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INCREASING SINGLE-WORD REQUESTS TO MULTIWORD REQUESTS IN CHILDREN WITH AUTISM AND RELATED DISABILITIES

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Initial language training with children with autism often focuses on the production of single-word requests (i.e., mands). As a child progresses in treatment, it is desirable to increase the mean length of utterance (MLU) of requests. The present study examined treatment outcomes of behavioral intervention designed to increase the MLU of requests in a larger sample of children with language delays ($n = 30$). Intervention consisted of prompts and differential reinforcement for lengthier requests, and trials were conducted flexibly throughout the treatment session. A non-concurrent multiple baseline across participants design was utilized to establish experimental control, and MLU intervention consisted of a baseline and treatment phase for each participant. Nonoverlap of all pairs (NAP) was employed to estimate an effect size. Overall treatment effects were medium to large (average NAP = 0.89; average $d = 2.36$), and the majority of the sample (70%) demonstrated strong treatment effects. Results suggest that targeted behavioral intervention to increase the length of requests can be effective for children with autism and associated language delays. Copyright © 2015 John Wiley & Sons, Ltd.

Autism is a neurodevelopmental disorder that is characterized by a disruption of normal social and language development and the presence of restricted and repetitive behaviors and/or interests (Bishop, Luyster, Richler, & Lord, 2008). According to the *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (American Psychiatric Association, 2013), impairments in language and social communication among children diagnosed with autism spectrum disorder (ASD) are 'pervasive and sustained'. However, the severity of communication impairment in children with autism can be quite varied; some children do not speak at all, while others achieve fluent speech (Kelley, 2011). It has been suggested by earlier studies that up to 50% of children with autism remain nonverbal, but more recent studies have shown this figure to

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be an overestimate (Lord, Risi, & Pickles, 2004; Kelley, 2011). Few current estimates are available, but one study found that 14% to 20% of their sample of children with autism were nonverbal, defined as using fewer than five words on a daily basis (Lord, Risi, & Pickles, 2004).

A subset of children diagnosed with autism acquires functional language skills only as a result of participation in intensive behavioral therapy (Eigsti, de Marchena, Schuh, & Kelley, 2011). Development of functional language skills is an essential treatment focus of children with autism for several reasons. A child who is unable to communicate his wants and needs to caregivers may engage in problematic behavior to communicate, such as self-injurious behaviors, aggression, and tantrums (Carr & Durand, 1985; Sundberg & Partington, 1998). Further, because social, cognitive, and language abilities have been shown to be more interdependent in children with autism, improving language abilities may also lead to improvement in other social and cognitive abilities (Kelley, 2011). Additionally, the presence of useful speech during the preschool years is thought to be somewhat predictive of later adult outcome in individuals with autism (Howlin, Goode, Hutton, & Rutter, 2004). Finally, having a child who is nonverbal is associated with a high level of stress in the family (Wetherby, Prizant, & Schuler, 2000).

Intensive behavioral interventions for children with developmental disabilities, including autism, often focus on social initiations in the form of requests as initial targets for skill development (Barbera, 2007; Rogers & Dawson, 2009; Sundberg & Partington, 1998). In the initial stages of request training with a child with limited language, only single words are usually targeted (i.e., 'juice' rather than 'I want some juice, please'). As a child progresses throughout treatment, it may be desirable to increase the mean length of utterance (MLU) of their requests in order to promote generalization and increase social appropriateness. MLU is widely accepted as a general index of grammatical development and is useful for evaluating the earliest stages of language development (Scarborough, Rescorla, Tager-Flusberg, Fowler, & Sudhalter, 1991). Miller and Chapman (1981) found MLU to be highly correlated with age and suggested normative age ranges for MLU based on their sample. However, children with autism often show delays in making the transition from using single words to multiword speech (Paul, 2008). Volden and Lord (1991) found that lower-functioning children with autism had significantly lower MLUs than age-matched typically developing peers. Interestingly, the authors did not find any significant differences between the groups on the number of utterances made, which suggests that children with autism may struggle specifically with increasing utterance length rather than with the amount of utterance production. As such, targeted intervention to promote generalized, multiword speech is often warranted.

