Modifying a naturalistic language intervention for use in an elementary school classroom

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Abstract

Background and aims: We evaluated a naturalistic language intervention (NLI) targeting expanded forms of expressive communication (e.g., two-word phrases) for elementary-aged children with autism spectrum disorder (ASD) and/or intellectual disability (ID). This study extends the findings of a previous study that evaluated an NLI for preschool-aged children who displayed social communication delays. In the previous study, one child was considered a non-responder to the original intervention; children with similar pre-intervention profiles to the non-responder were recruited for this study to evaluate a modified version of the NLI with a new participant group.

Methods: The NLI was evaluated within the context of a multiple probe design across children, with sessions conducted in a public school classroom. The modifications to the NLI resulted in varying dosages of the intervention provided across sessions and children. To analyze the moderating influence of the variation in dosage, we graphed each dosage variable to allow for a formative analysis of changes within and across study conditions.

Results: Results indicated increases in the target behavior for all three children when compared to probe sessions; however, for one child the consistency of changes were variable and, as such, may not be socially significant.

Conclusions and implications: This study extends the literature on conducting NLIs with minimally verbal children with ASD and ID in dynamic settings, like classrooms. Educators and related professionals can capitalize on natural opportunities for social communication in children who are minimally verbal but imitative by using naturalistic procedures to promote verbalizations during age-appropriate activities.

Keywords
Communication and language, school-age children, intervention/therapy

Children with autism spectrum disorder (ASD), and those with intellectual disability (ID) and associated social delays, are likely to develop some form of expressive communication to gain access to preferred items and activities (e.g., guide another person to a preferred item, use non-functional verbalizations), but may be less likely to use flexible and functional communication (e.g., multi-word phrase to express needs) during interactions in typical settings (Tager-Flusberg & Kasari, 2013). Expressive communication challenges are compounded by social delays, especially recognizing when and how to communicate in dynamic environments (e.g., classrooms), indicating a need to provide multiple opportunities to communicate in typical settings. Those who are able to produce functional expressive language might not receive adequate opportunities to communicate independently (Sigafoos, Roberts, Krer, Couzens, & Baglioni, 1994); this issue may be compounded as...
children transition from preschool to elementary school. Preschool classrooms typically focus on play-based instruction (Grisham-Brown & Hemmeter, 2017), while elementary school classrooms are more heavily influenced by academics and table-top activities. Content aligned with general education standards are being emphasized more, leaving less time to focus on foundational skills such as communication (Ayres, Lowrey, Douglas, & Sievers, 2011). In addition, inadequate opportunities to promote meaningful communication may be related to (a) inappropriate or incomplete training (e.g., lack of knowledge in personnel preparation programs; Barnhill, Polloway, & Sumutka, 2011), (b) general inexperience with naturalistic procedures (Roberts, Kaiser, Wolfe, Bryant, & Spidalieri, 2014; Rule, Losardo, Dinnebeil, Kaiser, & Rowland, 1998), or (c) practical challenges related to conducting individualized sessions (Wolery & Hemmeter, 2011).

Promoting independent functional requests

Naturalistic language interventions (NLIs) are commonly recommended to remediate deficits and delays in expressive communication (Schreibman et al., 2015). Such interventions capitalize on child interest and motivation for preferred items, to promote specific or generalized forms of expanded communication (Koegel & Koegel, 2012; Roberts & Kaiser, 2011). Specific forms of expanded communication refer to targeted words and word combinations. For example, Christensen-Sandfort and Whinnery (2013) taught preschoolers to say “bubbles”, “blow bubbles”, or “give me bubbles” based on children’s individualized language levels and communication needs. Generalized forms of expanded communication refer to utterances adhering to a target syntactical form, regardless of the word combinations that comprise the form. As an example, Hancock and Kaiser (2002) taught children with ASD and ID to use action-object phrases (e.g., drive car, throw ball, build blocks) and agent-action phrases (e.g., Mom, share; John, open). The researchers did not target specific word combinations that needed to comprise the action-object or agent-action phrases; rather, the children could provide any combination of action words and object words, as well as any combination of agent words and action words, so long as the combinations of words were contextually appropriate to the situation.

