THE USE OF A STIMULUS CONTROL TRANSFER PROCEDURE TO TEACH
SPONTANEOUS MANDING TO CHILDREN WITH AUTISM

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Current research indicates that the inability to spontaneously communicate needs or wants may result in the acquisition of unconventional forms of requesting such as aggression and tantrums. This in turn limits the amount of access that students with autism have to neurotypical peers and social environments. The purpose of this study was to investigate the effect of using a stimulus control transfer procedure on the acquisition of spontaneous mands. Four school-aged children with autism, two boys and two girls, participated in the study. A multiple baseline design across participants was utilized to demonstrate a functional relation between the stimulus control transfer procedures and the rate of spontaneous mands. Measurement variables included the frequency of spontaneous versus multiply-controlled mands during discrete trial training on a variety of verbal operants. Effectiveness of the intervention was analyzed through visual analysis and the magnitude of effect was assessed through effect size. Visual analysis indicated that three of the four participants learned to spontaneously mand for items out of view and demonstrated generalization across targets, staff and environments. The effect size for three participants were large ($d = 1.94; d = 2.2; \text{ and } d = 1.4$), whereas the outcome of intervention for one participant ($d = 0.98$) indicated moderate effect. The overall ($d = 1.15$) outcome demonstrated a large effect of the intervention on the rate of mands. Based on the results of this study, it is recommended that early and intensive behavior intervention programs for children with autism incorporate this type of procedure for socially significant outcomes.
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Introduction

Autism, once thought to be a rare disorder, has been increasing dramatically in prevalence rate (Yeargin-Allsop, Rice, Karapurkar, Doernberg, Boyle & Murphy, 2003). It is considered by some to be the second most common developmental disorder after intellectual disabilities (Bhasin, Brocksen, Avchen, & Braun, 2006). Research reports indicate that prevalence rates for autism in the United States between 1960 and 1980 ranged from 2 to 5 in 10,000. It increased dramatically from 2000 to 2009 when the prevalence rate was estimated to be 30 to 60 in 10,000 (Kogan et al., 2009). The prevalence rate between 2000 and 2008 was 1 in 88 children whereas the most recent report noted the prevalence to be 1 in 50 children based on parent reports in 2011-12 (Blumberg et al., 2013).

Although the reason for such dramatic increases in the prevalence rate continues to be debated (Matson & Kozlowski, 2011), there is no dispute about the need for accurate identification as the critical first step in the delivery of early and intensive intervention for young children with autism. The most recent edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013) merged the previously distinct disorders found under the pervasive developmental disorders category (i.e., Asperger syndrome, autistic disorder, pervasive developmental disorder—not otherwise specified) into one diagnostic category known as autism spectrum disorder. For the purposes of this study, the focus is on individuals with classic characteristics of autism.

Autism is a neurodevelopmental disorder characterized by deficits in two diagnostic domains including social communication and social interaction skills, and restricted, repetitive
patterns of behavior, interests, or activities (DSM-5). Social communication deficits most commonly observed include a lack of reciprocity, difficulties adjusting behavior to suit various social contexts, monotonous tone of voice, literal interpretation of words or phrases, and an overall lack of motivation to communicate (Scheuermann & Webber, 2002; Tager-Flusberg, 1981). These deficits, in some form, are associated with all individuals with autism and are the most prominent characteristic (National Research Council, 2001), leading to a devastating impact across the lifetime of the individual. Parents have often reported the absence or delay of communication skills in young children as the first indicator of a possible disability (De Giacomo & Fombonne, 1998; Howlin & Moore, 1997). Although the severity of communication impairments can vary dramatically from one child to another, there appears to be some similarity among the type of communication deficits observed in most young children with autism. It has been estimated that up to 50% of children with autism fail to develop functional, vocal verbal behavior (Bailey, Phillips, & Rutter, 1996; Bryson, 1996; Hartmann & Klatt, 2005; Webber & Scheuermann, 2008).

Research has demonstrated that children who struggle to develop a functional communication repertoire or who fail to develop meaningful communication altogether often acquire an alternative, less conventional form for expressing their needs and wants (Carr & Durand, 1985; Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007; Hall & Sundberg, 1987; Reese, Richman, Belmont, & Morse, 2005; Shafer, 1994). Absence of alternative methods to communicate may result in the emergence and occurrence of problem behaviors such as aggression, crying, and/or self-injurious behaviors. Furthermore, communication delays in children with autism limit and often
prohibit participation by the individual in social activities and experiences with peers (Charlop-Christy et al., 2002; Shabani et al., 2002; Shafer, 1994; Thiemann & Goldstein, 2001).

Social participation in natural environments can be enhanced by teaching children with autism to communicate more spontaneously, at least in situations where they have the opportunity to express their need or desire to access specific items or activities. In a study to teach spontaneous mands to young children with autism, Sweeney-Kerwin, Carbone, O’Brien, Zecchin, and Janecky (2007) used a rolling time delay and prompt fading procedure on multiply-controlled mand. The study showed that spontaneous mands increased and maintained but only one of the two participants generalized the skill to another adult. As noted by the authors, response generalization was not observed for any of the participants and had they been trained with a larger number of exemplars during intervention, their responses may have generalized to untrained targets. This suggestion was incorporated in the current study.

The current study utilized similar theoretical foundations and intervention procedures as the Sweeney-Kerwin et al. (2007) study but with very distinct differences. First, this study was conducted in elementary classrooms located on public school district campuses rather than tightly controlled clinical settings. Second, the intervention was implemented by classroom teachers instead of highly trained board certified behavior analysts. Third, measurement of spontaneous mands was conducted for all participants across a variety of targets including items, objects and activities instead of only edible items. These changes and additions were made in an effort to address the primary and secondary quality indicators of single subject experimental research and to demonstrate increased rigor.

Sound theoretical underpinnings are more likely to lead to effective scientific practices within clinical and applied settings. The theoretical framework that served as a foundation for
this study was based on the philosophy of applied behavior analysis (ABA) and Skinner’s analysis of verbal behavior (VB). Although the principles of ABA and VB are frequently applied independently, they are inextricably linked in the cited literature and applied settings in the context of communication intervention procedures (Greer & Ross, 2004; Rivard & Forget, 2012). The principles of ABA are at the very core of this study as illustrated by implementation of strategies such as prompting, prompt fading, manipulating motivating operations, and scheduled delivery of reinforcement. The systematic implementation of these principles and strategies were used to teach the operants of verbal behavior as defined by B. F. Skinner (1957).

Description of the Verbal Behavior Approach

As described by Skinner (1957), VB is “any movement capable of affecting another organism” (p. 14) that results in reinforcement by another person, the listener. The VB approach presented six elementary verbal operants and the controlling variables for each, thus providing a behavior analytic description of language acquisition (Sautter & LeBlanc, 2006). The six verbal operants introduced by Skinner (1957) in *Verbal Behavior* were mand, tact, echoic, intraverbal, textual, and transcription. The four operants most relevant to this study include the mand (i.e., a request), the tact (i.e., a label), the echoic (i.e., repeats word or sound), and intraverbal (i.e., fill-in-the-blank response). Each operant is controlled by specific independent variables (i.e., antecedents, consequences, and motivating variables), resulting in what is defined as a functional relation between environmental events and an organism’s behavior (Sundberg, 2007).

Additionally, research has substantiated Skinner’s original tenet of the functional independence of each verbal operant while demonstrating their inter-relatedness (Arntzen & Almas, 2002; Sautter & LeBlanc, 2006; Skinner, 1957). Specifically, the acquisition of a manding repertoire
has accelerated the acquisition of other verbal operants such as tacts (Kelley, Shillingsburg, Castro, Addison, & LaRue, 2007; Lamarre & Holland, 1985).

Existing research suggests that the mand is the most appropriate operant to teach before other operants (Shafer, 1994; Skinner, 1957; Sundberg & Michael, 2001). Drash, High, and Tudor (1999) used shaping, prompting, prompt fading, and manipulation of the motivating operation (MO) to establish a manding repertoire in three nonverbal boys diagnosed with autism. With the manding repertoire as a foundation, the authors were able to teach all three participants an echoic repertoire and two participants also learned an initial tact repertoire. After determining the favorite foods and toys of each participant, access to these items was limited, thus enhancing their motivational value, making it more likely they would function as a reinforcer.

The concept of functional independence of verbal operants plays a significant role in language and communication intervention based on Skinner’s analysis of verbal behavior. Simply put, responses controlled by variables related to one operant will not automatically come under the control of variables related to a different operant (Hall & Sundberg, 1987; Kelley, et al., 2007; Lamarre & Holland, 1985; Skinner, 1957; Watkins, Pack-Teixeira, & Howard, 1989). For example, even if a child has the ability to tact an object lying on a table (e.g., ball), there is no reason to expect that he also possesses the ability to request the ball when he wants to play with it. Functional independence dictates the need for direct instruction for each verbal operant as well as the use of specific behavior analytic procedures to transfer control of the mand from one set of controlling variables (e.g., prompts) to another (e.g., motivation to access). The controlling variables of the mand are the MO and the following consequence, that is, the contingent delivery of the item requested.
Motivating Operations

As a controlling variable, a strong MO must be present in order for manding to occur reliably. Therefore, it is extremely important for interventionists to continuously analyze the strength of an MO during mand training in order to ensure that the child has sufficient interest in an item, object or activity to exert the effort required to produce a mand (Sundberg, 2004). Perhaps one of the most effective methods for determining the motivational state is to offer choices of items previously observed to be valuable to the student. Once motivation for an item, object or activity is declared, mand training can be initiated.

The first mands acquired by children with autism are usually multiply controlled mands (Sundberg, 2004). A multiply controlled mand occurs when the MO is present along with an additional stimulus, such as a vocal prompt or the physical presence of the item the child wishes to obtain. A mand exhibited under these conditions may be controlled either by the vocal prompt, the item, or both. In contrast, spontaneous mands are those that occur only in the presence of the MO and a listener (Sundberg, 2004). They typically do not develop in young children with autism without direct and intense instruction (Carr & Kologinsky, 1983; Charlop-Christy et al. 2002; Charlop, Schreibman, & Thibodeau, 1985; Sundberg, 2004). Although it has been proposed that the lack of spontaneous manding in young children with autism is related to cognitive deficits, Carr and Kologinsky (1983) suggest that educational interventions that do not include prompt fading procedures combined with differential reinforcement are more likely to restrict spontaneity. In other words, students with autism can be taught to mand spontaneously through the use of ABA principles such as time delay, prompting, prompt fading and differential reinforcement.
Behavior Analytic Procedures Used to Teach Manding

The most significant difference between a multiply controlled mand (i.e., a mand that occurs when motivation is high and another stimulus is present) and a spontaneous mand is that in the latter case, even when the item is out of view, the child can still produce the mand to gain access to the item (Sweeney-Kerwin et al., 2007). Although both types of mands are useful, spontaneous manding is considered to be a more advanced form of verbal behavior. By releasing the control of the mand from multiple stimuli (i.e., the visible presence of the item or a prompt from the listener) that regulate its occurrence, the child would be able to request items or activities that s/he wants across a variety environments and listeners, demonstrating more control over his/her environment (Bondy, Tincani, & Frost, 2004; Carr & Kologinsky, 1983; Sautter & LeBlanc, 2006). Multiply controlled mands limit access to highly preferred items if a child has to choose from a limited array of items. In such situations, children with autism are more likely to mand based on visually displayed items or verbal prompts from an adult rather than based on personal motivation to access an item. The most efficient way to make this process more naturalistic and to encourage children to access reinforcers more frequently is to transfer control of the mand to the MO as the sole controlling variable. This allows learners to control their environment more efficiently and effectively as their behavior generalizes across other novel settings (Guess, Sailor, & Baer, 1974). Additionally, spontaneous mands are considered to be more functional, socially valid and similar to the natural requesting repertoires of typically developing children (Sigafoos, Kerr, Roberts, & Couzens, 1994).

To increase spontaneous manding of children with autism, research has documented the use of time delay procedures to eliminate the need for a vocal or visual prompt and transfer control from the prompt to naturally occurring stimuli by varying the time between the
presentation of the prompt and the natural stimuli (Cooper, Heron, & Heward, 2007; Sweeney-Kerwin et al., 2007; Wolery & Gast, 1984). Prompt, prompt fading and time delay are all considered to be stimulus control transfer procedures designed to produce spontaneous responding with limited errors (Cooper et al., 2007). The current study used these three procedures to transfer control of manding by students with autism from visible stimuli or prompts to the motivating operation (see Appendix A).

Significance of the Study

The ability to spontaneously communicate needs and desires can enhance the independence and overall welfare of individuals with autism. As noted previously, acquisition of communication skills can reduce the rate of problem behavior related to an inability to access reinforcing items and activities (Carr & Durand, 1985; Chiang, 2008; Sigafoos et al., 1994), and increase access and value of social environments (Black & Logan, 1995; Charlop-Christy et al., 2002). The current study was designed to expand the methodological rigor of the procedures described by Sweeney-Kerwin et al. (2007) to teach spontaneous manding. Specifically, the current study utilized a technically sound research design, followed scripted procedures that could be described with replicable precision, and included the measurement and reliability assessment of procedural fidelity.

Research Questions

1. Is there a functional relation between the use of a stimulus-control transfer procedure (i.e., time delay, prompt, and prompt fading) and levels of spontaneous manding?

2. As a function of intervention, will a higher rate of spontaneous mands be associated with trained or untrained targets during the generalization phase?
Methodology

Participants

The participants for this study included four children already diagnosed with autism (AU) who were enrolled in a public elementary school classroom specifically designed to serve students with severe communication disorders. They were recruited after the study was approved by the university’s Institutional Review Board if they met the following inclusion criteria. They had to (a) be previously diagnosed with autism through the local education agency; (b) be between the chronological ages of 3 and 7 years; (c) mand reliably (80% or more) for edible items, objects or activities, at least when verbally prompted or shown items or objects (as evaluated through classroom data); and (d) be a student in the classroom where the teacher was willing to participate in the training and implementation of intervention procedures with fidelity. Final selection of participants was made on the basis of data from reinforcer assessments conducted by classroom teachers for each individual prior to the start of the study. This process provided information on the type of items, objects and activities that each participant found reinforcing and was motivated to access during direct instruction sessions. Four participants met the inclusion criteria for the study. No participants were excluded from the study based on gender, race, or ethnicity as long as the inclusion criteria were met.

Praveen was a 7-year-old boy of East-Indian descent. He lived in a single-family household with his biological parents and one older sister. Initial observations and teacher report indicated that he primarily communicated using single word utterances to request and label items, activities, objects and pictures. He indicated his motivation to gain access to preferred items by reaching for the desired item or object. According to teacher data and baseline observations, his manding repertoire consisted of 6–8 one-word requests for visible items (e.g.,
chip, train, chocolate). His direct instruction program consisted of activities related to matching, sorting, labeling, and receptively identifying pictures and objects. According to his teacher, it generally took between 6–10 trials for Praveen to acquire new verbal operant targets. Detailed information regarding Praveen’s level of functioning on critical domains is provided in Table 1.

Angel was a 6-year-old Hispanic boy who lived in a single-family household with his biological mother and one older brother. Initial observations and teacher report indicated that he primarily communicated using a single sign to request and label items, activities, pictures and objects. He indicated his motivation to gain access to an item or object by reaching for it when he wanted something. According to teacher data and baseline observations, his manding repertoire consisted of 15–20 signs for visible items (e.g., pretzel, puzzle, iPad). His direct instruction program consisted of matching, sorting, labeling, and receptively identifying pictures and objects. According to his teacher, it generally took between 3–5 trials for Angel to acquire new verbal operant targets. Detailed diagnostic information is provided in Table 1.