Given that the transition from single-word requests to multiword utterances is an identified challenge for children with autism, intervention specifically designed to

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increase the MLU of requests is warranted. As such, increasing MLU has been identified as an important language goal for children with developmental delays (Yoder, Spruytenburg, Edwards, & Davies, 1995). Several prior investigations examined treatment effects of interventions designed to increase multiword utterances in children with language delays. Rogers-Warren and Warren (1980) developed a language training technique called the mand-model procedure in order to produce acquisition and enhance generalization of previously taught language skills. During intervention with the mand-model procedure, when the child shows interest in an item or activity, the adult mands for the child to verbally request the desired material at hand with a statement such as, 'Tell me what you want'. If the child responds with an appropriate verbal response, the adult provides descriptive praise and delivers the item/activity. If the child's response is inadequate, the adult provides a model of the appropriate response, such as 'Red ball, please' (Rogers-Warren & Warren, 1980). In addition to the potential for increasing generalization, the mand-model procedure has also been employed as a method of direct language training. Warren, McQuarter, and Rogers-Warren (1984) evaluated the effects of the mand-model procedure as a direct intervention method for children with language delays. Notably, this study examined MLU as a dependent variable. The investigators used the mand-model procedure as described earlier in their first experimental condition. A modified version of the mand-model procedure was then implemented in which at least two-word utterances were required from participants. Results indicated that only when the two-word utterance requirement was implemented did MLUs increase appreciably. Following the second phase of intervention, all three participants' MLUs showed an increase from baseline, and those increases were maintained when the mand-model procedures were faded out (Warren et al., 1984).

Hart and Risley (1980) taught participants in their study to use compound sentences when requesting access to toys. Following instruction, they found that when compared with a control group, these children used more complex vocabulary and sentence structure that had not been directly taught. Peterson, Carta, and Greenwood (2005) trained three parents to use enhanced milieu language teaching for their children at risk for language delays. Although increasing MLU was not directly targeted, the authors found increases in MLU for all three of their participants following intervention. In a recent investigation into the emergence of novel request (i.e., mand) forms, Hernandez, Hanley, Ingvarsson, and Tiger (2007) evaluated the extent to which training both single-word (e.g., 'truck') and framed (e.g., 'I want the truck, please') requests would result in the emergence of novel requests. They concluded that once single-word requests have been acquired, training one or a few framed requests is likely to result in the emergence of untrained requests. Thus, they recommended that frames (e.g., 'I want…' and 'can I have…') should be targeted when teaching requests in order to promote the development of more complex and socially desirable request forms.

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Some early studies also examined the use of 'expansions', which have been described as adult utterances that follow the child's utterance and serve to increase the syntactic or semantic complexity of the message (Yoder et al., 1995). An example of such an adult expansion might be, 'You want the juice', following a child's reaching for juice and saying 'juice'. In this way, the adult provides a model of a more complex phrase of greater length for the child to imitate. Studies have shown the use of expansions to be effective at increasing syntactic development in children who are typically developing (Nelson, Carskadden, & Bonvillian, 1973; Nelson, 1977) as well as those with developmental disorders (Scherer & Olswang, 1989). A more recent study examined the effect of a similar intervention termed 'broad target recasts' (BTR) on the length of utterances of children with specific language and intelligibility impairments (Yoder, Camarata, & Gardner, 2005). BTR treatment afforded recasts of child vocalizations that either expanded sentence length or corrected articulation errors. The authors did not find a significant treatment effect of BTR on MLU after controlling for pretreatment variables; however, they did find follow-up improvements in speech intelligibility in children whose speech accuracy was lower prior to treatment (Yoder et al., 2005).

Overall, very little research has been published on the effectiveness of interventions to increase the MLU of children who present with language delays. Of the studies that have been completed, several did not target an increase in MLU specifically (e.g., Hart & Risley, 1980; Hernandez et al., 2007), and most relied on single-subject research and small sample sizes (e.g., Hernandez et al., 2007; Nelson, 1977; Peterson et al., 2005; Yoder et al., 1995). Also, the interventions employed by the various studies varied widely. Thus, the generality of the results from these previous studies is limited. A review of the relevant research highlights the need for additional replications of similar treatment procedures, studies with larger sample sizes, and methods that aggregate single-subject data (e.g., effect sizes).