It should be noted that targeting expanded forms of expressive communication (e.g., Christensen-Sandfort & Whinnery, 2013; Hancock & Kaiser, 2002) allows a learner to better control their environment by communicating with increased precision. For example, a child that commonly uses a one-word utterance in the form of object labels (e.g., “car”) provides information about the type of item for which he or she requests. If that child is taught to engage in an expanded form of communication such as an action-object phrase (e.g., “drive car”), then the child is able to communicate information about the item they would like access to and how the child wants to interact with the item. Likewise, for children that do not independently and readily use any vocal communication (e.g., child reaches towards items or moves adult’s hand towards items to request), targeting a one-word utterance is an expanded form of communication as the utterance provides more precise information than reaching in the general direction of an item.

Although NLIs are commonly recommended, some children, especially those classified as having “moderate” or “severe” ASD and ID, might not respond or display variable responding to NLIs (Tager-Flusberg & Kasari, 2013). A relatively recent review by Lane, Lieberman-Betz, and Gast (2016a) evaluated the rigor and effectiveness of NLIs and increases in independent expressive communication in children with ASD and those with related social communication delays; the review focused on the dependent variable of requesting items and activities when an adult used an environmental arrangement strategy (e.g., pause in routine; withholding a preferred item). Results indicated that methodologically rigorous and effective interventions typically (a) promoted responsive interactions between adults and children, (b) adults initially presented full verbal models of novel words or phrases (0 s prompt delay trials), followed by using a mand-model or time delay (e.g., 5 s prompt delay trials) procedure, and (c) adults provided positive attention and access to a preferred item or activity. Although these individual components of effective interventions were identified, additional studies on the effectiveness of components were suggested. In addition, results indicated that only a limited number of studies were conducted in authentic settings. Lane et al. recommended conducting studies that incorporate contemporary guidelines for methodological rigor (e.g., What Works Clearinghouse [WWC]; Kratochwill et al., 2013) and evaluating individual components from effective studies that used a NLI in authentic settings, like classrooms. Although a number of interventions are available for promoting communicative behaviors (e.g., Enhanced Milieu Teaching; Picture Exchange Communication System; Pivotal Response Training), this review focused on identifying components of NLIs that promote independent expressive language in response to an environmental arrangement strategy— an early building block for developing more advanced forms of communication.
Promoting initiations through appropriate engagement

The purpose of this study was to extend findings from a previous study by authors (Lane, Shepley, & Lieberman-Betz, 2016b) that targeted expressive communication in children who displayed characteristics of ASD in a preschool. Procedures were based on identified components of effective interventions in the Lane et al. (2016b) review. The intervention consisted of (a) using environmental arrangement strategies to evoke initiations, (b) waiting 5 s for an independent target word, (c) providing up to two models of the target response if the participant did not use the word to request, (d) waiting 5 s for the participant to respond to the verbal models, and (e) providing preferred items or activities following attempts at expressive verbal communication. Three of four participants responded to the intervention and one required modifications due to challenges maintaining the child’s motivation. Initiations to environmental arrangement strategies were used as a behavioral proxy of the child’s motivation. That is, by measuring and graphing the percentage of trials in which the child engaged in a vocal request, vocal approximation, reach, or point following an environmental arrangement strategy, visual analysis of the data indicated a decelerating contratherapeutic trend. This suggested that although the child initially demonstrated interest in the toys and items used in the study, over time the child less frequently engaged with and sought out toys and items. Anecdotal reports supported these data, as the child often engaged in stereotypic play with his hair while sitting in a bean bag chair.

This study recruited participants with similar pre-intervention profiles to the non-responder, with an emphasis on using child interest to promote engagement in age-appropriate play and activities. Children with disabilities, including children with ASD and ID, are more likely than their same-age peers to display difficulties using toys and items appropriately, potentially establishing a long-standing pattern of idiosyncratic non-functional behaviors (self-stimulatory behaviors with toys or items). Given the established relationship between item use and language in children with ASD (e.g., advanced forms of play are positively correlated with syntactically advanced forms of expressive communication; Lieberman & Yoder, 2012), those who conduct NLIs should first consider promoting age-appropriate engagement with toys and items, followed by introducing adult models to promote appropriate communication (McCauley, Fey, & Gillam, 2017). Establishment of appropriate engagement and routines with items allows participants to become familiar with toys, routines, and activities before introducing additional demands during instructional sessions. Considering the findings of Lane et al.’s (2016a) review and authors (Lane et al., 2016b) evaluation of effective NLI components, this study potentially adds to the literature by evaluating an NLI for promoting early expressive communication in children with ASD and ID in an authentic educational setting, an elementary school classroom. The research question guiding this study was: When an NLI is implemented in an elementary school classroom, will young children with ASD and ID display increases in the percentage of independent expressive communication, using generalized forms of expressive language?