Daneesha was a 5-year-old African American girl who lived in a single-family household with her biological parents and one younger brother. Initial observations and teacher report indicated that she primarily communicated using a single sign to request items and activities. She typically indicated her motivation to gain access to an item by reaching for it when prompted by the teacher. According to teacher data and baseline observations, her manding repertoire consisted of 3–5 single signs for visible items (e.g., chocolate, movie, markers). Additionally, a verbal prompt (e.g., “What do you want?”) and a gestural prompt (e.g., sign modeled by the teacher) were often required to elicit manding. Frequently a full physical prompt (i.e., the teacher positioned her hands) was required in order for Daneesha to produce the correct sign for what she wanted to access. Her direct instruction program was limited to matching and sorting.
pictures and objects. According to her teacher, it took over a 100 trials for Daneesha to acquire new verbal operant targets. Detailed diagnostic information for Daneesha is provided in Table 1.

Vanessa was a 5-year-old Hispanic girl who lived in a single-family household with her biological mother and one older sister. Initial observations and teacher report indicated that she primarily communicated using single signs to request items and activities. She typically indicated her motivation to gain access to an item or object by reaching for it or by leading a staff member to the object if it was visible but out of reach. According to teacher data and baseline observations, her manding repertoire consisted of approximately 7–9 signs for visible items (e.g., water, car, candy). Her direct instruction program consisted of activities related to matching, sorting, counting, labeling, and receptively identifying objects and pictures. According to her teacher, it generally took between 5–8 trials for Vanessa to acquire new verbal operant targets. Detailed diagnostic information is provided in Table 1.

Setting

This study was conducted in four different elementary public school classrooms in a school district in the South-Central region of the United States and was designed specifically for students with severe communication delays and children with autism. Each of these four classrooms was characterized by several core instructional components including the use of discrete trial training and natural environment teaching based on the principles of applied behavior analysis. Each classroom was approximately 20’ x 20’ and was equipped with tables, chairs, computer workstations, and storage cabinets. Although the arrangement for individual classrooms differed, the major components noted above were present in each classroom. The experimental sessions occurred in the classroom where the teacher and student sat across the table facing each other.
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| Praveen     | • Developmental Activities Screening Inventory – II (DASI – II)  
• Standard score = 41 (very poor)  
• Developmental Assessment of Young Children (DAYC)  
• Standard score = <50 (very poor – 6 month range) | • Adaptive Behavior Assessment – II (ABAS – II)  
• Extremely low in all areas; motor subtest relative strength | Autism Evaluation that included:  
• Review of Records  
• Parent Interview  
• Autism Diagnostic Observation Schedule (ADOS) Module 1  
• Autism Spectrum Rating Scales (ASRS) – Parent  
• Autism Spectrum Rating Scales (ASRS) – Teacher  
• Social Responsiveness Scale, Parent (SRS)  
• Results of evaluation indicate student meets TEA eligibility criteria consistent with an autism spectrum disorder | • Developmental Assessment of Young Children (DAYC)  
• Communication Subtest - <50 (very poor)  
• Preschool Language Scale – 4 (PLS-4)  
• Could not be completed due to non-compliance  
• Receptive-Expressive Emergent Language Test – 3 (REEL -3)  
• Receptive Language = <55 (very poor)  
• Expressive Language = <55 (very poor) |

*(table continues)*
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<td>eligibility criteria</td>
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<td></td>
<td></td>
<td></td>
<td>autism spectrum</td>
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<td>disorder</td>
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</tbody>
</table>

- Preschool Language Scales – Fifth Edition (PLS-5)
- Standard score – 50 (severely delayed range)

*(table continues)*
<table>
<thead>
<tr>
<th>Participant</th>
<th>Cognitive/Intellectual</th>
<th>Adaptive Behavior</th>
<th>Emotional/Behavioral</th>
<th>Language/Communication</th>
</tr>
</thead>
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<tr>
<td>Daneesha</td>
<td>Developmental Activities Screening Inventory – II (DASI-II)</td>
<td>No Adaptive Behavior Scale completed</td>
<td>Autism Evaluation that included:</td>
<td>The Test of Early Communication &amp; Emerging Language (TECEL)</td>
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<tr>
<td></td>
<td>Standard score = 46 (poor)</td>
<td></td>
<td>Review of records</td>
<td>Based on observation, direct interaction, and parent interview, performance indicates a language age of 3 months</td>
</tr>
<tr>
<td></td>
<td>Developmental Assessment of Young Children (DAYC)</td>
<td></td>
<td>Parent Interview</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Standard score = &lt;50 (very poor)</td>
<td></td>
<td>Teacher Interview</td>
<td></td>
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<td></td>
<td></td>
<td>Classroom Observation</td>
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<td></td>
<td>Autism Diagnostic Observation Schedule (ADOS) Module 1</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Autism Spectrum Rating Scales (ASRS), 2-5 years – Teacher and Home</td>
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<tr>
<td></td>
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<td></td>
<td>Results of evaluation indicate student meets TEA eligibility criteria consistent with an autism spectrum disorder</td>
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<td></td>
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<td></td>
<td>Results indicate a severe receptive-expressive language deficit</td>
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</table>
Table 1 (continued).

<table>
<thead>
<tr>
<th>Participant</th>
<th>Cognitive/Intellectual</th>
<th>Adaptive Behavior</th>
<th>Emotional/Behavioral</th>
<th>Language/Communication</th>
</tr>
</thead>
</table>
| Vanessa     | Developmental Assessment of Young Children (DAYC)  
               • Standard score = 70 (low)  
               • Kaufman Assessment Battery of Children – II Nonverbal Index (NVI)  
               • Standard score = 40 (extremely low) | Adaptive Behavior Assessment System II Parent Form (ABAS II)  
               • General Adaptive Composite (GAC) Score = 47 (extremely low)  
               • Adaptive Behavior Assessment System II Teacher Form (ABAS II)  
               • General Adapt Composite (GAC) Score = 58 (extremely low) | Autism Evaluation that included:  
               • Review of records  
               • Parent Interview  
               • Autism Diagnostic Observation Schedule (ADOS) Module 1  
               • Gilliam Autism Rating Scale, Second Edition (GARS-2) – Parent  
               • Childhood Autism Rating Scale  
               • Results of evaluation indicate student meets TEA eligibility criteria consistent with an autism spectrum disorder | Functional Communication Profile – Revised (used to rate and assess skill categories of communication)  
               • Moderate - Severe Impairment noted in expressive language, pragmatic/social, receptive language, sensory, and speech |
Dependent Variables

In accordance with best-practice recommendations for single subject research methodology (Horner et al., 2005; Reichow, Doehring, Cicchetti, & Volkmar, 2011), the dependent measures used in this study were operationally defined, measured frequently throughout various experimental phases, assessed for consistency by multiple observers, and socially significant to the teachers and parents of participants and the field. The following dependent variables were measured in the study.

Spontaneous or MO-Controlled Mands

An MO-controlled mand was defined as: (a) an unprompted request (i.e., vocal, sign or pictures) that was made for a specific item, object or activity when it or its picture/symbol was not physically present or visible to the student; and (b) the student had to engage with the item when reinforced with access to it following a mand (i.e., demonstrate motivation for it). An example of an MO-controlled mand was requesting soda stored in the refrigerator while seated at the direct instruction table. A non-example was requesting soda after seeing a staff member holding a can of soda (i.e., an MC-controlled mand), or the student not drinking the soda after being given a can after manding (i.e., not really motivated to access it).

Spontaneous (or MO) mands were measured in terms of the frequency of occurrence during the 15 minute (15-min) instructional session. Opportunities for manding were held constant across participants and two experimental phases (i.e., baseline and intervention) of the study. A MO-controlled mand was counted as an occurrence when a student requested an item not visible or present during the instructional context. If a prompt or item was presented during instruction and the student manded for it, an occurrence was counted only if the mand occurred after 15 seconds (15-s) of the presentation of the item or prompt.
Multiply Controlled or MC Mands

These were defined as verbal requests made for a specific item, object or activity when the item or its picture or any associating symbol (e.g., logo) was present and visible to the student and served as a prompt. A multiply controlled (MC) mand occurred when the MO was present along with an additional stimulus, such as a vocal prompt or the physical presence of the item the child wanted to obtain. Examples included requesting a chip when the teacher was holding a bag of chips or requesting to jump on the trampoline after entering a room where the trampoline was in plain view. Non-examples included (a) requesting items or activities that were not visible to the student (i.e., MO-controlled mand); and (b) pointing to an item following a teacher’s prompt (e.g., “what do you want?”).

MC mands were measured in terms of the frequency of occurrence during the 15-min instructional session. Following the presentation of a prompt, if the mand occurred within 15-s it was counted as MC-mand.

Procedures for Data Collection

Equipment and Materials

Discrete trial training sessions with each participant were recorded using a digital video camcorder. Each classroom teacher was provided with a camcorder capable of recording up to 4 hours of data on the internal hard drive. A digital timer was used to record the duration of the time delay procedure that was implemented during the intervention phase. The classroom teacher was responsible for setting the timer for each occurrence of the time delay procedure according to the scripted instructions provided to maintain intervention fidelity.
Direct Observation of Behavior

Direct observation of target responses for all participants was conducted by reviewing video recordings on a daily basis. Each discrete trial teaching (DTT) session was divided into intervals per trial. For each interval, data were recorded on the following components: (a) the number of opportunities for the participant to mand; (b) the number of times a participant manded; (c) the number of MC and MO-controlled mands; (d) the type of targets (e.g., edible, object or activity) for which the student manded; and (e) the number of times each participant was allowed to access a target (preferred) item as a reinforcer. The raw data, as recorded on the data sheets, were transferred to an electronic spreadsheet (e.g., Excel) to create a visual graph of the behavioral pattern. The lead investigator for this study served as the primary data coder.

Interobserver Agreement

To ensure the integrity of measurement of the dependent variables, interobserver agreement (IOA) was collected for 30% of all observations across various experimental conditions. One additional (secondary) data coder naïve to the purpose of the study, received up to 4 hours of hands-on-training in the specific data collection procedures required for recording the occurrence and non-occurrence of target responses related to this study. The data coder was a doctoral student in the Autism Intervention program and a board certified behavior analyst with ample experience in working with individuals with autism. Additionally, the secondary data coder was also trained to collect daily data on the teaching procedures implemented by teachers, however, she was not informed that these procedures constituted procedural fidelity. Reliability assessments on procedural integrity of the intervention were conducted by the primary observer. Data collection training and practice sessions continued until three consecutive sessions
demonstrated an agreement of 90% or higher between both observers for each participant in the study.

In order to calculate IOA, data collected by both observers was compared on a trial-by-trial basis for each 15-min session for the study. When both coders recorded the mand as being evoked by the same controlling variable (MC or MO-controlled) during a specific trial, it was noted as an agreement (+). A disagreement (-) was noted when both observers failed to record the same controlling variable (i.e., one notes MC and the other notes MO) during the same trial. The formula used to calculate IOA consisted of dividing the agreements by the sum of agreements plus disagreements and multiplying by 100 in order to generate a percentage. The outcomes of IOA for spontaneous mands are as follows: Praveen ($M = 99\%$; range = 92–100%), Angel ($M = 99\%$; range = 92–100%), Danesha ($M = 96\%$; range = 85–100%), and Vanessa ($M = 91\%$; range = 79–100%).

Additionally, in order to assess the degree of agreement between observers on MO and MC mands, Krippendorff’s alpha ($\alpha$) and percent agreements were calculated for each individual participant and overall for the group (see Table 2). As shown, for the overall Krippendorff’s $\alpha$ indicated near perfect agreement ($\alpha$s ranging from .95 to .99; percent agreement ranging from 94.7 to 95.3). Similarly, agreement for each of the individual participants was also near perfect ($\alpha$s ranging from .85 to 1.00 percent agreement ranging from 84.8 to 97.3). Overall, this suggests is that both observers tended to reported similar frequencies of observed child behaviors for both MO and MC mands.
### Table 2

*Summary of Inter-rater Reliability (IRR)*

<table>
<thead>
<tr>
<th></th>
<th>Krippendorff’s α</th>
<th>% Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Sample</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MC Mands</td>
<td>.95</td>
<td>95.3</td>
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<tr>
<td>MO Mands</td>
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<td>94.7</td>
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<tr>
<td>Combined</td>
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<tr>
<td><strong>Angel</strong></td>
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<tr>
<td>MC Mands</td>
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</tr>
<tr>
<td>MO Mands</td>
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</tr>
<tr>
<td>Combined</td>
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<tr>
<td><strong>Daneesha</strong></td>
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<tr>
<td>MC Mands</td>
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</tr>
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<td><strong>Praveen</strong></td>
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<tr>
<td>MC Mands</td>
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<td>MO Mands</td>
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<td>Combined</td>
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<tr>
<td><strong>Vanessa</strong></td>
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<tr>
<td>MC Mands</td>
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<td>MO Mands</td>
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<td>88.4</td>
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<tr>
<td>Combined</td>
<td>.98</td>
<td>85.9</td>
</tr>
</tbody>
</table>

*Research Design*

A single subject multiple baseline design across participants (Gast, 2012) was used to demonstrate a functional relation between the use of a stimulus control transfer procedure (independent variable) and the acquisition of spontaneous mands (dependent variable). The design demonstrated data for three phases including baseline, intervention, and generalization.
Experimental Procedures

Instructional Context

The instructional context for teaching spontaneous manding constituted the use of discrete trial teaching, errorless learning, and a schedule of reinforcement.

Discrete Trial Teaching

Discrete trial teaching (DTT) consisted of an instructional session during which trials specific to learning objectives on the IEP were presented to the student. The learning objectives were varied throughout the session, meaning the teacher presented a variety of tasks related to different verbal operants appropriate for each individual student. For example, one student had IEP objectives with tacting targets (labeling), intraverbal targets (“A cow says ____”), and manding targets (requesting). Additionally, within a direct instruction session, the teacher interspersed difficult objectives (i.e., those that had not been mastered) with easier objectives (i.e., those already mastered). Theoretically, interspersing of a higher number of easy (mastered) objectives with a fewer number of difficult (acquisition) objectives allows the student to access reinforcement more frequently and helps to maintain motivation to participate in the teaching session (Volkert, Lerman, Trosclair, Addison, & Kodak, 2008). In effect, a dense schedule of reinforcement abolishes the motivation to engage in escape-maintained problem behavior (Michael, 1988).

Errorless Teaching

During the course of the DTT session, the instructor implemented errorless teaching procedures. Specifically, when teaching a new objective, the instructor delivered the SD (e.g., “touch the book”) and immediately prompted the correct response and delivered the reinforcer. The teacher immediately presented another trial (“touch the book”) in an attempt to get a less
prompted response. If the student responded correctly the teacher provided a reinforcer of a larger magnitude than the previous prompted response (e.g., more enthusiastic praise, larger piece of a food item, etc.). Over time, the teacher systematically faded the prompts associated with teaching the objective until the student was able to produce an unprompted response.

Highly preferred items (as determined by teacher data) were used only for the purpose of delivering reinforcement, not for the purpose of instruction. Therefore, if chips, video, and ball were all highly preferred items, the teacher did not design teaching trials that required the student to tact these items, respond to intraverbal responses using the name of any of these items, or receptively identify any of the items. They were used strictly as reinforcers during the experimental session of this study. They were not used as reinforcers for teaching activities outside the DTT sessions for the study in order to retain the motivation value of the reinforcers (Michael, 1988).

Schedule of Reinforcement

Because reinforcement is an integral component of the DTT process, it was critical that the amount and type of reinforcement be consistent for each participant across all experimental phases, including baseline. This was to ensure that the amount or type of reinforcement did not present itself as a confounding variable. The number of opportunities to mand (followed by reinforcement) during the baseline phase were counted for each participant and the same number of opportunities were presented consistently across all experimental phases. For example, if baseline data revealed that a participant had an average of nine opportunities to mand (and receive a reinforcer) per session, an average of nine opportunities per session was maintained throughout the intervention phase for that participant. Maintaining a consistent schedule of
reinforcement across phases for each participant reduced the threat to internal validity where the schedule of reinforcement could act as a confounding variable.