When conducting single-case research (SCR), it may be desirable to evaluate intervention effectiveness by quantifying data across participants, especially when seeking to enhance support for an 'evidence-based practice' (Parker & Vannest, 2009). The use of effect sizes in SCR offers several advantages over relying on visual analysis alone, such as increased objectivity, precision, dependability, and general credibility (Parker & Hagan-Burke, 2007). Cohen's d has been noted to be the most frequently used effect size in SCR (Parker & Hagan-Burke, 2007); however, it has also been criticized for its use in SCR because of unmet data assumptions and poor interpretability (Parker & Vannest, 2009). As an alternative, several nonparametric measures of nonoverlapping data have been suggested for use in quantifying results of SCR. These measures include percentage of nonoverlapping data (Scruggs, Mastropieri, & Casto, 1987), percentage of data points exceeding the median (Ma, 2006), percentage of all nonoverlapping data (Parker, Hagan-Burke, & Vannest, 2007), and nonoverlap of all pairs (NAP; Parker & Vannest, 2009). These measures differ slightly in how they are

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calculated, but all attempt to describe the extent to which data in the baseline and intervention phases overlap (Parker & Vannest, 2009).

Nonoverlap of all pairs has several advantages over other nonoverlap indices as well as other standard effect sizes (e.g., Cohen's *d*). NAP requires few data assumptions, can be efficiently calculated by hand, and is strongly correlated with visual analysis judgments (Parker & Vannest, 2009). NAP is a probability score that normally ranges from .5 to 1 and can be interpreted as the probability that a treatment phase data point will be higher than a baseline phase data point. Thus, its primary value in SCR is as a measure of intervention effectiveness. In a sample of SCR participants, NAP can be calculated for each participant by hand from their SCR graph and then can be averaged across participants to calculate an overall effect size for the entire sample. NAP has demonstrated utility in summarizing data overlap between phase A data points and phase B data points from SCR graphs and can be defined as 'the percent of non-overlapping data between baseline and treatment phases' (Parker & Vannest, 2009).

Although it is a relatively new measure of effect size, there has been a surge of NAP use in studies involving single-case design over the past several years. NAP has been recently used in SCR either as the primary measure or as an adjunct measure of intervention effectiveness for various interventions, such as pediatric feeding treatments (Sharp, Jaquess, Morton, & Herzinger, 2010), computer-based interventions to teach communication skills to children with ASD (Ramdoss et al., 2011), behavioral contracting to increase treatment adherence (Hufford, Williams, Malec, & Cravotta, 2012), an automated vocabulary and comprehension intervention (Spencer et al., 2012), and an iPad play story to increase pretend play skills (Murdock, Ganz, & Crittendon, 2013).

The present study aims to add to the literature on interventions to increase the MLU of children with ASD and related developmental disorders. Our study seeks to determine the treatment outcomes of an intervention designed to increase the MLU of requests in a larger sample of children with ASD and related developmental disabilities ($n = 30$). In order to quantify data across participants, NAP will be utilized to obtain an overall measure of intervention effectiveness. Parker and Vannest's (2009) suggested interpretive guidelines for NAP will be utilized to estimate the strength of effects observed with MLU intervention. Along with NAP, the more commonly used effect size Cohen's *d* will also be calculated and reported as an adjunct measure of effect size.

METHOD

Participants, Setting, and Materials

Potential participants were identified by searching current and discharged clients' electronic charts at a large outpatient treatment center for children with developmental

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disabilities. Client charts were searched to see if they contained a data graph for MLU of clients' requesting behavior. If a client's chart contained an MLU graph, they were considered for participation in the study. To be eligible for participation in our study, the following criteria had to be met: (i) the client's legal guardian had to provide consent for dissemination of the client's data and (ii) the client had to have received at least five sessions of MLU intervention during their treatment. Of the 201 client charts, 30 met the aforementioned criteria.