Method

Inclusion criteria and participants

Three participants were recruited for this study: Samuel, Kamal, and Conner. Inclusion criteria for participants were as follows: (a) between five and eight-years of age; (b) previously diagnosed with or eligible for services under the category of ASD or ID; (c) did not readily use expressive language to communicate (e.g., child typically requested by guiding an adult’s hand towards items); (d) displayed limited use of items, including toys and related materials; and (e) attended school 80% or more school days within the last two months. Six students were initially selected based on teacher recommendation (third author). Additional screening data were collected by the second and fourth author by observing each student across at least two mornings during free-play activities (i.e., times embedded within the school day or during breaks from 1:1 instruction; students could engage in a teacher approved recreation or leisure activity; no academic demands were placed on students during this time). Data were collected using running records during observations (Grisham-Brown & Pretti-Frontczak, 2011), with specific attention given to engagement in spontaneous oral language, pretend play behaviors, and repetitive play behaviors. Three children were excluded from the study based on consistent use of two- to three-word phrases and engagement in pretend play behaviors across multiple toy sets and activities. The three students recruited for this study did not engage in pretend play behaviors, and the teacher report aligned with screening data indicating each child typically engaged with the same few items during free-play activities. In addition, each of the three students inconsistently used one word to request items and activities, and typically used gestures (e.g., reaching) to request preferred items and activities. Institutional review board approval was obtained and parental consent for all participants was obtained prior to starting the study.
Samuel was an eight-year-old, African-American (Non-Hispanic) male with a diagnosis of ASD (severe classification on the Childhood Autism Rating Scale, Second Edition [CARS-2]; at times, he would communicate using pictures following verbal prompts from adults or attempt to imitate adults’ verbal models, but did not consistently use any words independently to communicate. Samuel’s individualized education plan indicated that he received a standard score of 46 on the Kaufman Assessment Battery for Children, Second Edition and a 42 on the Adaptive Behavior Assessment System, Second Edition. The authors collected screening data that indicated that Samuel’s social and cognitive play aligned with the definitions for solitary social play and functional cognitive play, as described by Barton (2016; taxonomy of play). Solitary social play refers to a “child [who typically] plays alone with different toys than those of peers near him” and functional cognitive play refers to a child who “uses objects in the manner in which they are supposed to be used” (Barton, 2016, p. 269). Samuel typically interacted with a dry-erase board and marker during free-play, drawing the same geometric figures with interconnected lines.

Kamal was a seven-year-old, Asian-American (Non-Hispanic) male with multiple disabilities (cerebral hypoxia, cortical visual impairment, cognitive delays), requiring a wheelchair to navigate the environment. Kamal’s family moved to the United States from Pakistan when he was four years of age and his family spoke both English and Urdu in the home; he had a repertoire of approximately 20 words which were comprised of a combination of action words and object words. He did not use multi-word phrases. Kamal’s individualized education plan indicated that he had a standard score of 27 on the Vineland Adaptive Behavior Scales, Second Edition (Vineland-II), but a cognitive evaluation was not completed by the school psychologist (due to reported difficulties with testing; unable to obtain a score). Screening data indicated that Kamal’s play behaviors aligned with the description of functional cognitive play (Barton, 2016). We were unable to make a determination regarding social play due to the physical layout of the classroom, which separated students who used wheelchairs from students who engaged in aggressive behaviors towards peers (i.e., Kamal was with classroom staff rather than peers during screening observations). During free-play, Kamal typically chose to pass a bouncy ball with classroom staff or have one of three specific books read to him.

Conner was a six-year-old, African-American (Non-Hispanic) male who was previously diagnosed with ASD (severe classification on the CARS-2). Conner interchangeably used pictures and single words to communicate; he had a repertoire of approximately 10 words which were all object labels. Conner individualized education plan indicated that he had a full-scale standard score of 58 on the Stanford-Binet Intelligence Scales, Fifth Edition, and a standard score of 51 on the Vineland-II. Screening data indicated that Conner’s play met definitions for solitary social play and sensorimotor cognitive play. Sensorimotor play refers to a child who “explore[s] the world by touching, biting, tasting, hitting, [and] kicking” (Barton, 2016, p. 269). Conner typically rolled around on a bean bag or balanced the weight of his body on corner of table using his hands during free-play.