Baseline

The instructional context in baseline constituted the teaching sessions as described above. During baseline, the items identified as highly preferred targets (documented in data collected by the teacher prior to the beginning of the study) were removed from the view of the participant (but accessible to the teacher) but other reinforcers or less preferred items (e.g., crackers) were visible to the student. If a participant manded for a visible item, it was recorded as a MC mand. If a participant manded for an invisible item, it was recorded as a MO mand. This set-up allowed for measurement of both, MC- and MO-controlled mands. The occurrence of MO-controlled mands for each item were recorded daily during two separate Direct Instruction (DI) sessions, across at least five concurrent sessions for all participants in order to evaluate the behavioral pattern. The number of days for baseline varied across participants. During the DTT sessions, correct responding was reinforced with access to low preference items and activities that had not been selected as targets unless a participant manded for them without being prompted. With parent cooperation, access to target items was limited to delivery at school during the experimental sessions only in order to maintain the reinforcing value of each item. Although the teaching sessions in baseline were identical to those in the intervention phase, no intervention procedures in the form of a stimulus control transfer procedure was implemented during baseline.

Intervention (Stimulus Control Transfer Procedure)

The instructional context for intervention was the same as baseline with the exception of availability of high preference items as reinforcers for correct responding, and utilizing the time
delay and prompt fading procedures noted by Sweeney-Kerwin et al. (2007). At the beginning of the first intervention session, one most highly preferred targeted item was shown to the student for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three) to indicate availability of the item as a reinforcer. As soon as the item was removed from the student’s view, the DTT session began. When a student responded correctly during a trial and an opportunity to access a reinforcer was available, the teacher initially presented the item for about 3-s without an accompanying verbal prompt. If the student manded for the item within 15-s, a small portion of the item (e.g., piece of cookie, chip, or viewing video for 15-s seconds) was delivered immediately and the student’s response was recorded as a MC mand. Following the delivery of the requested item, the teacher implemented a 2-min time delay during which time the target item was removed from the participant’s view (by hiding it under the table). If the participant manded for the displayed item after 15-s and during this time delay, the response was recorded as MO-controlled and reinforced immediately. If a MO-controlled mand did not occur by the end of the 2-min interval, the item was shown again (for 3 seconds) as a prompt for the mand. If the participant manded for the item, s/he was provided with access for 15-s and the next 2-min time delay was initiated.

During the second and all subsequent intervention sessions, the target item was not displayed for the first 5 minutes of the 15-min DTT session (i.e., inserted time delay + prompt fading as noted by Sweeney-Kerwin et al., 2007). This provided each participant the opportunity to request the item without the presentation of a prompt. If the participant manded for the item during the allotted 5 minutes, the response was immediately reinforced and stimulus-control transfer from a MC mand (i.e., presence of the item) to an MO-controlled or spontaneous mand (i.e., item out of view) was considered to have occurred. The addition of this component ensured
that the interventionist did not provide unnecessary visual prompts by displaying the item and thereby potentially promoting dependence on the presence of the prompt. For the remainder of the 15-minute session, the item was not displayed at all and as a result, only MO-controlled mands for the specific high preference item occurred. However, if the participant manded for a visible low preference item, it was delivered but was recorded as a MC mand. If a participant did not request the item during the first 5 minutes of the session, the item was displayed (for 3 seconds) and the time delay and prompt fade procedures (as described above) were implemented for the rest of the session.

When Participant 1 began to emit MO-controlled mands at a steady, stable and higher rate than baseline, intervention was implemented with the second participant. These procedures continued to be implemented until each participant had been exposed to all targeted items during the intervention phase. When the frequency of occurrence of MO mands for one target was high and stable, a new target item (next in rank order of preference items) was introduced. Data from this phase addressed Research Question 1.

Generalization Across Targets

Following the intervention phase, if a participant emitted MO controlled mands at rates significantly higher than baseline (at least 50% higher and minimal overlap in data), generalization across untrained targets was evaluated for that participant. Generalization was assessed in a natural setting during which the participants were engaged in either small group activities (e.g., art project) or whole class routines (e.g., morning snack). This was to evaluate the extent to which participants spontaneously manded for trained or untrained targets as a function of the stimulus control transfer procedure (addresses Research Question 2). The stimulus control transfer procedure utilized during the intervention phase was not implemented
in this phase in order to assess for response generalization. Any item, object or activity regardless of preference (high or low), that was used in baseline or intervention was categorized as a “target” or “trained target” and the ones not used previously were categorized as “non-target” or “untrained target.” Data were recorded on the frequency of MO mands for trained or untrained targets to evaluate the extent to which response generalization was observed.

Training of Interventionists

The lead investigator for this study has a bachelor’s degree in special education and a master’s degree in special education (autism). Additionally she is currently enrolled in a PhD program at a local university. She had completed all the coursework required for the board certified behavior analyst certification and is working on accumulating supervision hours. She had worked in the field of special education for the last 28 years as a classroom teacher, consulting teacher, autism specialist, and special education administrator. In her current role, she is responsible for the supervision of special education teachers and the delivery of evidence-based practices for students with autism.

The classroom teacher for each participant served as the interventionist for this study. Most classroom teachers in the autism program in this school district are well-trained in the use and implementation of the principles of applied behavior analysis and verbal behavior. Even though none of the teachers were board certified behavior analysts, they did benefit from consultations provided to the school district teachers by Dr. Vincent Carbone prior to the initiation of the study.

Praveen’s teacher has a bachelor of arts degree in law and justice and is alternatively certified to teach special education (EC-12, Generalist EC-6). Through attendance at workshops and trainings she had acquired over 30 hours of instruction related to applied behavior analysis,
verbal behavior, and teaching children with autism. She had completed 7 years as a special education classroom teacher.

Angel’s teacher has a bachelor of arts degree in psychology and a master’s degree in special education (autism). She had completed the required coursework related to the board certified behavior analyst certification. She had completed her seventh year of teaching students with special needs.

Daneesha’s teacher has bachelor of arts degree in psychology and a master of science degree in education with an emphasis in early childhood education and autism. She had attended numerous trainings related specifically to teaching children with autism, including a 3-day training (18 hours) with Dr. Vincent J. Carbone prior to initiating the study. She had completed her ninth year of teaching students with special needs.

Vanessa’s teacher has a bachelor of arts degree in sociology and is certified to teach special education (EC-12, Generalist EC-6). She had attended numerous trainings related specifically to teaching children with autism and had completed 2 years of teaching students with special needs.

Each classroom teacher (i.e., interventionist) was provided with specific training in the implementation of time delay combined with prompt fading procedures for the purpose of this study. In order to provide the interventionists with the necessary skills to implement the intervention with fidelity, a detailed script depicting the step-by-step procedures was used. Specifically, the interventionists individually received approximately three hours of training across three, 1-hour sessions prior to intervention for each participant.

The training for each interventionist was conducted in his/her classroom by the lead investigator with a student who was not participating in the study. This training corresponded
with the phase change for each participant from baseline to intervention. Each training session consisted of a review of the terminology and daily data collection procedures for their student, modeling of the time delay procedures, role play of the intervention procedures by the interventionists with the lead investigator, corrective feedback, and an opportunity for the interventionists to practice the procedure following feedback. Each training opportunity ended with a required demonstration of the skills taught during the session to determine the skill level of each interventionist.

Interventionists were required to demonstrate 100% mastery in the implementation of the intervention procedure (i.e., prompt fade and time delay) as measured by successful completion of each step of the intervention protocol in the correct order across three consecutive training sessions. Training continued until all interventionists demonstrated mastery. Mastery was achieved after an average of two training sessions per interventionist.

Fidelity of Implementation

Treatment integrity was recorded by the secondary observer and reliability sessions were conducted by the primary observer (or lead investigator) in order to minimize the probability of observer drift and potential bias. Observers viewed the videotaped data of DTT sessions and recorded interventionist behaviors as described in the script for implementation of intervention. This script was converted into a fidelity checklist with notations made for whether or not the specific procedures were implemented accurately and sequentially by each interventionist (see Appendix B). When interventionists missed specific steps from the checklist (e.g., turning on the timer or limiting reinforcer access to 15-s), the lead investigator conducted retraining sessions. These prompts occurred during the early stages of the intervention. Treatment integrity data were recorded for approximately 30% of intervention sessions for each participant.
Script to Ensure Fidelity of Implementation of Intervention—Stimulus Control Transfer Procedure

Session 1:

1. At the beginning of the first 15-minute Direct Instruction (DI) session conducted during the Intervention Phase, display any one of the previously selected targets (e.g., edible item, activity, or object) for 3 seconds (for a vocal count of three—one thousand one, one thousand two, one thousand three). Remove the target out of view of the participant by placing it under the desk.

2. Begin the DI session with scheduled instruction for the IEP objective. During any of the instructional trials:
   a. If the participant mands for the edible/object/activity (sign or vocal) within 15 seconds of the target being displayed (in Step 1), immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record the child’s behavior as a MC mand. Remove the target out of view of the participant by placing it under the desk.
   b. If the participant mands for the edible/object/activity (sign or vocal) after 15 seconds of displaying the target, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record the child’s behavior as a MO mand. Remove the target out of view of the participant by placing it under the desk.

3. Following either a MC mand or a MO mand, set the timer for 2 minutes and begin the 2 minute time delay. Continue with DI session. The target is still out of view.
a. If the participant mands for the edible/object/activity (sign or vocal) during the 2 minute time delay, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset timer for 2 minutes and start the next time delay.

b. If the participant does not mand for the edible/object/activity (sign or vocal) during the 2 minute time delay, display the target again for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three) by raising it from under the desk to the eye level of the child. Following the display of the target, if the participant mands for the edible/object/activity (sign or vocal) within 15 seconds after the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record the child’s behavior as a MC mand. If the participant mands for the target after 15 seconds or more following the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset the timer for 2 minutes and start the next time delay.

4. Continue with this procedure for the duration of first 15-minute Direct Instruction (DI) session conducted during the Intervention Phase.

Session 2 and all subsequent intervention sessions:

1. Beginning with Session 2, and all remaining sessions in the Intervention Phase, the target item will not be displayed for the first 5 minutes.
2. Begin DI session with scheduled instruction for the IEP objective. During any of the instructional trials:
   a. If the participant mands for the target item during this 5 minute period:
      i. Immediately deliver target (edible item = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds)
      ii. Record as MO mand
      iii. Continue with DI session
      iv. The target remains out of view for the remainder of the session
   b. If the participant does not mand for the target during this 5 minute period:
      i. Display the target at the end of the 5 minute period;
      ii. If the participant mands for the edible/object/activity (sign or vocal) within 10 seconds of the target being displayed, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MC mand. Continue with DI session with target out of view.
      iii. If the participant mands for the item/object/activity (sign or vocal) 15 seconds after the display of the target, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Continue with DI session with the target out of view.

3. Following either a MC mand or a MO mand, set the timer for 2 minutes and begin the 2 minute time delay. Target is out of view.
a. If the participant mands for the edible/object/activity (sign or vocal) during the 2 minute time delay:
   i. immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds);
   ii. record as a MO mand;
   iii. reset timer for 2 minutes and start the next time delay.

b. If the participant does not mand for the edible/object/activity (sign or vocal) during the 2 minute time delay:
   i. display the target again for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three);
   ii. following the display of the target, if the participant mands for the edible/object/activity (sign or vocal) within 15 seconds after the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds);
   iii. record as a MC mand;
   iv. If the participant mands for the target after 15 seconds or more following the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset the timer for 2 minutes and start the next time delay.

4. Continue with this procedure for the duration of the session.

The outcomes for procedural fidelity are as follows: Praveen (M = 95%; range = 88–100%), Angel (M = 94%; range = 64–100%), Daneesha (M = 95%; range = 75–100%), Vanessa
(\(M = 100\%\)). When fidelity of implementation rates dropped below 90% on any given session, the lead investigator conducted additional training with the interventionist. Additionally, consistent and frequent contact (e.g., emails, phone calls, text messages, classroom visits) between the lead investigator and the interventionists was maintained throughout the study to ensure procedural fidelity.

**Social Validity**

In order to determine the consumer satisfaction and acceptability of the intervention procedures from the perspective of stakeholders, a brief teacher and parent survey was administered after experimental sessions were completed. Social validity measures for teachers provided information on the extent to which they were satisfied with the technical aspects of the intervention and the relevance of the outcome for their students. Similarly, information from parents helped determine the extent to which they valued the outcome and whether or not spontaneous manding made any difference to the quality of life of their children. A detailed response to the questions on the social validity measure is presented in Table 3.

The questionnaires completed by all four interventionists and indicated strong agreement with the acceptability and the ease of implementation of intervention procedures. Agreement and strong agreement was indicated by the interventionists in the areas related to increased access to reinforcement by the participants and use of these procedures with other students in the future (see Appendix C). The questionnaires were completed by only two of the four parents. Two indicated agreement and strong agreement regarding the acceptability and outcomes of the study. Perhaps most importantly the results of the questionnaire indicated that the parents believed that their child’s participation in the study had improved their life, either directly or indirectly (see Appendix D; see Appendix E for Detailed Methodology).
### Social Validity Results – Teacher

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning to request items that are not present has resulted in increased access to reinforcement for the participant</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>“now that he can ask for things out of view rate of manding has increased”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“she isn’t limited to just items on the table”</td>
</tr>
<tr>
<td>The procedures used in this study are acceptable to me on a personal and professional level</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>“same types of procedures I’m already using just in a different combination”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“I felt very comfortable implementing these procedures”</td>
</tr>
<tr>
<td>The procedures used in this study were easy to understand and implement</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>100%</td>
<td>“Very easy”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“They fit right into my DI sessions”</td>
</tr>
<tr>
<td>I will use these procedures with other students in the class who were not included in the study</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
<td>“Absolutely!”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“I have at least 2 other students I can’t wait to use this with”</td>
</tr>
</tbody>
</table>

*(table continues)*
Table 3 (continued).

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Undecided</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation in this study has resulted in my child being able to spontaneously mand (request items out of view)</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Learning to request items that are not present has resulted in increased access to reinforcement for my child</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>The procedures used in this study were acceptable to me</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>My child’s participation in this study has improved my life, either directly or indirectly</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Results

The video data were coded, graphed and analyzed concurrently with data collection for each participant using the scientific principles of visual analysis typical of single subject research methodology. Visual analysis was used to determine the existence of a functional relation between the independent and dependent variables and to specifically determine the stability of the behavioral pattern, change in the level of performance and the direction of the trend line. Additionally, effect size was computed to obtain a measure of the magnitude of effect of the intervention on the dependent variable. Results are discussed in relation to the specific research questions.

Stimulus-Control Transfer Procedure and Rate of Spontaneous Manding

As predicted, baseline data for Praveen showed zero rates of spontaneous manding across five consecutive sessions. Given a stable behavioral pattern, intervention was initiated with Praveen starting Session 6. Data showed that he did not immediately respond to intervention and demonstrated a variable pattern of behavior. However, starting Session 17 (i.e., 12th intervention session), Praveen showed a steady increase in the level of MO mands in spite of variability in the pattern. It should be noted that Praveen was absent from school for 10 days during the intervention phase due to ill health. During intervention, Praveen was taught to spontaneously mand with two targets (i.e., marble, nut). In addition to these two trained targets, Praveen spontaneously manded for nine (82%) untrained targets (i.e., car, ball, train, play doh, movie, puzzle, airplane, water, popcorn, cookie, and chip) for the first time during intervention. When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 6.4$; Mdn = 5; range = 0–19) was observed during the intervention phase. Overall, the stability envelope indicated that higher than 80% of the intervention data were within 20% of the median indicating
overall stability (Gast, 2012). The percentage of overlapping data was minimal ($POD = 14\%$; $PND = 86\%$) and not observed after Session 13. Overall, Praveen’s data ($M = 6.4$ MOs per 15-min session) appear to indicate an increase in spontaneous manding as a function of the intervention.