Demographic information such as age, gender, and primary diagnosis was obtained from each participant's electronic chart. Our sample consisted predominantly of male children (80%) and of individuals diagnosed with autism (76.7%). The remainder of the sample had documented primary diagnoses of developmental delay (3.3%), pervasive developmental disorder not otherwise specified (10%), or other medical and/or developmental condition (10%). The median age of participants in our sample was four years. Participants were further classified into the age groups of four years and under (56.7%) or five years and older (43.3%). Table 1 summarizes the demographic data of our sample.

Participants had received treatment through a behavioral intervention program aimed at improving communication in children with developmental disabilities and language deficits. Participants received clinic-based or home-based treatment sessions 2 to 6 h/day, two to five days per week. All treatment plans and interventions were supervised by a licensed psychologist and Board Certified Behavior Analyst. Participants exhibited requests in the form of primarily one-word utterances of

Table 1. Demographic characteristics of a sample of children ($n = 30$) who received treatment for MLU.

Demographic	Number
Gender	
% male	80.00
% female	20.00
Age	
Mean	5.36
Median	4.00
% >4 years	43.30
% ≤4 years	56.70
Primary diagnosis	
% intellectual disability	0.00
% autism	76.70
% developmental delay	3.30
% PDD-NOS	10.00
% other	10.00

MLU, mean length of utterance; PDD-NOS, pervasive developmental disorder not otherwise specified.

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preferred items or activities (e.g., 'cookie'). Participants had been taught in a one-on-one format using discrete trial instruction and incidental teaching. MLU treatment was conducted in a room containing furniture and the relevant reinforcing items, in the playroom, or on the playground. Other children and instructors may have been present but did not interact with participants during sessions.

Procedures

Intervention for Increasing Mean Length of Utterance

Participants received intervention specifically for increasing MLU as a part of their overall behavior treatment programming. MLU sessions included two phases, baseline and treatment, and the experimental design consisted of a nonconcurrent multiple baseline across participants.

Baseline

Probe sessions conducted prior to the implementation of MLU intervention were considered baseline. During the baseline phase, the therapist interspersed several request opportunities with other structured instructional tasks. Standard teaching procedures as dictated by each individual child's program and treatment plan were conducted. Thus, all skills and requests were taught using behavioral strategies (e.g., prompts and prompt fading and differential reinforcement), and requests were prompted throughout the session primarily when the participant indicated interest in a targeted request item. During the baseline phase, only single-word requests were prompted. These procedures were in place each day for the entire time the participant was present in the clinic. The baseline phase was continued until each individual participant's treatment team indicated treatment for MLU was warranted and MLU reached stable levels. Thus, baseline lengths varied, and implementation of treatment was staggered.

Mean Length of Utterance Treatment

Following baseline, a treatment phase was implemented for the purpose of increasing the length of each individual utterance when the child independently requested. Treatment was conducted flexibly throughout participants' sessions and consisted of prompts and differential reinforcement for lengthier requests. If the child independently requested for an item or activity using fewer words than required, the therapist prompted a request using a phrase of a targeted length (e.g., two to three words or three to five words) as dictated by the participant's treatment plan. Therapists

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provided either the entire phrase as a prompt or one word at a time. For example, if the child said ‘juice’, the therapist could prompt ‘I want juice’ or ‘I’ (pause for the child to repeat) ‘want’ (pause for the child to repeat) ‘juice’ (pause for the child to repeat). Other examples of prompts used are listed in Table 2. These procedures were in place each day for the entire duration of the participant’s session. As a child’s MLU increased, requests of greater lengths were differentially reinforced as directed by the participant’s treatment plan. For example, the treatment plan for a specific participant might require three consecutive daily probes meeting the MLU requirement before increasing to the next level. Another participant’s treatment plan may require five consecutive daily probes meeting the MLU requirement. In general, three to five consecutive days or four out of five days with probes meeting the requirements were observed before moving to the next level. Requirements for MLU did not exceed five words.