Instructor and setting

Sessions were conducted by a master’s level scholar (fourth author) in the participating students’ special education classroom. The instructor received training from the first and second author on how to conduct probe and intervention sessions until she implemented procedures with fidelity. The training consisted of a didactic lecture, handout, role-play, practice, and performance-based feedback. Practice and performance-based feedback were conducted at a university-based early childhood preschool in which the first and second author were affiliated; the children participating in the practice were not part of this study. Practice and performance-based feedback continued until the trainee engaged in all NLI procedures with 100% accuracy across multiple trials. If errors occurred during the study, the instructor and second author met to discuss and remediate issues.

Study sessions were embedded within the classroom’s morning schedule and occurred during planned non-academic activities for each student. These times were considered free-play activities within the classroom and occurred during breakfast, after breakfast (while peers finished eating), breaks from 1:1 instruction, and following 1:1 academic instruction (e.g., discrete trial instruction). During sessions, approximately 5–10 students were present in the classroom and engaged in individual or small group activities with paraeducators and the teacher.

Target behaviors and measurement

The dependent variable was children’s independent use of an expanded form of expressive oral language to request preferred items and activities in response to an environmental arrangement strategy (e.g., pause in routine, items in view but out of reach). Expanded forms of expressive language referred to vocal utterances that were syntactically different and more complex than the utterances commonly used by each child, and that
provided additional information to the child’s communication partner about the request.

Within our study, each child’s target expanded form of expressive language was selected based on screening data collected by the second and fourth author, with input and approval form the child’s classroom teacher. Throughout screening observations Samuel and Conner were observed using the word “please” to request items but did not readily use object labels. Thus, object labels were targeted as their expanded (i.e., different and more complex) form of requesting. Similarly, Kamal used action or object labels to request, but did not readily combine these two forms of expressive language and, as such, action labels plus an additional word were targeted as his expanded form of communication (e.g., action-object phrase, action-agent phrase).

Trial-by-trial event recording was used to measure children’s responses. An independent response was defined as a child providing a target response or an approximation of a target response following the instructor’s presentation of an environmental arrangement strategy. A prompted response referred to a child providing the target response or an approximation within 5 s of the instructor’s verbal model. In addition, children’s spontaneous communication was measured across all sessions and referred to any use of an instructional target for a preferred item or activity outside of instructor-presented environmental arrangement strategies. Lastly, the start and end time of each session was recorded by the instructor.

**Modification**

For Samuel, one of his preferred activities was playing with Play-Doh. When prompted to request “Play-Doh” he would say either “Play” or “Doh” but did not say both words in combination. Given that he did not independently use any vocal words to communicate prior to the study, we allowed for an approximation of “Play-Doh” to be scored as correct.

**General procedures**

Sessions were conducted four mornings a week during non-academic activities in the children’s classroom. The same materials were available across both probe and intervention sessions. During sessions, children were allowed to engage in recreation and leisure activities at various locations in the room, based on availability (e.g., if a designated “break” area of the classroom was at capacity with other peers, then a student engaged in an activity at their desk). We did not use a predetermined session duration or number of trials for each session. The only criterion was that a minimum of three trials be conducted each session, and a session should end at any point a child needed to begin a new scheduled activity or return to an ongoing activity. Sessions typically lasted between 7 and 10 min, with number of trials dependent on a child’s interest in items and activities. That is, if a child was not demonstrating interest in available materials (e.g., engaging with materials in an appropriate manner), then there would be no opportunity for the instructor to engage in an environmental arrangement strategy, and therefore, no opportunity to conduct a meaningful learning trial. Our rationale for having varying session lengths and number of trials per session was to better account for the embedded nature of the intervention and capitalize on child interests, which aligns with recommendations for teaching communication to children with ASD (Schreibman et al., 2015) and the broader communication intervention literature (Warren, Fey, & Yoder, 2007). In addition, to the fullest extent possible, we did not want to add a new scheduled activity to a student’s daily schedule; rather, we wanted to take advantage of the already occurring non-academic times to demonstrate their potential as an instructional time to target communication in elementary school classrooms. It should be noted that the amount of time children spent in non-academic recreation and leisure activities often varied due to the (a) number of teachers and staff in the room, (b) training of those teachers and staff, (c) number of children in the room, and (d) behaviors of those children in the room. As such, establishing a set duration of NLI to be provided across each session would have limited the study’s ecological validity (Ledford, Hall, Conder, & Lane, 2016).