The data on MC mands for Praveen indicated a higher rate during baseline ($M = 9.2$; Mdn = 9) when compared to the rate of MO mands ($M = 0$). Conversely, following the introduction of intervention, data indicated a reduction in the rate of MC mands ($M = 6.5$; Mdn = 6) while a concurrent increase in MO manding ($M = 6.34$; Mdn = 5) was observed.

Following an increasing trend in response to intervention for Praveen, intervention was initiated with Angel. Data showed that he did not immediately respond to intervention either, demonstrating a variable pattern of behavior for the first few sessions. However, starting at Session 24 (i.e., sixth intervention session), Angel showed a steady increase in the level of MO mands in spite of variability in the pattern. Angel was taught to spontaneously mand during intervention using one target (i.e., doodle). However, as early as the third intervention session, Angel spontaneously manded for untrained items (i.e., iPad, book) and continued to emit MO mands for nine other untrained targets (i.e., coke, puzzle, chip, play doh, song, yellow, headphones, cracker, candy) during this phase. All of the untrained targets (100%) were requested for the first time during the intervention phase. When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 9.7$; Mdn = 11; range = 0–23) was observed during intervention. The minimally overlapping data ($POD = 10\%$; $PND = 90\%$) and a steadily increasing trend indicated the effectiveness of the intervention. A decrease in the rate noted in Session 26, may have been due to the occurrence of negatively reinforced (i.e., escape) problem behavior.
Angel’s baseline data demonstrated higher rates of MC mands ($M = 10.7; \text{Mdn} = 11$) when compared to rate of MO mands ($M = 0$). During intervention, an increase in MO mands ($M = 9.7; \text{Mdn} = 11$) resulted in a corresponding decrease in the rate of MC mands ($M = 2.6; \text{Mdn} = 0$).

Following an increasing trend in the pattern of spontaneous mands for Angel and zero rates for Daneesha during baseline, intervention was initiated with her. Following the introduction of the intervention, rates of spontaneous manding increased slightly ($M = 1.6; \text{Mdn} = 1$) over baseline rates ($M = 0$). Even though a dramatic increase in MO mands was observed during the first session of the intervention phase, Daneesha did not maintain high rates of spontaneous manding during this phase, showing a high percentage of data overlap ($POD = 43\%$). The rate of MC mands ($M = 16.6; \text{Mdn} = 15.5$) was significantly higher than MO mands ($M = 0$) during baseline. Following intervention, the rate of MC mands decreased ($M = 5.9; \text{Mdn} = 5.6$) but MO manding rates ($M = 1.6; \text{Mdn} = 1$) did not concurrently increase as predicted. Because Daneesha did not reach the criterion for acquisition rate of MO mands (i.e., 50% higher than baseline), intervention was discontinued with her, the generalization phase was not evaluated either, but intervention was initiated with the last participant, Vanessa.

Vanessa did not immediately respond to intervention as demonstrated by a variable pattern of behavior. However, starting in Session 64 (i.e., the sixth intervention session), she showed a steady increase in the level of MO mands in spite of a variable pattern. During intervention, Vanessa was taught to spontaneously mand on one target (i.e., dinosaur). However, Vanessa began to spontaneously mand for six (71%) other untrained targets (i.e., people, candy, chocolate, cookie, drink, spider) for the first time during intervention. When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 9.1; \text{Mdn} = 3.5; \text{range} = 0–29$)
was observed during intervention. The minimal amount of overlapping data ($POD = 29\%$; $PND = 71\%$) and an increasing trend appear to indicate the effectiveness of the intervention.

Baseline data for Vanessa demonstrated a higher rate for MC mands ($M = 7.7$; $Mdn = 7$) compared to MO mands ($M = 0$). Following the introduction of intervention, the manding rates were reversed (MC, $M = 4.3$; $Mdn = 4$; MO, $M = 9.1$; $Mdn = 3.5$; see Figures 1 and 2).

![Figure 1. Frequency of MC controlled mands for all participants.](image)
As predicted, participants began to spontaneously mand for untrained targets at a higher rate when compared to relatively lower rates for trained targets (see Table 4).

Figure 2. Frequency of MO controlled mands for all participants.

Trained and Untrained MO Mands During Generalization
Table 4

*Trained and Untrained Mands*

<table>
<thead>
<tr>
<th></th>
<th>MC Trained</th>
<th>MC Untrained</th>
<th>MO Trained</th>
<th>MO Untrained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Praveen</td>
<td>2</td>
<td>20</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Angel</td>
<td>1</td>
<td>12</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Daneesha</td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Vanessa</td>
<td>1</td>
<td>14</td>
<td>1</td>
<td>7</td>
</tr>
</tbody>
</table>

During generalization, Praveen manded for both trained and untrained targets, providing a demonstration of response generalization. Additionally, stimulus generalization was demonstrated through spontaneous mands across multiple environments (i.e., classroom and speech therapy) and instructors (i.e., teacher, speech therapist, and paraprofessional). According to the classroom teacher, Praveen continued to spontaneously mand for trained and untrained targets with multiple staff members long after the study concluded. At the beginning of the next school year, Praveen’s teacher reported that he had maintained the ability mand for items out of view following the summer break during which time he received no formal intervention. Finally, the generalization data for Praveen demonstrated lower rates of MC mands ($M = 0$) while rates for MO mands continued to increase ($M = 7.8; \text{Mdn} = 8$).

Data for Angel showed response generalization in the form of spontaneous mands for untrained targets and stimulus generalization in the form of manding with multiple staff members (i.e., classroom teacher, paraprofessional). His classroom teacher reported that Angel continued to request a variety of items that were out of view in the classroom environment.
Finally, data during the generalization phase indicated the rate of MO mands ($M = 7$; Mdn = 6) remained higher than the rate of MC mands ($M = 1.2$; Mdn = 0).

Along with response generalization (i.e., manding for untrained targets), Vanessa also demonstrated stimulus generalization by spontaneously manding for trained and untrained targets across multiple instructors (i.e., teachers, paraprofessional) during generalization. Vanessa attended a special education summer school program between the conclusion of the study and the beginning of the next school year. Her summer school teacher reported that Vanessa spontaneously manded for items out of view with a variety of staff members. Additionally, when taught a new mand for unfamiliar items she was often observed to spontaneously use the new mand to gain access to the item when out of view. During generalization, MC manding rates ($M = 1.25$; Mdn = 1) continued to decrease and MO manding rates ($M = 9.6$; Mdn = 8.5) increased.

Effect Size of the Magnitude of Intervention on Spontaneous Mands

Effect size, recently recognized as a critical component of single-subject research in determining magnitude of effect (Horner & Kratochwill, 2012; Kratochwill et al., 2013), was calculated for spontaneous mands for all participants across baseline and intervention phases using Cohen’s $d$ index. The effect size for three participants are large [Praveen ($d = 1.94$); Angel ($d = 2.2$); and Vanessa ($d = 1.4$)], whereas the outcome of intervention for Daneesha ($d = 0.98$) indicated moderate effect. However, the overall ($d = 1.15$) outcome demonstrated a large effect (see Appendix F for Unabridged Results).

Discussion

Results of this study appear to indicate the effectiveness of implementing a stimulus control transfer procedure for three of four participants on the frequency of spontaneous mands
in children with autism (Research Question 1) and generalization of mands to untrained targets (Research Question 2), environments and staff members. Results indicated a demonstration of a functional relation between the independent and dependent variables for three of four participants. Even though the effect size for one participant (i.e., Daneesha) showed moderate effect, visual analysis of the data showed that the intervention did not indicate a clinically significant outcome. This section will discuss the findings of the study, implications for practice, limitations of the study, and directions for future research.

**Spontaneous Mands**

A spontaneous manding repertoire in a child with autism generally requires direct and intense instruction (Charlop-Christy, et al. 2002; Sundberg, 2004). Research has demonstrated that the use of behavior analytic procedures such as prompting, prompt fading and time delay are effective in transferring the control of a mand from a vocal or visual prompt to a mand that is spontaneously produced as the result of motivation (Cooper et al., 2007; Sweeney-Kerwin et al., 2007; Wolery & Gast, 1984). The development of a spontaneous manding repertoire has been shown to decrease rates of problem behavior, allow more effective and efficient control of the environment, and provide children with increased social opportunities (Charlop-Christy, et al., 2002; Shafer, 1994).

The results of the current study demonstrated moderate effect for one participant and large effects for three participants based on visual analyses and effect size. Similar results were reported by Carr and Kologinsky (1983) when the use of prompt and prompt fading procedures resulted in the acquisition of spontaneous mands by six children. Learned behaviors were also shown to generalize across untrained listeners. However, the one major difference between the current study and the study by Carr and Kologinsky (1983) has to do with the operational
definition of the dependent variable. Carr and Kologinsky (1983) defined spontaneous mands as requests in the presence of an adult that did not require an imitative prompt. In the current study, spontaneous mands were defined as requests that occurred only in the presence of the MO and a listener (Sundberg, 2004), and the participant had to engage with the item providing evidence of motivation (Sweeney-Kerwin et al., 2007). This definition verified that the high rate of mands for three of four participants was related to the motivational value of the item rather than just the presence of an adult.

Similar to the results of the current study, Endicott and Higbee (2007) also reported that the participants acquired the mands (for information) quickly and generalized the skill across items, settings, and people. In addition to the use of behavior analytic procedures, the common component found across these studies was the presence of a strong MO. As noted previously, a manding repertoire cannot be acquired in the absence of motivation, thus requiring the interventionist to ascertain not only the presence but the strength of the MO during instruction (Sundberg, 2004). Strong MOs were established and maintained throughout the current study by limiting access to highly reinforcing items to intervention sessions only.

All of the children in this study demonstrated zero levels of spontaneous manding during baseline prior to the introduction of intervention. Implementation of the stimulus control transfer procedure indicated that the intervention led to an overall increase in the total number of spontaneous mands for three of the four participants. The lack of predicted responding by one participant (i.e., Daneesha) was initially believed to be a function of a lack of response efficiency. In other words, magnitude of the reinforcer may not have matched the effort required to produce a spontaneous mand. However, increasing the amount of time Daneesha was allowed access to the item from 15-s to 60-s still did not improve the rate of manding.
In addition, data on procedural fidelity showed that Daneesha’s teacher implemented the intervention procedures with integrity ($M = 95\%; \text{ range} = 75–100\%)$. This suggests that lack of clinical effect was not due to compromises in the fidelity of implementation of intervention procedures. In fact, she continued to show a higher rate of MC mands during intervention until Session 38. In an attempt to increase MO mands, all preferred and non-preferred items were completely removed from the instructional context but it resulted in lower rates of MC mands during sessions 39 to 52. It was determined that Daneesha’s behavior was controlled by vocal or visible prompts and she may not spontaneously mand at this point in time.

No clinically significant outcome for Daneesha may be attributed to a slower rate of acquisition across all areas of instruction when compared to the other participants. She received the highest number of intervention sessions (35) compared to other participants. Additionally, she frequently “scrolled” through her repertoire of signs when attempting to request an item, indicating either a weak manding capacity or dependency on a prompt from the teacher.

Although research-based interventions offer educators the most reliable means of achieving improved outcomes for students, sometimes even the most effective interventions are not likely to improve the performance of non-responders (Cook & Cook, 2011; Cook & Odom, 2013).

The goal of any applied research is to facilitate generalization of behavior to non-trained settings. In the current study, three of the four participants began to very quickly and spontaneously mand for untrained items during intervention. Praveen manded for an untrained item as early as the fifth intervention session, Angel began spontaneously manding for untrained items in the third session, and Vanessa’s first spontaneous mand for an untrained item came in the seventh intervention session. Based on these results, the generalization phase consisted of
measuring spontaneous mands across environments and people rather than just trained and untrained targets.

The current study extends the results of the Sweeney-Kerwin et al. (2007) study in at least two ways. First, Sweeney-Kerwin et al. (2007) reported a lack of response generalization given that participants failed to spontaneously mand for items that had not been exposed to the intervention procedure. As previously discussed, response generalization was observed for three participants during the intervention phase in the current study. Secondly, Sweeney-Kerwin et al. (2007) noted that generality of their findings was limited by the use of only edible items as reinforcers. The current study demonstrated the effects of a stimulus control transfer procedure on MOs related to reinforcing items other than food (e.g., train, car, iPad, people, dinosaur, etc.). One additional finding of the study as reported by the classroom teachers indicated an unplanned reduction in prompt levels used to evoke mands. A verbal prompt by the teacher to indicate the opportunity to mand (e.g., “What do you want?”) was present prior to the beginning of the study and was observed often during baseline.

Anecdotally the interventionists reported that the need for the verbal prompts faded automatically as participants began to spontaneously mand more frequently. The teachers reported that they simply paused and participants manded, or when motivation was strongest they made the request before the pause occurred. It is possible that the three participants in the study demonstrated response generalization because of the use of multiple exemplars as opposed to the use of food items alone as reinforcers. Participants appear to have learned that they could mand for preferred items, objects and activities not only during the instructional sessions but also during other routines like snack-time, small group projects, and speech therapy. One participant
(i.e., Angel) even showed untrained extensions to the original mand (e.g., instead of asking for play-doh, he asked for yellow play-doh).

Finally, compared to previous research designed to teach manding to individuals with autism, this study appears to meet all the criteria for high quality research described by Reichow et al. (2011). Specifically, this study includes all of the primary quality indicators for single subject experimental designs. A table listing participant characteristics that provided information related to age and gender, diagnoses, characteristics of interventionists, and standardized tests and test scores was included. The independent variable was defined in such a way that seems to make replication possible and was accompanied by a detailed script. Similarly, the dependent variable was well-defined and linked to the measures used within the study. The baseline condition was operationally defined and contained more than three data points that appeared to be stable with no trend. Visual analysis revealed stable data with less than 25% overlap between adjacent phases for three participants while demonstrating a change in behavior pattern following the implementation of the intervention. Finally, the study contained three demonstrations of experimental effect resulting from manipulation of the independent variable at different points during the study. Additionally, the study also meets all secondary quality indicators for single subject experimental designs.

Implications for Practice

The importance of a spontaneous manding repertoire in children with autism has been well documented (Bondy, Tincani & Frost, 2004; Carr & Kologinsky, 1983; Sautter & LeBlanc, 2006). However, this skill requires direct intervention. As demonstrated by the current study, only when manding came under the control of the MO and a listener were the participants able to gain access to a larger variety of reinforcing items and activities. Intervention programs for
children with autism may want to include such procedures as a part of their professional
development training for teachers of children with autism. Additionally, incorporating the
stimulus control transfer procedure into individual direct instruction programs for students whose
manding repertoire is considered to be controlled by the presence of the item or a prompt
provided by the instructor may be warranted.

Bridging the research to practice gap has been a motivating component from the
beginning of this study. One specific focus was on demonstrating the efficacy of interventions in
public school classrooms that had previously been implemented in clinical settings with highly
trained personnel. As noted, this study was conducted in a public school with the classroom
teachers serving as the interventionists. Comments from the teachers indicated they found the
procedures easy to implement and professionally acceptable and that they would use them with
other students who had not participated in the study. It should also be noted that the parents who
responded to the questionnaire also indicated satisfaction with the results of the study and
believed their lives had been improved because their child participated in the study. While not
only contributing to the work linked to bridging the research-to-practice gap, these components
(i.e., location in public school and use of teachers as interventionists) also demonstrate a high
degree of social validity.