Probe Sessions

Throughout both phases, 10-min probe sessions were conducted in which spontaneous, independent requests were recorded. During these probes, the therapist worked with the child as she typically would by interspersing several requesting opportunities with other structured instructional tasks. During probes conducted during the baseline phase, the therapist continued to prompt one-word requests if none were emitted. During probes conducted during the MLU treatment phase, the therapist continued to prompt multiword requests. The therapist recorded the number of words uttered each time the child independently requested; prompted requests were not recorded. The MLU was then calculated for each 10-min probe by dividing the total number of words used by the number of requests that occurred. The number of request occurrences varied across sessions and across participants because request opportunities were initiated by the participant.

Table 2. Examples of prompts utilized during mean length of utterance treatment.

Child says	Therapist prompt
Juice	Give me juice
Playdoh	I want Playdoh
Lego	Stack Lego; stack blue Lego
Video	Turn it on; press play
Book	Open book; turn page
Bubbles	Blow the bubbles
Jump	I want to jump; Can I jump

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Quantifying Treatment Outcomes

The experimental design utilized was nonconcurrent multiple baseline across participants. However, in order to quantify results across the entire sample, NAP was selected as a measure of intervention effectiveness. NAP was hand calculated for each participant using data from his or her MLU graph. The procedure outlined by Parker and Vannest (2009) for hand calculation of NAP was followed. Within each participant's MLU graph, all baseline data points were compared with all treatment data points, and the total number of possible comparisons was calculated (number of baseline data points multiplied by number of treatment data points). If a baseline data point value was higher than a treatment data point value, that comparison was marked as an 'overlap'. If a baseline data point value was equal to a treatment data point value, that comparison was marked as a 'tie'. The total number of baseline/treatment 'overlaps' and 'ties' were counted for each graph. These totals were then used in the following equation to solve for NAP for each participant:

$$\text{NAP} = \frac{\text{Num of total BL/TX comparisons} - [\text{Num. compar. that overlap} + (0.5)\ (\text{Num. compar. that tie})]}{\text{Number of total BL/TX comparisons}}$$

The average NAP of the sample ($n = 30$) was then calculated by summing together each individual NAP score and dividing by 30. Additionally, the standard effect size Cohen's *d* was calculated from each participant's NAP score using the formula given by Parker and Vannest (2009). Finally, the average *d* for the entire sample was calculated by summing together each *d* and dividing by 30.

A second trained researcher performed reliability checks on the data calculations for NAP and Cohen's *d* for all 30 participants (100%). Reliability checks yielded 100% agreement.

RESULTS

The number of baseline and treatment sessions conducted during MLU treatment varied across participants. The average number of baseline sessions was 5.8 and ranged from 3 to 23; treatment sessions averaged 66.2 and ranged from 7 to 266. In baseline, each participant's MLU was stable. Although not the focus of the current analysis, a review of the results of each participant shows that for the vast majority of participants (26 out of 30), improvement was seen with the introduction of intervention. Specifically, increases in the number of words used independently as requests increased for most participants (data not shown but available upon request from the corresponding author).

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The primary focus of analysis was the calculation of an effect size estimate using NAP. Individual NAP values ranged from 0.32 to 1.0, and the mean NAP value for the entire sample ($n = 30$) was 0.89 (*SD*: 0.19; 95% CI [0.82, 0.96]). Based on the interpretive ranges provided by Parker and Vannest (2009), the MLU intervention yielded medium treatment effects in our overall sample. Parker and Vannest (2009) provide tentative interpretive ranges for NAP describing a weak effect (0–0.65), medium effect (0.66–0.92), and large/strong effect (0.93–1.0). Strong treatment effects were demonstrated by 70% of the participants, medium effects by 16.7% of the participants, and weak effects by 13.3% of the participants. The average *d* for the overall sample ($n = 30$) was 2.36, indicating a strong overall effect according to interpretive guidelines for Cohen's *d* (Aberson, 2010). The *d* values of the sample ranged from −0.55 to 3.46. According to *d* values, strong treatment effects were demonstrated by 86.7% of the sample, medium effects by 3.3%, and weak effects by 10%. These results are presented in Table 3.

