Direct examination of the impact of changing the intensity of intervention on acquisition and maintenance remains a question for future research.

Improvements in JA are associated with more positive intervention outcomes in general (Kasari et al. 2008). This intervention shows promise in addressing foundational social-communication skills including eye gaze, requesting, and JA relatively rapidly. Such an intervention, implemented when toddlers are just identified as having ASD, may positively impact overall intervention outcomes. We demonstrated maintenance at 1 month follow up, but with such a brief intervention and the extensive social-communication impairments in this population, it is necessary to examine broader outcomes and conduct follow up over a longer period of time (Landa and Kalb 2012).

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Compliance with Ethical Standards

Funding This study does not have any funding source.

Ethical Approval All procedures performed in the present study were reviewed and approved by Queens College, CUNY Institutional Review Board for the protection of human subjects in research and research related activities. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from the parents of all the participants included in the study.

Conflict of Interest Madiha Muzammal declares that she has no conflict of interest. Emily Jones declares that she has no conflict of interest.

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