In their list of primary quality indicators of single subject experimental designs, Reichow
et al. (2011) specifically note that independent variables must be defined in such a way that
replication is possible. The teachers in this study were trained to use a script that outlined each
step of the intervention phase in detail. Not only did the script ensure procedural fidelity of this
study it also provided future researchers with the necessary information for replication, another
step in bridging the research-to-practice gap. The use of a detailed script is a crucial component
that practitioners will want to consider when incorporating a stimulus control transfer procedure into their intervention programs.

Finally, behavior analytic principles used to teach children with autism to mand have been well-established as evidence based practices. However, as suggested by Cook and Odom (2013), outcomes related to evidence-based practices are not the same for every child. This study demonstrated that student profiles are an integral component in determining who will benefit from specific interventions and suggests that participants who require very few trials to acquire new information and have a strong manding repertoire are most likely to benefit from these types of procedures. This information will be important for teachers and interventionists to consider when assimilating these procedures into classrooms and individual programs in order to ensure the best use of instructional time for students.

Limitations of the Study

A single-subject research design (Gast, 2012) was used in this study to determine the functional relation between a stimulus control transfer procedure and the frequency of spontaneous mands. A characteristic of single-subject research includes small samples sizes and although this study meets criteria for the number of participants in a multiple baseline design (Reichow et al., 2011), potential limitation to external validity may exist due to limited small number of participants (Gast, 2012).

An additional limitation of the study was that maintenance data were not collected following the generalization phase because of the end of the school year and participants were no longer available. However, anecdotal reports from the summer Extended School Year program for some of the participants indicated maintenance of learned mands and generalization to a new location with new staff members.
Directions for Future Research

The ability to spontaneously make requests in order to get needs and desires met can significantly enhance the quality of life for individuals with autism. Therefore, it is critical that future research focus on determining the most efficient and effective components of teaching spontaneous mands to children with autism.

This study was conducted in public school classrooms by special education teachers who were not board certified behavior analysts or researchers, demonstrating the potential for similar results in classrooms within other school districts. However, given the small sample size of this study, future research should continue to concentrate on public school programs in order to determine the efficacy of such procedures in comparable environments.

Three participants of this study appeared to easily generalize the skill of spontaneously manding within the school environment (i.e., classroom, speech therapy room). Future research may want to focus on training parents and caregivers to implement the intervention used in the home to determine if similar rates of spontaneous mands are observed across people and untrained mands in a novel environment. Given the ease with which the steps of the procedure were acquired by the teachers in the study, it is reasonable to expect that parents would be able to implement them in order to provide additional learning opportunities for the child in the home environment.

As mentioned previously, student profiles appear to be closely related to outcomes associated with the implementation of evidence-based practices. Future research designed to link student profiles with specific intervention components might provide teachers and interventionists with a more efficient way of selecting teaching procedures for individual children.
Finally, continued research into interventions related specifically to spontaneous manding should be extended to functionally distinct mands, including manding for information as well as mands related to actions by adults resulting in access to a reinforcer. These types of manding repertoires will further advance the social opportunities of children with autism as well as allowing them to control their environment more effectively.

References


Autism, once thought to be a rare disorder, has dramatically increased in prevalence rate both nationally and internationally (Yeargin-Allsopp, Rice, Karapurkar, Doernberg, Boyle, & Murphy, 2003). It is considered by some to be the second most common developmental disability after intellectual disabilities (Bhasin, Brocksen, Avchen, & Braun, 2006). Research reports indicate that prevalence rates for autism in the United States between 1960 and 1980 ranged from 2 to 5 in 10,000. It increased dramatically from 2000 to 2009 when the prevalence rate was estimated to be 30 to 60 in 10,000 (Kogan, et al., 2009). The most recent prevalence rate for autism in the U.S. between 2000 and 2008 indicates 1 in 88 children (Center for Disease Control and Prevention, 2012). The prevalence rate in the United States appears to be comparable to those found in other countries. A study conducted in the United Arab Emirates revealed 58 children per 10,000 had features of autism (Eapen, Mabrouk, Zoubeidi, & Yunis, 2007) whereas a rate of 250 per 10,000 was reported in Iran (Ghanizadeh, 2008). An autism prevalence rate of 8.6 per 1,000 was reported for a cohort of children born between 1984–1993 in Iceland (Magnusson & Saemundsen, 2001) while similar data revealed a rate of 14.8 per 10,000 among young children in Asia (Sun & Allison, 2010).

Although the reason for such dramatic increases in the prevalence rate continues to be debated (Matson & Kozlowski, 2011), there is no dispute about the need for accurate identification as the critical first step in the delivery of early and intensive intervention for young children with autism. In the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association [APA], 2000), the pervasive developmental disorders category includes the following disorders: Asperger syndrome, autistic disorder, childhood disintegrative disorder, pervasive developmental disorder—not otherwise specified, and Rett’s disorder. It is common practice to view these disorders on a spectrum, commonly referred to as autism spectrum
disorders (ASD). For the purposes of this study, the focus will be on individuals with classic characteristics of autism (AU).

Autism is a neurodevelopmental disorder characterized by deficits in three diagnostic domains: social interactions, communication (verbal and non-verbal), and restricted and repetitive patterns of behavior and interests including stereotypy. Social deficits most commonly observed include a lack of eye contact during social interactions, an inability to attend to and accurately interpret social cues, and a preference to interact with toys or objects rather than people. Communication deficits typically include a delay in the acquisition of language, literal interpretation of words or phrases, and an overall lack of motivation to communicate. Repetitive patterns or stereotypic behaviors are best described as movements or activities that individuals engage in repetitively, such as rocking, flapping hands, and lining up objects such as crayons and cars. Restricted patterns of interest include obsession or preoccupation with items or parts of objects such as trains or wheels on toy cars, as well as strict adherence to routines, routes and daily schedules (APA, 2000; Webber & Scheuermann, 2008). Generally speaking, the combination of discrete behaviors from each diagnostic domain results in the devastating overall impact of autism, a life-long disorder, that limits the individual’s ability to interact and function effectively within their social environment. When compared to individuals diagnosed with Asperger disorder or pervasive developmental disorder—not otherwise specified (PDD-NOS), individuals diagnosed with autism are considered to have the most severe symptoms (Webber & Scheuermann, 2008).

Communication deficits, in some form, are associated with all individuals with autism and they are often the most prominent characteristic associated with the disorder (National Research Council, 2001). Parents have often reported the absence or delay of communication
skills in young children as the first indicator of a possible disability (De Giacomo & Fombonne, 1998; Howlin & Moore, 1997). Although the severity of communication impairments can vary dramatically from one child to another, there appears to be some similarity among the type of communication deficits observed in most young children with autism. It has been estimated that up to 50% of children with autism fail to develop functional, vocal verbal behavior (Bailey, Phillips, & Rutter, 1996; Bryson, 1996; Hartmann & Klatt, 2005; Webber & Scheuermann, 2008). Of the individuals who do acquire verbal skills, many are unable to participate in a conversation effectively because they interpret words or phrases in a literal manner, speak in a monotonous tone of voice, and use immature grammar patterns (Scheuermann & Webber, 2002; Tager-Flusberg, 1981). Scheuermann and Webber (2002) suggest that the inability to “communicate in a functional manner may be the most handicapping of any of the symptoms of this disorder” (p. 7) and frequently has a devastating impact across the lifetime of the individual with autism.

Research has demonstrated that children who struggle to develop a functional communication repertoire or who fail to develop meaningful communication altogether often acquire an alternative, less conventional form for expressing their needs and wants (Carr & Durand, 1985; Charlop-Christy, Carpenter, Le, LeBlanc, & Kellet, 2002; Dominick, Davis, Lainhart, Tager-Flusberg, & Folstein, 2007; Hall & Sundberg, 1987; Reese, Richman, Belmont, & Morse, 2005; Shafer, 1994). Absence of alternative methods to communicate may result in the emergence and occurrence of problem behaviors such as aggression, crying, and/or self-injurious behaviors. Furthermore, communication delays in children with autism limits and often prohibits participation by the individual in social activities and experiences with peers (Charlop-
Given the importance of language and communication in the developmental trajectory of any child, especially one with autism, early and intensive intervention programs make communication training a priority (Prelock, Paul, & Allen, 2011). Drash and Tudor (1993) suggested that because “verbal behavior evolves in most young children through a series of changing contingencies of reinforcement, these can be discovered, analyzed, and explicitly programmed for young children with existing delays in their verbal repertoire” (p. 20). While there is rarely any need to provide typically developing children with explicit instruction in communication, children with autism and limited verbal skills are at risk for developing problem behavior in the absence of functional communication. Without early, intensive, and focused intervention in the acquisition of verbal behavior, individuals with limited communication skills who develop problem behavior run the risk of experiencing exclusion from peers and social environments (Shafer, 1994). Therefore, early and intensive intervention programs for teaching language and communication skills to children with autism need to utilize evidence-based practices that are characterized by methodological rigor and socially valid outcomes (Odom et al., 2005; Reichow & Wolery, 2009). Most empirically effective early and intensive interventions focusing on communication training are based on the principles of applied behavior analysis (Boyd, Odom, Humphreys, & Sam, 2010). The use of behavior analytic procedures has become a familiar component in programs designed specifically for students with autism as well as the focus of several studies related to the acquisition of verbal behavior (Braam & Sunderg, 1991; Hall & Sundberg, 1987; Stafford, Sundberg, & Braam, 1988).
Theoretical Foundations for the Study

Sound theoretical underpinnings are more likely to lead to effective scientific practices within clinical and applied settings. This section describes the theoretical framework that serves as a foundation for the proposed study including the philosophy of ABA and Skinner’s analysis of VB. Although the principles of ABA and VB are frequently applied independently, they are inextricably linked in the cited literature and applied settings in the context of communication intervention procedures (Greer & Ross, 2004; Rivard & Forget, 2012).

Applied Behavior Analysis

The development of the field of behavior analysis, most appropriately viewed as an evolution that has occurred across several decades, began in early 1900 when Watson (1924) proposed the study of observable behavior, a departure from typical psychological constructs that had focused on mental states, thoughts and feelings. Although limited empirical evidence supported his hypothesis, Watson (1924) suggested the presence of a relation between environmental stimuli and individual’s responses associated with those stimuli (Cooper, Heron, & Heward, 2007). Although the original stimulus-response model advocated by Watson (1924) endured revisions and debate over the years, his work highlighted the importance of the study of behavior as a science and also advanced the discussion of behavior among psychologists and philosophers (Schneider & Morris, 1987).

In 1938, B.F. Skinner noted that the stimulus-response theory postulated by Watson (1924) failed to account for behaviors that appeared to be volitional and spontaneous and proposed the concept of operant behavior, which resulted in the conceptualization of the three-term contingency, one of the most significant scientific advances in the study of human behavior. Skinner’s three-term contingency was an improvement on Watson’s (1924) stimulus-response
theory because it demonstrated that operant behaviors could be strengthened when followed by reinforcers. This seminal body of work by Skinner resulted in the evolution of the science of behavior analysis (Miller, 2006). By 1938, Skinner had conceptualized and defined the major tenets of the science of behavior, including “a focus on the behavior of the single organism, rate of response as the main dependent variable, the cumulative recorder, the operant-respondent distinction with the related difference between the conditioned stimulus (CS) and SD, and the effects of various kinds of intermittent reinforcement” (Michael, 1980, p. 1). Three decades later, Baer, Wolf, and Risely (1968) presented seven defining characteristics of applied behavior analysis and suggested they be used to evaluate the quality of behavioral interventions. In 1987, almost twenty years later, these authors reiterated their previously proposed dimensions that the practice of applied behavior analysis should be applied, behavioral, analytic, technological, conceptually systematic, effective, and capable of generalization (Baer, Wolf, & Risely, 1987, p. 314).

ABA is defined as “the science in which tactics derived from the principles of behavior are applied systematically to improve socially significant behavior and experimentation is used to identify the variables responsible for behavior change” (Cooper et al., 2007, p. 20). At the very core of this proposed study are the principles of ABA as illustrated by the proposed implementation of such tactics as prompting, prompt fading, stimulus control transfer procedures, motivating operations, manipulation of motivating operations, and reinforcement. The systematic implementation of these principles and tactics can be used to teach the operants of Verbal Behavior, as defined by B. F. Skinner. A more detailed description of the verbal operants will follow in the next section.
In 1934, concurrent with his work related to operant behavior and the field of applied behavior analysis, Skinner began work on the behavior analytic interpretation of language acquisition. Based on similar analyses and principles, Skinner suggested that language is an observable behavior that is learned through the same contingencies as other behavior, specifically stimulus control, reinforcement and extinction (Cooper et al., 2007).

Prior to the advent of applied behavior analytic procedures, communication-based interventions were most often based on biological and cognitive theories of language development. Chomsky (1959), one of the most prominent supporters of the biological theory, argued that human beings were born with communicative and linguistic abilities and that environmental and behavioral components played no part in the acquisition of communicative skills. Similarly, as noted by Sundberg (2007), cognitive psychologists suggested that language acquisition is based on the cognitive ability of the individual to process and retrieve stored information and that acquisition of communicative skills happens naturally without direct intervention.

In contrast to the biological and cognitive theories of language development, Skinner’s (1957) seminal work delineated a verbal behavior approach to language acquisition. The VB approach presented six elementary verbal operants and the controlling variables for each, thus providing a behavior analytic description of language acquisition (Sautter & LeBlanc, 2006). Verbal behavior, as described by Skinner (1957), is “any movement capable of affecting another organism” (p. 14) that results in reinforcement by another person, the listener. Each operant is controlled by specific independent variables (antecedents, consequences, motivating variables), resulting in what is defined as a functional relation between environmental events and an
organism’s behavior (Sundberg, 2007). This concept is described in greater detail in the following section as it relates to four of the six elementary verbal operants—mand, tact, echoic, and intraverbal (see Table A.1). Additionally, research has substantiated Skinner’s (1957) original tenet of the functional independence of each verbal operant while demonstrating their inter-relatedness (Arntzen & Almas, 2002; Sautter & LeBlanc, 2006). Specifically, the acquisition of a manding repertoire has accelerated the acquisition of other verbal operants such as tacts (Kelley, Schillingsburg, Castro, Addison, & LaRue, 2007; Lamarre & Holland, 1985). This concept will also be described in more specificity in the following section.