The guideline for introducing the intervention to the next child was when the target child independently (i.e., unprompted) used the target form of expressive language for three consecutive sessions for 50% of trials or more, compared to responding observed during probe sessions. This criterion was established by reviewing and using criteria in studies published in peer-reviewed journals that targeted expressive communication in young children (e.g., Roberts et al., 2014), as well as guidelines for staggering introduction of an intervention within the context of a time-lagged design (Gast, Lloyd, & Ledford, 2014).

**Probe sessions**

During probe sessions, the instructor established routines with each child by following their lead (child-selected materials or activities) or, initially, offering a choice between preferred items or activities. When applicable, the instructor took turns with materials and, after every two to three turns, paused and
waited for the child to initiate to an item or activity. Kamal had a physical disability, which limited his ability to manipulate items (potentially impacting his interest in play with certain toys). Thus, the instructor managed most of the items and activities during sessions with Kamal. A child’s natural interest in an item or activity set the stage for an instructional trial. When the instructor engaged in an environmental arrangement strategy, she waited for the child to initiate. Following an initiation from the child (e.g., reaching for item, non-word vocalizations, word vocalizations that differed from target language forms), she waited 5 s for an independent response while withholding access to the item or activity. The child received access to the item or activity, contingent on engagement in any communicative request (e.g., reaching for item, vocalization). Also, the instructor provided positive statements for engaging in the activity, or a related comment (e.g., “This is fun!”). The instructor did not provide models of the target forms of expressive language during probe sessions.

**Intervention sessions**

Intervention sessions were identical to probe sessions (e.g., instructor followed child’s lead, engaged in turn taking), except for the introduction of the NLI (see Figure 1 for a flow chart of the intervention). Initially, 0 s prompt delay sessions were conducted to provide children with verbal models of the target form of expressive language. Verbal models varied based on the current item or activity with which a child was engaged, and a child’s target form of expressive language. During 0 s prompt delay sessions, following an initiation for an item or action during a routine activity the instructor immediately provided a verbal model of the target form of expressive language. If the child imitated the verbal model within 5 s, he received access to the item or activity and continued the current activity. If the child did not provide a target response, the instructor provided a verbal model again and waited an additional 5 s for a response. Following the second 5 s prompt delay, regardless of responding, the child was reinforced with access to the item or action and continuation of the activity. Once children responded to 0 s model prompts at least 50% of opportunities for one session, the prompt was delayed in time by 5 s. Thus, instead of immediately providing a verbal model following an initiation, the instructor waited 5 s for an independent response then proceeded through the steps described above, providing a verbal model up to two times within each opportunity for a target response. If a child articulated a correct response, the instructor expanded the response with one to two additional words, contingent on the activity and the child’s target expanded language form. If a child displayed a spontaneous response at any point during the session, the instructor responded with a related statement or provided access to a requested item or activity.

**Experimental design**

A multiple probe design across children was used to evaluate the effectiveness of a NLI and increases in expressive communication. The multiple probe design aligned with contemporary guidelines for single case experimental designs (Gast et al., 2014) and What Works Clearinghouse (2017). Data were collected across all children during probe sessions to ensure data were stable for each child prior to introducing the intervention. In addition, data were collected for each child at least every eight sessions for children awaiting intervention and surrounding the implementation of the intervention in each tier. Finally, at least three consecutive data points were collected immediately before introducing the intervention with each child. Spontaneous communication was measured within the context of the multiple probe design across children, but decisions about when to introduce the intervention were based on the target behavior of independent expressive communication of expanded forms of requests in response to an environmental arrangement strategy.

**Data analysis**

The study’s primary dependent variable, percentage of independent target responses, was visually analyzed; level, trend, stability, overlap, consistency of effect, and immediacy of effect were evaluated. Also, given the use of a time-lagged design, vertical analysis of data was conducted. Each of these were considered and reviewed when conducting a formative and summative analysis and determining presence or absence of a functional relation (see Ledford, Lane, & Severini, 2018; Lane & Gast, 2014).