The average MLU during the baseline phase across all participants was 1.41 words, or an age equivalent of 19–22 months according to Miller and Chapman's (1981) norms. During the treatment phase, the average MLU across all participants was 2.61 words, or an age equivalent of 31–34 months. The average change in MLU from baseline to treatment phases was an increase of 1.20 words, which corresponds to a 12-month improvement in age equivalence. See Table 4 for these results.

Table 3. Strength of MLU intervention effects in current sample using NAP and *d* interpretive guidelines.

Intervention effects	% of sample according to NAP	% of sample according to *d*
Weak	13.3	10.0
Medium	16.7	3.3
Large/strong	70.0	86.7

MLU, mean length of utterance; NAP, nonoverlap of all pairs.

Table 4. Average MLU values and age equivalents (Miller & Chapman, 1981) at baseline and treatment phases.

Phase	Average MLU	Age equivalent
Baseline	1.41	19–22 months
Treatment	2.61	31–34 months
BL/tx difference	1.20	12 months

MLU, mean length of utterance; BL/tx, baseline/treatment.

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DISCUSSION

The current study provides strong evidence for the use of a targeted behavioral intervention to increase the length of utterances when requesting by children diagnosed with autism and related disabilities. The intervention shown to be effective in this study utilized prompting of greater phrase lengths and differential reinforcement of lengthier requests. In our sample of 30 children, we found that this intervention to increase the MLU of requests was effective, with 70% of participants achieving a large/strong effect according to NAP interpretive guidelines (Parker & Vannest, 2009). Notably, the average increase in MLU represents a developmental improvement equivalent to 12 months. Given that the average number of treatment sessions was 66.2, if treatment sessions were conducted daily, these results could be achieved in a little over three months. Thus, these dramatic improvements in MLU were seen in a relatively short amount of time. Only one of the previous studies reviewed utilized the behavioral techniques of prompting and differential reinforcement for the purpose of increasing the MLU of children's requests in the ASD population (Hernandez et al., 2007), and that study was limited by a small sample size ($n = 3$). Thus, our study provides support for the use of specific behavioral strategies to increase MLU in a larger sample of children with ASD ($N = 30$).

Increasing the length of utterances emitted by children with autism and related disabilities is a critical step in further developing their functional communication skills. Typically developing children often begin uttering two-word phrases before the age of two years, and their sentence length continues to increase during the preschool period (Kim, Paul, Tager-Flusberg, & Lord, 2014). However, many children with autism and related disabilities are not diagnosed until the age of four years (Centers for Disease Control and Prevention, 2014) and may begin intervention with little to no functional communication skills. Further, uttering greater phrase lengths may constitute a unique difficulty in children with ASD (Volden & Lord, 1991). Thus, time-efficient and effective strategies to facilitate more complex and socially valid vocal communication are vital for these children's development. Further, while the ability to request using one word can be a monumental step for a child with autism who previously could not communicate, multiword requests offer advantages over single-word requests. For example, multiword requests can convey more complex information, are more socially accepted, and can help clarify the speaker's intent for the listener. For example, saying 'cup' may not be easily understood as a request, whereas the same word, 'cup', when accompanied by a frame (e.g., 'May I have…') clarifies for the listener that the speaker wants a cup, and therefore, the listener may assist the speaker by giving him or her a cup. Thus, more meaningful interactions may occur. Our study provides evidence that intervention to increase MLU using behavioral strategies can yield rapid and strong treatment effects in children with ASD and related developmental disabilities.