Skinner’s analysis of verbal behavior has become synonymous with teaching communication to children with autism (McGreevy, 2009). Critical to the effective implementation of VB are the principles of ABA (specifically motivating operations, manipulation of motivating operations, reinforcement, prompt and prompt fading, and stimulus control transfer procedures). The VB approach, in conjunction with the principles of ABA, provides a precise and well-defined foundation upon which this study will be based (Oah & Dickinson, 1989; Sautter & LeBlanc, 2006; Shafer, 1994).
Table A.1

Skinner’s Primary Verbal Operants

<table>
<thead>
<tr>
<th>Verbal Operant</th>
<th>Definition</th>
<th>Antecedent</th>
<th>Behavior</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mand</td>
<td>Verbal operant controlled by the motivating operation and the specific reinforcer requested</td>
<td>Student has been eating salty chips (salty chips creating motivation for access to water)</td>
<td>Student says “Water”</td>
<td>Teacher gives student a drink of water - Student gains access to the specific reinforcer - water</td>
</tr>
<tr>
<td>Tact</td>
<td>Verbal operant controlled by a nonverbal discriminative stimulus such as the object or the picture of an object</td>
<td>Student sees a glass of water</td>
<td>Student says: “Water”</td>
<td>Teacher says: “That's right! It's water. Nice job!” (generalized conditioned reinforcement in the form of social praise and attention)</td>
</tr>
<tr>
<td>Echoic</td>
<td>Verbal operant controlled by a verbal discriminative stimulus</td>
<td>Teacher says: “Water”</td>
<td>Student says: “Water”</td>
<td>Teacher says: “Nice job saying water!” (generalized conditioned reinforcer in the form of social praise and attention)</td>
</tr>
<tr>
<td>Intraverbal</td>
<td>Verbal operant that occurs in response to a verbal discriminative stimulus</td>
<td>Teacher says: “Tell me something you like to drink”</td>
<td>Student says: “Water”</td>
<td>Teacher says: “That's right! You like to drink water!” (generalized conditioned reinforcement in the form of social praise and attention)</td>
</tr>
</tbody>
</table>

*Skinner’s Analysis of Verbal Behavior in Language Instruction*

The use of Skinner’s analysis of verbal behavior to teach language to children with autism has been well documented in the literature. McGreevy (2009) noted that between 1975 and 2003 “at least 80 empirical investigations based on Skinner’s analysis [references omitted]
have provided data indicating the importance of specific variables or the effectiveness of teaching specific operants to children and adults with developmental disabilities, including ASD” (p. 139). Over 40 additional studies supporting the use of Skinner’s analysis to teach language and communication skills to children with autism have been documented in the existing literature since 2003 (McGreevy, 2009). These studies, and other studies with similar objectives, have noted that the mand, a “verbal operant for which the form of the response is under the functional control of motivating operations and specific reinforcement” (Sundberg, 2007, p. 530), is considered to be the first operant learned by typically developing children (Drash, High, & Tudor, 1999; Sundberg, 2007). Because manding results in access to items or activities the speaker wants, this verbal operant may be the easiest for the interventionist to teach and easiest for the student to acquire (Shafer, 1994; Sundberg & Partington, 1998). In other words, the mand benefits the speaker because the listener delivers the item, toy or object as requested (Skinner, 1957), thus making the mand a potentially more reinforcing operant to teach and acquire. Additionally, research has also demonstrated that training on the development of a manding repertoire first, makes training on other verbal operants less difficult (Arntzen & Almas, 2002; Braam & Sundberg, 1991; Carroll & Hesse, 1987; Drash, High, & Tudor, 1999).

Based on research suggesting that the mand is the most appropriate operant to teach first (Shafer, 1994; Skinner, 1957; Sundberg & Michael, 2001), Drash, High and Tudor (1999) used shaping, prompting and prompt fading, and manipulation of the motivating operation to establish a manding repertoire in three boys who were nonverbal and diagnosed with autism. With the manding repertoire as a foundation, the authors were able to teach all three participants an echoic repertoire and two of the participants were also taught an initial tact repertoire. These behavior analytic procedures (shaping, prompting and prompt fading, and manipulation of the motivating
operation) were essential in the development of a vocal mand repertoire as well as an echoic and tacting repertoire. After determining the favorite foods and toys of each participant, access to these items was limited, thus enhancing the value of the items and making it more likely they would function as a reinforcing consequence (manipulation of the motivating operation), a necessary component when teaching a manding repertoire.

Shaping is the procedure through which reinforcement is used to shape approximations of a response currently in the student’s repertoire into a response that is closer to the target response. For example, when teaching a student to request “water,” a teacher using shaping might initially reinforce the vocalization “wa.” Once that vocalization occurs at stable rates, the teacher may only reinforce vocalizations of “wat,” and continue delivering reinforcement for successive approximations that are closer to the word “water.” The instructor would need to present prompts (i.e. antecedent stimuli) to ensure correct responding by the student which then would result in access to a reinforce (Lamarre and Holland, 1985; Pellecchia and Hineline, 2007). When teaching a student to request an apple (after the student has declared motivation for the apple either by reaching for it or pointing in the direction of the apple) the teacher may hold up an apple and say “apple” with the word “apple” serving as the verbal prompt. Once the student begins to say “apple” consistently following the verbal prompt, the teacher made insert a delay between the time when she holds up the apple and the word “apple” in an attempt to fade the prompt. Once the student begins to respond reliably when the teacher holds up the apple, independent responding and mastery of the target has been achieved without further reinforcement for the learned response. Pellecchia and Hineline (2007) used vocal prompts paired with incidental teaching strategies to teach three preschool children with autism to mand for preferred items with an adult instructor. The authors determined that the acquired manding
behavior of the participants did not generalize to peers or siblings. Limited generalization to other adults (parents) was also noted. The results of this study extended the findings of Lamarre and Holland (1985) who had demonstrated the functional independence of verbal operants, indicating the need for direct instruction of each operant. In other words, simply learning how to tact a toy or item will not result in that tact becoming a mand when the child wants to play with the toy or item.

Additionally, research has also demonstrated the positive effects of a manding repertoire on reduced problem behavior and increased access to social situations and peers in children with autism (Richman, Wacker & Winborn, 2001; Charlop-Christy et al., 2002; Durand & Carr, 1992). Durand and Carr (1992) found that functional communication training and timeout were both effective in reducing rates of problem behavior maintained by adult attention. However, the results indicated that low rates of problem behavior were sustained only for the participants who received functional communication training, suggesting that “teaching children to recruit the stimuli maintaining their challenging behavior in a more appropriate manner may not only reduce these problem behaviors initially but may also facilitate maintenance” (Durand & Carr, 1992, p. 790).

The six elementary verbal operants introduced by Skinner (1957) in *Verbal Behavior* were mand, tact, echoic, intraverbal, textual, and transcription. Four of those operants (mand, tact, echoic, intraverbal) will be discussed in detail in this section. The operants are defined by the functional relationship between the response and the independent variables associated with that verbal operant. In the case of the mand, “water please” is under the control of the motivating operation—a desire for water due to a state of deprivation—resulting in access to a glass of water, the specified reinforcer. The mand is the only verbal operant under the control of
the motivating operation followed by access to a reinforcer specifically requested by the speaker. As noted earlier, learning to mand is typically easier to teach and more quickly acquired and can lead to the acquisition of other verbal operants (Sundberg & Michael, 2001; Sundberg, 2004).

The tact is defined by Skinner (1957) as “a verbal operant in which a response of given form is evoked (or at least strengthened) by a particular object or event or property of an object or event. We account for the strength by showing that in the presence of the object or event, a response of that form is characteristically reinforced in a given verbal community” (p.82). In other words, the presence of a specific object or event (nonverbal discriminative stimulus) such as an elephant is likely to evoke the response “elephant” and will produce generalized conditioned reinforcement typically in the form of praise and attention (e.g., “You are right, that is an elephant!”). It should be noted that the picture of an elephant will not function as a discriminative stimulus until the student says “elephant” in the presence of the picture and reinforcement is delivered for the response (Sundberg, 2007). The difference between tacting and manding is that tacting does not result in access to the object or item (reinforcer) that was the source of motivation due to deprivation or limited access. Carroll and Hesse (1987) found that a mand-to-tact transfer procedure was more efficient for teaching six typically developing children (one female and five males) to name parts of disassembled toys than a tact-only procedure. Arntzen and Almas (2002), replicated the study by Carroll and Hesse and showed that alternating mand and tact trials allowed the participants (two typically developing 3-year-old girls and three boys with developmental disabilities) to acquire tacts more rapidly than in the tact-only condition. Both studies demonstrate the benefit of teaching the mand first in order to more efficiently teach other verbal operants, specifically the tact.
An echoic repertoire is an essential component in early intervention programs aimed at developing verbal behavior in young children with autism (Ward, Osnes, & Partington, 2007). An echoic response is controlled by a verbal discriminative stimulus and produces generalized conditioned reinforcement such as adult attention. It is best described as the student repeating exactly what is said by the teacher (the teacher says “shoe” and the student repeats “shoe”). An echoic differs from echolalia, a characteristic frequently associated with autism, in that an echoic response is under stimulus control—meaning that the student will repeat a single word (or in some cases a phrase) said by an adult if reinforced for doing so. In order for a response to be classified as an echoic there must be point-to-point correspondence and formal similarity. Point-to-point correspondence “occurs when the beginning, middle, and end of the verbal stimulus matches the beginning, middle, and end of the verbal response” (Cooper et al., 2007, p. 701). Formal similarity is said to occur “when the controlling antecedent stimulus and the response or response product (a) share the same sense mode (e.g., both stimulus and response are visual, auditory, or tactile) and (b) physically resemble each other” (Cooper et al., 2007, p. 696). Ward, Osnes, & Partington (2007) used a multi-component package consisting of automatic reinforcement and socially mediated reinforcement (pairing a reinforcer with a specific sound, reinforcement of vocal play, and reinforcement of incidental echoic responses) to develop an echoic repertoire in two participants, both with limited verbal repertoires. One participant had limited vocal play and no echoic behavior while the other engaged in high rates of vocal play but lacked a reliable echoic repertoire. The study resulted in an increase in echoics and vocal play for both participants. Once a student is able to repeat words and phrases, a stimulus control transfer procedure can be used to bring the echoic under the control of other stimuli in order to teach additional verbal operants such as tacts and intraverbals.
The last verbal operant constitutes intraverbal responses. Intraverbals are an integral part of a speaker’s verbal repertoire and are critical in the development of appropriate social interactions and conversational speech (Sundberg & Sundberg, 2011). Giving the response “Austin” after hearing the teacher ask “What is the capital of Texas?” is an example of an intraverbal response. A defining feature of the intraverbal is the absence of point-to-point correspondence between the verbal stimulus and the verbal response, meaning that the verbal stimulus and verbal response do not match as described in the echoic responses. Intraverbal responses are maintained by generalized conditioned reinforcement such as social praise, attention, or tokens. Sundberg, San Juan, Dawdy, & Argüelles (1990) implemented the use of prompting, fading, manipulation of establishing operations, and differential reinforcement to determine the number of trials necessary to acquire mands, tacts, and intraverbals for two male participants with traumatic brain injury and weak mand, tact, and intraverbal behavior. The results of the study revealed that even with direct instruction the acquisition of a mand repertoire was difficult while tacts and intraverbals were more easily and quickly acquired. These results differ from those reported in similar studies with participants with developmental disabilities (Braam & Poling, 1983; Carroll & Hesse, 1987; Hall & Sundberg, 1987) in which manding was the first operant acquired and most easily learned. The authors concluded “it is possible that the current data may simply demonstrate some of the differences between these two populations” (Sundberg, San Juan, Dawdy, & Argüelles, 1990, p. 96). Specifically, the authors suggest that the participants with traumatic brain injury had the ability to engage in verbal behavior and had a somewhat intact manding repertoire that allowed them to access preferred items and activities. In contrast, the participants with developmental disabilities frequently have limited or non-existent verbal repertoires at the beginning of their respective studies.
The concept of functional independence of verbal operants plays a significant role in early intervention programs that are based on Skinner’s analysis of verbal behavior. Simply put, responses controlled by variables related to one operant will not automatically come under the control of variables related to a different operant (Hall & Sundberg, 1987; Kelley et al., 2007; Lamarre & Holland, 1985; Skinner, 1957; Watkins, Pack-Teixteira, & Howard, 1989). As discussed earlier, even if a child has the ability to tact an object lying on a table (e.g., ball) there is no reason to expect that he also possesses the ability to request the ball when he wants to play with it. Functional independence dictates the need for direct instruction for each verbal operant as well as the use of specific behavior analytic procedures to transfer control from one set of controlling variables to another. Some of these procedures will be discussed in greater detail later in this section.

Motivating Operations

The controlling variables of the mand are the motivating operation (MO) and the consequence, or the contingent delivery of the item requested. The concept of the motivating operation has evolved over several decades and has undergone many refinements by different researchers in the field. In his early works, Skinner wrote extensively about the operant nature of motivation. Beginning with Behavior of Organisms, Skinner (1938) depicted motivation as a variable that controlled behavior and was careful to differentiate motivation from a discriminative stimulus (Sundberg, 2004). In Principles of Psychology, Keller and Schoenfeld (1950) continued the discussion and offered more support for the relationship between deprivation and satiation and responding. Furthermore, they argued that reinforcement was not the only variable that controls responding and suggested the term “establishing operation” to describe antecedent events and stimuli as controlling variables. Skinner (1953) continued to
describe and discuss the relationship between motivation and responding in *Science and Human Behavior*, in which he detailed the connection between conditions of deprivation, satiation and aversive stimuli and human behavior. Later, in *Verbal Behavior*, Skinner (1957) examined the relationship between the acquisition of language and the motivational variable, concluding that the manipulation of the motivating operation, an independent variable, can lead to the acquisition of a verbal behavior repertoire.

In 1982, Jack Michael began writing a series of articles devoted to the discussion and refinement of behavior analytic terminology related to motivation (Michael, 1982, 1988, 1993, 2000). Initially he adopted the term “establishing operation” which was first proposed by Keller and Schoenfeld (1950). Michael (1982) defined an establishing operation as “any change in the environment which alters the effectiveness of some object or event as reinforcement and simultaneously alters the momentary frequency of the behavior that has been followed by that reinforcement” (p. 150-151). Additionally, in this paper and subsequent writings, Michael characterized the distinction between motivational stimuli and discriminative stimuli, noting that a discriminative stimulus “signals the availability of reinforcement” (p. 150) while a motivational variable is related to the effectiveness of an environmental stimulus to act as a reinforcer. Moreover, Michael made further distinctions regarding the role of deprivation, satiation and aversive stimuli as they relate to operant responding. It was not until 2003, that the term “motivating operation” was first introduced by Laraway, Snycerski, Michael, and Poling (2003). Laraway et al. argued that the term “establishing operation” was limiting because it “implies only an increase in the effectiveness of a consequence as a reinforcer or punisher, yet many motivating variables *decrease* the effectiveness of consequences” (p. 408). Laraway et al.
suggested that motivating operation (MO) would more accurately define the behavioral effects of motivation.

As defined by Michael (2007), a motivating operation is “an environmental variable that (a) alters (increases or decreases) the reinforcing effectiveness of some stimulus, object, or event; and (b) alters (increases or decreases) the current frequency of all behaviors that have been reinforced by that stimulus, object or event” (p. 699). In other words, MOs alter the value of a reinforcer at a specific moment in time and alter the frequency of behaviors related to gaining access to the stimulus or event. In essence, MOs are comprised of two defining characteristics—value-altering and behavior-altering effects (Langthorne & McGill, 2009; Laraway et al., 2003). States of deprivation will increase the value of a particular stimulus, object, or event and will evoke behaviors that have been reinforced by access to that particular stimulus, object, or event while a state of satiation will decrease the value of a particular stimulus, object or event thereby abolishing motivation for the stimulus, object or event. As a result, the behaviors that have been reinforced in the past by that specific stimulus, object or event could occur less frequently. Therefore, when a child has had limited access to a favorite movie (i.e., state of deprivation), the movie becomes an effective reinforcer and the behaviors that previously resulted in access to a movie (e.g., manding for the movie, going to the video cabinet and pointing) are more likely to occur. The state of deprivation is said to have established motivation for movie. Conversely, if the student has just spent 45 minutes watching a movie (i.e., state of satiation), it is unlikely that his motivation will be strong enough to engage in behaviors that may have resulted in the delivery of movie in the past. The state of satiation is said to have abolished the motivation for movie.
Vollmer and Iwata (1991) used naturally occurring states of deprivation and satiation to determine the effects of each on the rate of responding by five adult males with severe intellectual disabilities. The food deprivation condition was scheduled just prior to lunch in order to make food items more valuable to each participant, while the social deprivation condition was contrived by removing all social attention for 15 minutes prior to work sessions. Conditions of satiation were contrived by allowing participants access to preferred stimuli for 15-30 minutes prior to each work session (e.g. 15 minutes of social interaction, 30 minutes of listening to music, etc.) and by scheduling sessions 15 minutes following lunch and allowing access to food items for 10 minutes prior to the start of a work session. Each work session required the participant to engage in a motor task involving switch closure or block placement. Results indicated that the highest rates of responding were recorded during the deprivation conditions as opposed to the conditions of satiation, thus extending the literature related to the effect of manipulation of establishing operations on the behavior of individuals with autism.