As a post-hoc measure to identify dosage variables that potentially moderated the effects of the NLI, we first calculated the mean and standard deviation of the following variables across probe and intervention conditions: (a) duration of session as measured in minutes, (b) number of trials per session, and (c) rate of trials per minute per session. Differences in the means provide information about how the level of data changed across conditions; differences to the standard deviation provide information about how the variability of the data changed across conditions. Difficulties arise when attempting to interpret the significance of these differences as the data are auto-
Correlated, and as such, a simple t-test cannot be conducted due to the dependency present in the data. Therefore, we graphed each dosage variable within the multiple probe design to allow for a formative analysis. Specifically, we determined if changes to any dosage variable between probe and intervention conditions were similar to changes in the children’s percentage of independent correct responses across probe and intervention conditions. To determine if similarities were present, we evaluated each tier of each dosage variable’s graph to determine if the data points consistently differed between probe and intervention conditions (dichotomous determination of consistent differences present or consistent differences not present). We then compared our determination at each tier for each dosage variable with our determinations regarding basic demonstrations of effect for each tier of our primary dependent variable’s graph (i.e., percentage of independent correct responses). When determinations of differences in dosage variable graphs matched determinations of effect in the child responding graph, this suggested that dosage variables moderated the effects of the NLI. The same visual analysis procedures used with the study’s primary dependent variable were used when formatively analyzing dosage variables, with the exception that data were not analyzed vertically.

**Interobserver agreement and procedural fidelity**

Interobserver agreement (IOA) and procedural fidelity (PF) data were collected for 30.9% of all sessions and for 20.0 to 37.5% of sessions in each condition for each child. IOA was calculated for target responses by using trial-by-trial agreement and dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. A gross measure of IOA was conducted for spontaneous communication by dividing the smaller count of behaviors by the larger count and multiplying by 100 (Ayres & Ledford, 2014).

PF was calculated by dividing number of observed behaviors by the number of planned behaviors and multiplying by 100 (Billingsley, White, & Munson, 1980). PF was collected on the following teacher behaviors: (a) use of environmental arrangement strategies, (b) appropriate duration of waiting for child’s response to an environmental arrangement strategy, and (c) appropriate consequences (e.g., prompting, providing access to requested item) provided for child responses. Mean IOA and PF were 100% for Samuel, 98% for Kamal, and 97–99% for Conner, meeting contemporary guidelines for adequate IOA and fidelity. Two IOA errors occurred throughout the entire study; one was due to a data collector being too far away to hear a

![Image of Flowchart]

**Figure 1.** Flowchart of the naturalistic language intervention used during intervention sessions.
child’s response, and one was due to data collectors disagreeing regarding whether a child’s response should be scored as a prompted or unprompted correct response. Three procedural fidelity errors were recorded; two occurred due to the instructor waiting too long or not long enough before providing a prompt, and one occurred when the instructor provided an incorrect prompt (i.e., action label instead of object label). It should be noted that we did not collect formative data on the instructor’s use of strategies to promote engagement (e.g., establishing routines, providing choices, taking turns).

**Results**

Refer to Figure 2 for a graphic display of children’s expressive communication data across all sessions. During probe sessions, a zero-celerating trend was

![Figure 2](image-url)  
*Figure 2.* Percentage of independent and prompted correct responses across children; each child’s target expanded form of expressive langue is in italics below the child’s name; the numbers above the data points in the intervention condition refer to the time-delay in effect for the sessions below.
observed in the data; none of the children displayed independent expressive language of the targeted communication forms. Once the intervention was introduced in Tier 1, Samuel responded to the instructor prompt 70–100% of opportunities. During the sixth, and subsequent sessions, a variable accelerating trend in a therapeutic direction was observed for independent expressive communication. Percentage of non-overlapping data (PND) was calculated and yielded 61.5% non-overlap when considering all data points in the intervention condition and 66.7% non-overlap when data collected in the 0 s session was removed; the 0 s prompt delay session does not allow for independent responding given the nature of the session (model prompt provided before the participant has an opportunity to verbalize a target expanded form). In Tier 2, Kamal responded to the instructor prompt approximately 80% of opportunities during the first session, with an accelerating trend in a therapeutic direction observed in the second and subsequent sessions. PND yielded 83.3% non-overlap (all data) and 100% non-overlap when responding during the 0 s session was removed.