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Because of our larger sample size, we were able to provide a quantification of MLU intervention effectiveness (via NAP), which was lacking in previous studies. Thus, the current study also represents a meaningful addition to the growing body of literature that has used NAP as a means of quantifying intervention effectiveness in single-subject experimental designs. Quantification of results from single-case experimental designs by calculating an effect size is important for several reasons. First, effect sizes can offer greater objectivity than visual analysis alone (Parker & Hagan-Burke, 2007). Also, calculating effect sizes facilitates the inclusion of single-subject designs in meta-analyses (Allison & Gorman, 1993). Third, effect sizes help the practitioner determine if a given treatment intervention will lead to clinically significant improvement (Parker & Brossart, 2003). Recent scholarship has investigated various nonoverlap indices in order to quantify results from single-subject research to obtain an effect size (e.g., Ma, 2006; Parker, Hagan-Burke, & Vannest, 2007; Manolov, Solanas, Sierra, & Evans, 2011), and NAP has consistently performed favorably against other nonoverlap indices (Parker & Vannest, 2009; Manolov et al., 2011).

Although the body of evidence supporting the use of NAP as a measure of intervention effectiveness in SCR is promising, it is still a relatively new index that does not yet have robust validation (Manolov et al., 2011). For example, NAP's use across different types of single-case designs is currently being investigated. Parker and Vannest (2009) recommended the use of NAP after reporting results from their sample of 200 AB contrasts. However, after investigating the use of NAP with multiple baseline designs, Petersen-Brown, Karich, and Symons (2012) found that typical NAP values were larger than those reported by Parker and Vannest (2009). Based on their findings, Petersen-Brown and colleagues offered cutoff scores for magnitude of effect that are different than those of Parker and Vannest (2009). Petersen-Brown and colleagues proposed that a possible explanation for their larger NAP values was the nature of the interventions they studied rather than the experimental design. The authors examined reading, math, and writing interventions that involved the acquisition of skills. Thus, the dependent variables studied would not be expected to return to baseline levels if the intervention were withdrawn. The current study also utilized a multiple-baseline design; however, it did not solely involve skill acquisition *per se*. Although the participants were taught a new skill of using multiword requests, those requests were also maintained by differential reinforcement. We speculate that if the MLU intervention had been completely withdrawn (i.e., differential reinforcement for longer utterances), the dependent variable (MLU) would have been expected to return to baseline levels. Thus, we chose to employ Parker and Vannest's (2009) cutoff scores rather than those of Petersen-Brown et al. (2012).

Nonoverlap of all pairs, along with all other simple nonoverlap indices, does not provide information on the level of improvement across baseline and treatment

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phases, only the magnitude of whether there was a clear improvement or not. For example, a participant could have three baseline MLU points with a value of 1, and 10 treatment MLU points of 1.2, and still achieve a NAP score of 1.0 (large/strong effect). Thus, NAP alone should not be used when interpreting the clinical significance of a given treatment for a particular client. For this reason, we included both baseline and treatment average MLU scores, as well as MLU age equivalents (Miller & Chapman, 1981) at baseline and treatment. The majority of our participants made clinically significant gains in MLU following treatment (i.e., 12-month increase in age equivalence). This provides further validation of the effectiveness of MLU treatment for our sample.

There were also several limitations of the MLU intervention examined in our study. First, the intervention assumes that a greater sentence length leads to more effective communication. However, data on the variability of phrases emitted by participants during MLU treatment were not collected. Thus, a child might have emitted the same phrase (i.e., 'I want juice please') for the entire 10-min treatment probe (although anecdotally this did not happen). Limited variability of requesting behavior limits the social appropriateness and effectiveness of the child's verbal behavior. Also, the long-term maintenance of increases in MLU was not assessed during this study, limiting the conclusions that can be made about long-term functional language improvement. Finally, MLU treatment was conducted in a one-on-one setting. Generalization to other environments (i.e., in the child's home) was not assessed in this study.

Future studies should examine the variability of responses emitted during MLU intervention and perhaps directly target increases in variability along with increases in MLU. Also, maintenance of increases in MLU following the withdrawal of treatment should be assessed in order to make conclusions about the duration of treatment effects. Finally, future studies should examine the generalization of MLU treatment effects across settings, perhaps by including data from parent observation in the child's home. In sum, our study provides further evidence that specific intervention to increase MLU of requests can be effective in children with ASD and related developmental disabilities. Our study also underscores the utility of quantifying results across an entire sample using NAP as a measure of intervention effectiveness. The NAP values included in our results lend themselves to easy inclusion in future meta-analyses.

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