Using a multi-element research design, Rispoli et al. (2008) examined the effects of access to preferred items prior to academic instruction with two young boys with autism. A functional analysis conducted immediately prior to the study revealed that problem behavior was primarily maintained by access to tangible items (blank white paper) for one participant while problem behavior was jointly maintained by access to tangible items (musical book) and escape from demands for the other participant. One 20-minute activity session was conducted per day within a general education classroom during which academic demands were placed on the participants. Just preceding the activity session, each participant was exposed to a pre-session condition in which access to the previously identified item was allowed or a pre-session
condition in which the participants followed their daily routine and no access to the preferred item was allowed for at least 2 hours prior to the 20-minute activity.

As a controlling variable, a strong MO must be present in order for manding to occur reliably. Therefore, it is extremely important for instructors and interventionists to continuously analyze the strength of an MO during mand training to ensure that the child has sufficient interest in an item, object or activity to exert the effort required to produce a mand (Sundberg, 2004).

For example, if a student is reaching for a doll on a shelf while simultaneously vocalizing, there is likely a strong MO for gaining access to the doll and presents an excellent opportunity for teaching a mand for the item. Similarly, a child reaching out to take a can of soda is declaring his motivation for gaining access to the drink. Pointing, reaching, grabbing, and even engaging in problem behavior in the presence of specific items (and in the presence of a listener) may be considered forms of requesting and provide teachers with targets for manding programs. A strong MO must be present immediately prior to mand training and perhaps one of the most effective methods for determining motivation is to offer choices of items previously observed to be valuable to the student. Once motivation is declared the mand training session can begin.

As noted by Sundberg (2004), an individual’s motivation for any item, food, or activity can change quickly. Additionally, he suggests that MOs may potentially “compete with each other” (Sundberg, 2004, p. 11) in that the MO for a particular item may be very strong until the individual sees a different item they are motivated to obtain. The continual evaluation of the MO during mand training is necessary in order to teach a child a manding repertoire. As mentioned above, without the presence of a strong MO, teaching a child to request an item or object is unlikely to occur. It may be necessary to manipulate motivation to ensure a strong MO prior to instruction (Lang et al., 2010; Laraway et al., 2003; Ribeiro, Elias, Goyos, & Miguel, 2010).
the most basic level, the effects of satiation and deprivation, as noted previously, allow an instructor to manipulate the value of any particular item in order to alter the behavior of the student. By limiting access to a favorite toy (and thereby increasing the value of the toy) the teacher will have a number of opportunities to teach the child to request the toy. Additionally, by limiting the amount of time the student has access to the toy after each request will also assist in maintaining the value of the toy as a reinforcer. Similarly, as demonstrated in a local pub where complimentary salty snacks are served, the proprietor sets up the conditions to contrive an MO for a drink. Thus, following the consumption of the salty snacks, patrons are more likely to order beverages in order to satisfy their thirst.

The first mands acquired by children with autism are usually multiply controlled mands (Sundberg, 2004). A multiply controlled mand occurs when the MO is present along with an additional stimulus, such as a vocal prompt or the physical presence of the item the child wishes to obtain. A mand exhibited under these conditions may be controlled either by the vocal prompt, the item, or both. In contrast, spontaneous mands are those that occur only in the presence of the MO and a listener (Sundberg, 2004). They typically do not develop in young children with autism without direct and intense instruction (Carr & Kologinsky, 1983; Charlop, Schreibman, & Thibodeau, 1985; Charlop-Christy et al. 2002; Sundberg, 2004). Although it has been proposed that the lack of spontaneous manding in young children with autism is related to cognitive deficits, Carr and Kologinsky (1983) suggest that educational interventions that do not include prompt fading procedures combined with differential reinforcement are more likely to restrict spontaneity. In other words, students with autism can be taught to mand spontaneously through the use of behavior analytic principles such as time delay, prompting, prompt fading and differential reinforcement. Failure to acquire a spontaneous manding repertoire appears to be
more closely related to a lack of implementation of appropriate teaching strategies rather than the cognitive abilities of the student.

The next section will describe in detail behavior analytic procedures related to teaching manding to young children with autism as well as specific procedures used to transfer stimulus control from the presence of the item to the motivating operation.

Behavior Analytic Procedures Used to Teach Manding

The most significant difference between a multiply controlled mand (i.e., a mand that occurs when motivation is high and another stimulus is present) and a spontaneous mand is that in the latter case, even when the item is out of view, the child can still produce the mand to gain access to the item (Sweeney-Kerwin, Carbone, O’Brien, Zecchin, & Janecky, 2007). Although both types of mands are useful, spontaneous manding is considered to be a more advanced form of verbal behavior. By releasing the control of the mand from multiple stimuli (either the presence of the item or a prompt from the listener) that control its occurrence, the child is now able to request items or activities that s/he wants across a variety environments and listeners, demonstrating more control over his/her environment (Bondy, Tincani, & Frost, 2004; Carr & Kologinsky, 1983; Sautter & LeBlanc, 2006). Multiply controlled mands restrict access to preferred items in situations where the actual item is visible or in situations where the listener is trained to provide a vocal prompt. In such situations, children with autism are more likely to mand based on the prompts displayed rather than based on personal motivation. The most efficient way to make this process more naturalistic and to encourage children with autism to access reinforcement more frequently is to transfer control of the mand to the MO as the sole controlling variable. This will allow learners to control their environment more efficiently and effectively as their behavior generalizes across other settings where direct instruction was not
provided (Guess, Sailor, & Baer, 1974). Additionally, spontaneous mands are considered to be more functional, socially appropriate and similar to the naturalistic requesting repertoires of typically developing children (Sigafoos, Kerr, Roberts, & Couzens, 1994).

To address the issue of limited spontaneous manding by students with autism (the limited ability by students to request items that are not present), research has implemented the use of time delay procedures to eliminate the need for a vocal or visual prompt and to transfer control from the [artificial] prompt to naturally occurring stimuli by varying the time between the presentation of the prompt and the natural stimuli (Cooper et al., 2007; Sweeney-Kerwin et al., 2007; Wolery & Gast, 1984). Prompt, prompt fading and time delay are all considered to be stimulus control transfer procedures designed to produce spontaneous responding with limited errors (Cooper et al., 2007). Carr and Kologinsky (1983) used prompt and prompt fading procedures combined with differential reinforcement to teach six children with autism to spontaneously request reinforcers using sign language. Rates and variety of spontaneous mands increased across all participants while generalization of spontaneous mands to novel listeners was also noted. Similarly, Carr and Durand (1985) used a prompt (echoic stimulus) and prompt fading procedure to teach children with developmental disabilities to request adult attention instead of engaging in problem behavior. Additionally, Hall and Sundberg (1987) also used prompts (tact and imitative) and prompt fading to teach participants to use manual sign to request missing items needed to complete chains of behavior that lead to access to reinforcers. Each of these studies successfully transferred control of the mand to the motivating operation and a listener, resulting in spontaneous manding by the participant.
Conclusion

To summarize, teaching students with autism to spontaneously mand is a critical skill. The research clearly indicates that through the combined use of the principles of applied behavior analysis and the analysis of verbal behavior students can successfully be taught to request items for which they have high motivation to obtain. Providing children with autism with a more sophisticated form of communication can potentially improve their access to social situations as well reduce problem behavior often associated with communication deficits.

References


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APPENDIX B

SUPPLEMENTAL TABLES
### Fidelity Checklist 1

<table>
<thead>
<tr>
<th>Date:</th>
<th>Participant:</th>
<th>Session:</th>
</tr>
</thead>
</table>

**Fidelity Checklist—Steps of Intervention Session 2 +**

- Target item displayed at beginning of session for 3 secs
- Target is removed from view—timer set for 2 min
- Begin DI session
- Target delivered immediately following MC or MO mand
- P allowed access to item/Bite sized portion
- Target removed from view
- Following MC or MO mand, timer re-set for 2 min time delay
- Target delivered immediately following mand during time delay
- P allowed access to item/bite sized portion
- Target removed from view
- Timer re-set
- Target displayed for 3 secs if P does not mand

P = Participant  
I = Interventionist  

Instructions: Enter + in the box beside each step the I completes correctly. Enter – in the box beside each step the I does not complete correctly
### Fidelity Checklist 2

<table>
<thead>
<tr>
<th>Date: __________</th>
<th>Participant: __________</th>
<th>Session: __________</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fidelity Checklist—Steps of Intervention Session 2 +</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target item is not displayed for first 5 minutes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If P mands for target item during 5 min period:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Continue DI session</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Target remains out of view of P for remainder of session</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If P does not mand for target item during 5 min period:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Deliver for 15 sec if P mands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Continue DI session</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Following any mand, begin 2 min. time delay with target out of view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If P mands during 2 min time delay:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Reset timer and start next time delay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If P does not mand during 2 min time delay:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. If P mands, deliver for 15 secs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset timer for 2 min and start next time delay</td>
<td></td>
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</tbody>
</table>

P = Participant  
I = Interventionist  
Instructions: Enter + in the box beside each step the I completes correctly. Enter – in the box beside each step the I does not complete correctly.
APPENDIX C

SOCIAL VALIDITY OF USING A TIME DELAY AND PROMPT FADE

PROCEDURE FOR TEACHERS
Date:
Name of Teacher:
School:

Directions: Please circle one of the five choices that best describes the extent to which you agree or disagree with each of the statements below.

<p>| | | | | | | |</p>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>strongly disagree</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly agree</td>
<td></td>
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</tr>
</tbody>
</table>

1. Participation in this study has resulted in my student being able to spontaneously mand (request items out of view).

2. The procedures used in this study are acceptable to me on a personal and professional level.

3. The procedures used in this study were easy to understand and implement.

4. I will use these procedures with other students in the class who were not included in the study.

Comments:
___________________________________________________________________________________________________
___________________________________________________________________________________________________
___________________________________________________________________________________________________
___________________________________________________________________________________________________
___________________________________________________________________________________________________
APPENDIX D

SOCIAL VALIDITY OF USING A TIME DELAY AND PROMPT FADE PROCEDURE FOR PARENTS
Date: 
Name of Parent: 
Name of Participant (Child): 

Directions: Please circle one of the five choices that best describes the extent to which you agree or disagree with each of the statements below.

1. Participation in this study has resulted in my child being able to spontaneously mand (request items out of view).

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td></td>
<td>strongly disagree</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly agree</td>
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</table>

2. Learning to request items that are not present has resulted in increased access to reinforcement for my child.

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<tr>
<td></td>
<td>strongly disagree</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly agree</td>
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</table>

3. The procedures used in this study are acceptable to me.

<table>
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<tbody>
<tr>
<td></td>
<td>strongly disagree</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly agree</td>
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4. My child's participation in this study has improved my life, either directly or indirectly.

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<tbody>
<tr>
<td></td>
<td>strongly disagree</td>
<td>disagree</td>
<td>undecided</td>
<td>agree</td>
<td>strongly agree</td>
</tr>
</tbody>
</table>

Comments:

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Participants

The participants for this study included four children already diagnosed with autism (AU) who were enrolled in a public elementary school classroom specifically designed to serve students with severe communication disorders. Participants were recruited through the distribution of flyers approved by the Institutional Review Board at UNT. The flyers were sent home to the parents of all students with autism between the ages of 3 and 6 years who are being served in a large North Texas school district. Parents who responded to the flyer were interviewed, along with the classroom teacher, in order to determine if the student met the inclusion criteria for this study.

Participants were selected if they met the following inclusion criteria. They had to be (a) previously diagnosed with autism through the local education agency; (b) between the chronological ages of 3 and 6 years; and (c) able to mand reliably for edible items, objects or activities, at least when verbally prompted or shown items or objects. The ability to mand reliably was evaluated on the basis of data maintained by the classroom teacher as an integral component of direct instruction in verbal behavior. The data reflected whether a child produced a vocal or signed mand when motivated, for at least 80% of the opportunities presented. The last criterion was the willingness of the classroom teacher to agree to attend and participate in the training sessions and implement the intervention procedures with fidelity.

Final selection of four participants was made on the basis of data from reinforcer assessments conducted by classroom teachers for each individual student prior to the start of the study. This process provided information on the type of items, objects and activities that each participant found reinforcing and was motivated to access during direct instruction sessions.

No participants were excluded from the study based on gender, race, or ethnicity as long as the inclusion criteria were met. Parents and/or legal guardians who expressed a desire for
their child to participate in the study were requested to sign a letter of informed consent (approved by the IRB). The letter described details regarding the purpose of the study, procedures, potential risks and possible benefits of participating in the study, procedures for maintaining confidentiality, and specific rights of participants. Four participants met the inclusion criteria for the study.

Praveen was a 7-year-old boy of East-Indian descent. He lived in a single-family household with his biological parents and one older sister. Initial observations and teacher report indicated that he primarily communicated using single word utterances to request and label items, activities, objects and pictures. He indicated his motivation to gain access to preferred items by reaching for the desired item or object. According to teacher data and baseline observations, his manding repertoire consisted of 6–8 one-word requests for visible items (e.g., chip, train, chocolate). His direct instruction program consisted of activities related to matching, sorting, labeling, and receptively identifying pictures and objects. According to his teacher, it generally took between 6–10 trials for Praveen to acquire new verbal operant targets. Detailed information regarding Praveen’s level of functioning on critical domains is provided in Table 1.

Angel was a 6-year-old Hispanic boy who lived in a single-family household with his biological mother and one older brother. Initial observations and teacher report indicated that he primarily communicated using a single sign to request and label items, activities, pictures and objects. He indicated his motivation to gain access to an item or object by reaching for it when he wanted something. According to teacher data and baseline observations, his manding repertoire consisted of 15–20 signs for visible items (e.g., pretzel, puzzle, iPad). His direct instruction program consisted of matching, sorting, labeling, and receptively identifying pictures and objects. According to his teacher, it generally took between 3–5 trials for Angel to acquire
new verbal operant targets. Detailed diagnostic information is provided in Table 1.

Daneesha was a 5-year-old, African American girl who lived in a single-family household with her biological parents and one younger brother. Initial observations and teacher report indicated that she primarily communicated using a single sign to request items and activities. She typically indicated her motivation to gain access to an item by reaching for it when prompted by the teacher. According to teacher data and baseline observations, her manding repertoire consisted of 3–5 single signs for visible items (e.g., chocolate, movie, markers). Additionally, a verbal prompt (e.g., “What do you want?”) and a gestural prompt (e.g., sign modeled by the teacher) were often required to elicit manding. Frequently a full physical prompt (i.e., the teacher positioned her hands) was required in order for Daneesha to produce the correct sign for what she wanted to access. Her direct instruction program was limited to matching and sorting pictures and objects. According to her teacher, it took over a 100 trials for Daneesha to acquire new verbal operant targets. Detailed diagnostic information for Daneesha is provided in Table 1.

Vanessa was a 5-year-old, Hispanic girl who lived in a single-family household with her biological mother and one older sister. Initial observations and teacher report indicated that she primarily communicated using single signs to request items and activities. She typically indicated her motivation to gain access to an item or object by reaching for it or by leading a staff member to the object if it was visible but out of reach. According to teacher data and baseline observations, her manding repertoire consisted of approximately 7–9 signs for visible items (e.g., water, car, candy). Her direct instruction program consisted of activities related to matching, sorting, counting, labeling, and receptively identifying objects and pictures. According to her teacher, it generally took between 5–8 trials for Vanessa to acquire new verbal
Setting

This study was conducted in four different elementary public school classrooms in a North Texas school district designed specifically for students with severe communication delays and children with autism. Each of these four classrooms was characterized by several core instructional components including the use of discrete trial training and natural environment teaching based on the principles of applied behavior analysis. Each classroom was approximately 20’ x 20’ and was equipped with tables, chairs, computer workstations, and storage cabinets. The classrooms were arranged in such a way that space was allocated for play and leisure, independent workstations, snack, and direct instruction on critical goals/objectives on the Individualized Education Plan (IEP). Materials for each student were organized in individual, three-drawer bins for ease of access and movement around the room between staff members. Although the arrangement for individual classrooms differed, the major components noted above were present in each classroom. The experimental sessions occurred in the classroom where the teacher and student sat across the table facing each other.