Conner displayed highly-variable responding in the target behavior across intervention sessions and, similar to Samuel, multiple intervention sessions occurred before an increase in independent expressive communication was observed. PND yielded 38.5% non-overlap (all data) and 55.6% non-overlap overlap when data collected during the 0 s sessions were removed from the calculation. A post-hoc split middle procedure was conducted independently by the first and second author, as well as an expert in visual analysis unaffiliated with the study, to estimate trend for prompted and unprompted responses for Conner. Both researchers and the unaffiliated expert calculated identical split middle procedures which indicated, although variable, an accelerating trend in a therapeutic direction for both prompted and unprompted responses. The results of the split middle procedure should be interpreted with caution; the split middle procedure has been more commonly used with ratio graphs in the literature and less so with equal interval graphs (Gast & Spriggs, 2014). Furthermore, Conner’s data did not reach the a priori established treatment effect of 50% independent responding across consecutive sessions.

Overall, consistent increases in expressive communication were observed in data series for all children during intervention, when compared to probe sessions, although there were some differences across children regarding delay and variability. In addition to planned opportunities for communication, spontaneous communication was measured, with minimal to variable increases observed during intervention sessions. During probe sessions none of the children spontaneously communicated, but during intervention sessions Samuel displayed two occurrences of spontaneous communication, Kamal thirteen, and Conner one.

**Dosage variables**

Table 1 displays descriptive statistics for the dosage variables across children and conditions. Changes in the mean duration of a session varied across children. Samuel’s mean duration per session decreased from probe to intervention conditions, while Kamal and Conner’s increased. The mean number of trials and rate of trials per session increased for all children from probe to intervention conditions. Standard deviations for the mean duration of a session decreased for all children across conditions, indicating that the duration of sessions in the intervention condition were more consistent when compared to probe sessions for each child. The standard deviation for the mean number of trials per session increased for all children across conditions, indicating that the duration of sessions in the intervention condition were more consistent when compared to probe sessions for each child. The standard deviation for the rate of trials across conditions decreased for Samuel and Conner but increased for Kamal.

Figure 3 presents graphed data for each dosage variable and Table 2 displays our determinations of effect and non-effect across dosage variables and

| Table 1. Descriptive dosage information across sessions. |
|----------------|----------------|----------------|----------------|----------------|
|               | Duration        | Number of trials | Rate of trials |
|               | Probe          | Int             | Probe          | Int             | Probe          | Int             |
| Child         | M   | SD  | M   | SD  | M    | SD  | M    | SD  | M    | SD  | M    | SD  |
| Samuel        | 10.50 | 6.14 | 8.08  | 4.09  | 4.20  | 1.10 | 5.46  | 2.99  | 0.50  | 0.34 | 0.68  | 0.14 |
| Kamal         | 7.88  | 3.23 | 10.33 | 2.42  | 4.00  | 0.53 | 7.17  | 1.17  | 0.57  | 0.18 | 0.72  | 0.21 |
| Conner        | 7.70  | 3.30 | 10.31 | 3.01  | 3.30  | 0.48 | 5.38  | 2.43  | 0.49  | 0.19 | 0.52  | 0.17 |
| All           | 8.27  | 3.83 | 9.41  | 3.49  | 3.74  | 0.75 | 5.75  | 2.54  | 0.52  | 0.21 | 0.62  | 0.18 |

Duration values are reported as minutes; rate of trials values are reported as rate per minute. M: mean; SD: standard deviation; Int: intervention.
independent child responding. Regarding the duration of sessions, we determined that there was no change between probe and intervention conditions due to variable and overlapping data between the conditions. For the rate of trials per session, we determined that there was no change between conditions due to overlapping data between the conditions. We determined that the number of trials per session consistently differed between conditions for all children, suggesting that the number of trials per session may have moderated the effects of the NLI on child responding.

**Discussion**

The purpose of this study was to extend the findings of a review by Lane et al. (2016a) and a study by Lane et al. (2016b), evaluating a NLI for elementary-aged children with ASD and or ID who (a) do not readily use expressive language to request preferred items and activities and (b) display limited use of items, including toys and related materials. Results indicated consistent increases in independent expressive communication for all children compared to responding during probe.
sessions, but delayed increases in independent expressive communication (two children; Kamal, Conner) and variability in responding were observed (one child; Conner) in the data. Although variable, the findings of this study extend the literature by further evaluating components of methodologically rigorous and effective NLIs for evoking expressive communication in response to environmental arrangement strategies (Lane et al., 2016a; Lane et al., 2016b).

Participants in this study were elementary-aged children considered minimally verbal, but imitative, who displayed limited engagement with items and activities. This study adds to the growing literature on remediating communication deficits in minimally verbal children, especially those with ASD and ID, in dynamic environments (cf. Tager-Flusberg & Kasari, 2013). Also, although a member of the research team conducted sessions, the NLI was embedded during typical leisure times in the classroom (e.g., a break from 1:1 direct instruction) so no student missed scheduled instruction. Given the results of this study, as well as long-term implications for promoting meaningful expressive communication in children with disabilities using naturalistic strategies (Wolery & Hemmeter, 2011), teachers, with support from other practitioners, should consider implementing NLIs throughout the day, capitalizing on natural opportunities to promote communication (e.g., play, mealtimes; Schreibman et al., 2015). In addition, although the dosage of the intervention varied across sessions for each child, we identified that the number of trials presented per session, rather than the total duration or rate of trials per session, may have moderated the effects of the NLI. This finding aligns with past research examining treatment intensity on communication outcomes for children with disabilities and expressive communication delays (Warren et al., 2007), suggesting that distributed trials may be more effective than massed trial presentation for some children.

Challenges encountered in this study warrant attention. At times, there were issues with competing reinforcers during leisure time (i.e., children had non-contingent access to various toys). Based on classroom teacher recommendations and anecdotal observations during screening, the research team decided to purchase and introduce novel materials in the classroom to evoke initiations during study sessions. The materials were introduced in the classroom two weeks prior to the start of the study. All children engaged in target responses with both classroom and newly introduced materials. Second, this study was conducted within a relatively short time period and the end of the school year did not allow for additional data collection, including collecting generalization data across instructors and settings. Extending the intervention throughout a school year, with attention given to routinely updating targets and expanding function and syntactical forms of communication, may be beneficial for maximizing outcomes. Third, although the instructor engaged in responsive interaction strategies to promote appropriate child engagement with items and activities, some children displayed continued challenges with appropriate manipulations of items. Thus, additional and more systematic instruction related to item use may be necessary before introducing adult models for communication (e.g., teaching pretend play behaviors and schemas (Barton, 2015)).

**Limitations and future research**

Limitations of this study warrant attention. First, we did not collect PF on the instructor’s use of strategies to promote engagement. Future investigations of NLIs should examine both the prompting system being used during trials and more general interactions between a participant and an instructor occurring between trials (e.g., following a child’s lead), as has been done in the recent literature targeting play in young children with disabilities (e.g., Barton, 2015). Second, we relied on qualitative data (e.g., anecdotal reports collected during screening observations) to determine if students met criteria to be included in this study, thus potentially limiting external validity. Future studies should consider also employing a standardized measure to determine inclusion or directly assessing if participants engage in a predetermined quantity and quality of behaviors related to communication and play. Lastly, our method for determining moderating

| Table 2. Determinations of consistent differences in data across conditions for primary dependent variable and dosage variables. |
|---|---|---|---|
| Child | Primary dependent variable | Dosage variables |
| | Independent correct responses | Duration of sessions | Number of trials | Rate of trials |
| Samuel | + | – | + | – |
| Kamal | + | – | + | – |
| Conner | + | – | + | – |

+: consistent differences present; –: consistent differences not present.
dosage variables did not rely on inferential statistics as is common with contemporary moderator analyses. As such, more research is needed on assessing moderators within single-case designs.

Conclusions

Although this study demonstrates potentially promising results, additional studies are needed in typical settings with indigenous implementers to evaluate the effects of NLIs with children who are traditionally minimally verbal and display significant cognitive delays. Future studies should continue to evaluate components of methodologically rigorous and effective NLIs for purposes of further refining our technologies. In addition, future studies should consider the extent to which these procedures, which were designed to promote independent expressive communication in response to an environmental arrangement strategy for minimally verbal children (ASD and ID), could compliment or extend established practices in the literature for purposes of further developing a unified theory of practice (Odom & Wolery, 2003) when promoting early expressive communication in children with significant communication needs.

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