Dependent Variables

In accordance with best-practice recommendations for single subject research methodology (Horner et al., 2005; Reichow et al., 2011), the dependent measures used in this study were operationally defined, measured frequently throughout various experimental phases, assessed for consistency by multiple observers, and socially significant to the teachers and parents of participants and the field. The following dependent variables were measured in the study.
Spontaneous or MO-Controlled Mands

An MO-controlled mand was defined as: (a) an unprompted request (i.e., vocal, sign or pictures) that was made for a specific item, object or activity when it or its picture/symbol was not physically present or visible to the student; and (b) the student had to engage with the item when it reinforced with access to it following a mand (i.e., demonstrate motivation for it). An example of an MO-controlled mand was requesting soda stored in the refrigerator while seated at the direct instruction table. A non-example was requesting soda after seeing a staff member holding a can of soda (i.e., an MC-controlled mand), or the student not drinking the soda after being given a can after manding (i.e., not really motivated to access it).

Spontaneous (or MO) mands were measured in terms of the frequency of occurrence during the 15 minute (15-min) instructional session. Opportunities for manding were held constant across participants and two experimental phases (i.e., baseline and intervention) of the study. A MO-controlled mand was counted as an occurrence when a student requested an item not visible or present during the instructional context. If a prompt or item was presented during instruction and the student manded for it, an occurrence was counted only if the mand occurred after 15 seconds (15-s) of the presentation of the item or prompt.

Multiply Controlled or MC Mands

These were defined as verbal requests made for a specific item, object or activity when the item or its picture or any associating symbol (e.g., logo) was present and visible to the student and served as a prompt. A multiply controlled (MC) mand occurred when the MO was present along with an additional stimulus, such as a vocal prompt or the physical presence of the item the child wanted to obtain. Examples included requesting a chip when the teacher was holding a bag of chips or requesting to jump on the trampoline after entering a room where the
trampoline was in plain view. Non-examples included (a) requesting items or activities that were not visible to the student (i.e., MO-controlled mand); and (b) pointing to an item following a teacher’s prompt (e.g., “what do you want?”).

MC mands were measured in terms of the frequency of occurrence during the 15-min instructional session. Following the presentation of a prompt, if the mand occurred within 15-s it was counted as MC-mand.

Procedures for Data Collection

Equipment and Materials

Discrete trial training sessions with each participant were recorded using a digital video camcorder. Each classroom teacher was provided with a camcorder capable of recording up to 4 hours of data on the internal hard drive. The camcorder was mounted on a small tripod placed on a table adjacent to the direct instruction area. This placement allowed the teacher to control the camcorder before and after each direct instruction session. Each afternoon the teacher uploaded the recorded DI sessions to a secure Dropbox folder for storage until the data were coded by the primary observer. A digital timer was used to time the duration of the time delay procedure that was implemented during the intervention phase of the study. The classroom teacher was responsible for setting the timer for each occurrence of the time delay procedure according to the scripted instructions provided to maintain intervention fidelity.

Direct Observation of Behavior

Direct observation of target responses for all participants was conducted by reviewing video recordings on a daily basis. Each discrete trial teaching (DTT) session was divided into intervals per trial. For each interval, data were recorded on the following components: (a) the number of opportunities for the participant to mand; (b) the number of times a participant
manded; (c) the number of MC and MO-controlled mands; (d) the type of targets (e.g., edible, object or activity) for which the student manded; and (e) the number of times each participant was allowed to access a target (preferred) item as a reinforcer. The raw data, as recorded on the data sheets, were transferred to an electronic spreadsheet (e.g., Excel) to create a visual graph of the behavioral pattern. The lead investigator for this study served as the primary data coder.

**Interobserver Agreement**

To ensure the integrity of measurement of the dependent variables, interobserver agreement (IOA) was collected for 30% of all observations across various experimental conditions. One additional (secondary) data coder received up to 4 hours of hands-on-training in the specific data collection procedures required for recording the occurrence and non-occurrence of target responses related to this study. The data coder was a doctoral student in the Autism Intervention program and a certified behavior analyst (BCBA) with ample experience in working with individuals with autism. Additionally, the secondary data coder was also trained to collect fidelity data on the implementation of the intervention while the primary observer conducted reliability assessments on procedural integrity of the intervention. Data collection training and practice sessions were continued until three consecutive sessions demonstrated an agreement of 90% or higher between both observers for each participant in the study.

In order to calculate IOA, data collected by both observers was compared on a trial-by-trial basis for each 15-min session for the study. When both coders recorded the mand as being evoked by the same controlling variable (MC or MO-controlled) during a specific trial, it was noted as an agreement (+). A disagreement (−) was noted when both observers failed to record the same controlling variable (i.e., one notes MC and the other notes MO) during the same trial. The formula used to calculate IOA consisted of dividing the agreements by the sum of
agreements plus disagreements and multiplying by 100 in order to generate a percentage.

The outcomes of IOA for spontaneous mands are as follows: Praveen ($M = 99\%$; range = 92–100%), Angel ($M = 99\%$; range = 92–100%), Daneesha ($M = 96\%$; range = 85–100%), and Vanessa ($M = 91\%$; range = 79–100%).

Additionally, in order to assess the degree of agreement between observers on MO and MC mands, Krippendorff’s alpha ($\alpha$) and percent agreements were calculated for each individual participant and overall for the group (see Table 2). As shown, for the overall Krippendorff’s $\alpha$ indicated near perfect agreement ($\alpha$s ranging from .95 to .99; percent agreement ranging from 94.7 to 95.3). Similarly, agreement for each of the individual participants was also near perfect ($\alpha$s ranging from .85 to 1.00 percent agreement ranging from 84.8 to 97.3). Overall, this suggests is that both observers tended to reported similar frequencies of observed child behaviors for both MO and MC mands.

Research Design

A single subject multiple baseline design across participants (Baer, Wolf, & Risely, 1968; Cooper et al., 2007; Gast, 2012; Kennedy, 2005) was used to demonstrate a functional relation between the use of a stimulus control transfer procedure (independent variable) and the acquisition of spontaneous mands (dependent variable). According to Gast (2012), a multiple baseline design is appropriate when dependent variables are functionally independent, yet similar enough that each would respond to the intervention only after it is implemented. Additionally, multiple baseline designs do not require withdrawal of the independent variable to demonstrate the effect of treatment on the target behaviors (Cooper et al., 2007). In this study, items determined to possess reinforcing value were selected as targets for each participant. The design demonstrated three phases including baseline, intervention, and generalization across targets for
Experimental Procedures

**Instructional Context**

The instructional context for teaching spontaneous manding constituted the use of discrete trial teaching, errorless learning, and a schedule of reinforcement.

**Discrete Trial Teaching**

Discrete trial teaching (DTT) consisted of an instructional session during which trials specific to learning objectives on the IEP were presented to the student. Each trial was comprised of a discriminative stimulus (S\(^D\)), a response (R), and a reinforcer (S\(^R^+\)). For example, if the learning trial required the student to touch the item named by the teacher, the teacher said
“Touch the block” (SD), the student would follow the prompt and touch the block (R), which was followed by the teacher saying “Nice touching the block” and gave the student a preferred item (SR+). The learning objectives were varied throughout the session, meaning the teacher presented a variety of tasks related to different verbal operants appropriate for each individual student. For example, one student had IEP objectives with tacking targets (labeling), intraverbal targets (“A cow says ____”), and manding targets (requesting). Additionally, within a direct instruction session, the teacher interspersed difficult objectives (i.e., those that had not been mastered) with easier objectives (i.e., those already mastered). Theoretically, interspersing of a higher number of easy ( mastered) objectives with a fewer number of difficult (acquisition) objectives allows the student to access reinforcement more frequently and helps to maintain motivation to participate in the teaching session (Volkert, Lerman, Trosclair, Addison, & Kodak, 2008). In effect, a dense schedule of reinforcement abolishes the motivation to engage in escape-maintained problem behavior (Michael, 1988).

**Errorless Teaching**

During the course of the DTT session, the instructor implemented errorless teaching procedures. Specifically, when teaching a new objective, the instructor delivered the SD (e.g., “touch the book”) and immediately prompted the correct response and delivered the reinforcer. The teacher immediately presented another trial (“touch the book”) in an attempt to get a less prompted response. If the student responded correctly the teacher provided a reinforcer of a larger magnitude than the previous prompted response (e.g., more enthusiastic praise, larger piece of a food item, etc.). Over time, the teacher systematically faded the prompts associated with teaching the objective until the student was able to produce an unprompted response. Highly preferred items (as determined by teacher data) were used only for the purpose of
delivering reinforcement, not for the purpose of instruction. Therefore, if chips, video, and ball were all highly preferred items, the teacher did not design teaching trials that required the student to tact these items, respond to intraverbal responses using the name of any of these items, or receptively identify any of the items. They were used strictly as reinforcers during the experimental session of this study. They were not used as reinforcers for teaching activities outside the DTT sessions for the study in order to retain the motivation value of the reinforcers (Michael, 1988).

Schedule of Reinforcement

Because reinforcement is an integral component of the DTT process, it was critical that the amount and type of reinforcement be consistent for each participant across all experimental phases, including baseline. This was to ensure that the amount or type of reinforcement did not present itself as a confounding variable. The number of opportunities to mand (followed by reinforcement) during the baseline phase were counted for each participant and the same number of opportunities were presented consistently across all experimental phases. For example, if baseline data revealed that a participant had an average of nine opportunities to mand (and receive a reinforcer) per session, an average of nine opportunities per session was maintained throughout the intervention phase for that participant. Maintaining a consistent schedule of reinforcement across phases for each participant reduced the threat to internal validity where the schedule of reinforcement could act as a confounding variable.
Baseline

The instructional context in baseline constituted the teaching sessions as described above. During baseline, the items identified as highly preferred targets (documented in data collected by the teacher prior to the beginning of the study) were removed from the view of the participant (but accessible to the teacher) but other reinforcers or less preferred items (e.g., crackers) were visible to the student. If a participant manded for a visible item, it was recorded as a MC mand. If a participant manded for an invisible item, it was recorded as a MO mand. This set-up allowed for measurement of both, MC- and MO-controlled mands. The occurrence of MO-controlled mands for each item were recorded daily during two separate Direct Instruction (DI) sessions, across at least five concurrent sessions for all participants in order to evaluate the behavioral pattern. The number of days for baseline varied across participants. During the DTT sessions, correct responding was reinforced with access to low preference items and activities that had not been selected as targets unless a participant manded for them without being prompted. With parent cooperation, access to target items was limited to delivery at school during the experimental sessions only in order to maintain the reinforcing value of each item. Although the teaching sessions in baseline were identical to those in the intervention phase, no intervention procedures in the form of a stimulus control transfer procedure was implemented during baseline.

Intervention (Stimulus Control Transfer Procedure)

The instructional context for intervention was the same as baseline with the exception of availability of high preference items as reinforcers for correct responding, and utilizing the time delay and prompt fading procedures noted by Sweeny-Kerwin et al. (2007). At the beginning of the first intervention session, one most highly preferred targeted item was shown to the student
for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three) to indicate availability of the item as a reinforcer. As soon as the item was removed from the student’s view, the DTT session began. When a student responded correctly during a trial and an opportunity to access a reinforcer was available, the teacher initially presented the item for about 3-s without an accompanying verbal prompt. If the student manded for the item within 15-s, a small portion of the item (e.g., piece of cookie, chip, or viewing video for 15-s seconds) was delivered immediately and the student’s response was recorded as a MC mand. Following the delivery of the requested item, the teacher implemented a 2-min time delay during which time the target item was removed from the participant’s view (by hiding it under the table). If the participant manded for the displayed item after 15-s and during this time delay, the response was recorded as MO-controlled and reinforced immediately. If a MO-controlled mand did not occur by the end of the 2-min interval, the item was shown again (for 3 seconds) as a prompt for the mand. If the participant manded for the item, s/he was provided with access for 15-s and the next 2-min time delay was initiated.

During the second and all subsequent intervention sessions, the target item was not displayed for the first 5 minutes of the 15-min DTT session (i.e., inserted time delay + prompt fading as noted by Sweeney-Kerwin et al., 2007). This provided each participant the opportunity to request the item without the presentation of a prompt. If the participant manded for the item during the allotted 5 minutes, the response was immediately reinforced and stimulus-control transfer from a MC mand (i.e., presence of the item) to an MO-controlled or spontaneous mand (i.e., item out of view) was considered to have occurred. The addition of this component ensured that the interventionist did not provide unnecessary visual prompts by displaying the item and thereby potentially promoting dependence on the presence of the prompt. For the remainder of
the 15-minute session, the item was not displayed at all and as a result, only MO-controlled mands for the specific high preference item occurred. However, if the participant manded for a visible low preference item, it was delivered but was recorded as a MC mand. If a participant did not request the item during the first 5 minutes of the session, the item was displayed (for 3 seconds) and the time delay and prompt fade procedures (as described above) were implemented for the rest of the session.

When Participant 1 began to emit MO-controlled mands at a steady, stable and higher rate than baseline, intervention was implemented with the second participant. These procedures continued to be implemented until each participant had been exposed to all targeted items during the intervention phase. When the frequency of occurrence of MO mands for one target was high and stable, a new target item (next in rank order of preference items) was introduced. Data from this phase addressed Research Question 1.

**Generalization Across Targets**

Following the intervention phase, if a participant emitted MO controlled mands at rates significantly higher than baseline (at least 50% higher and minimal overlap in data), generalization across untrained targets was evaluated for that participant (Stokes & Baer, 1977). The instructional context during generalization was a natural environment setting during which the participants were engaged in either small group activities (e.g., art project) or whole class routines (e.g., morning snack). This was to evaluate the extent to which participants spontaneously manded for trained or untrained targets as a function of the stimulus control transfer procedure (addresses Research Question 2). The stimulus control transfer procedure utilized during the intervention phase was not implemented in this phase in order to assess for response generalization. Any item, object or activity regardless of preference (high or low), that
was used in baseline or intervention was categorized as a “target” or “trained target” and the ones not used previously were categorized as “non-target” or “untrained target.” Data were recorded on the frequency of MO mands for trained or untrained targets to evaluate the extent to which response generalization was observed.

Training of Interventionists

The lead investigator for this study has a bachelor’s degree in special education and a master’s degree in special education (autism). She had completed all the coursework required for the board certified behavior analyst certification and is working on accumulating supervision hours. She had worked in the field of special education for the last 28 years as a classroom teacher, consulting teacher, autism specialist, and special education administrator. In her current role, she is responsible for the supervision of special education teachers and the delivery of evidence-based practices for students with autism.

The classroom teacher for each participant served as the interventionist for this study. Most classroom teachers in the autism program within this North Texas school district are well-trained in the use and implementation of the principles of applied behavior analysis and verbal behavior. However, none of them were board certified behavior analysts.

Praveen’s teacher has a bachelor of arts degree in law and justice and is alternatively certified to teach special education (EC-12, Generalist EC-6). Through attendance at workshops and trainings she had acquired over 30 hours of instruction related to applied behavior analysis, verbal behavior, and teaching children with autism. She had completed 7 years as a special education classroom teacher.

Angel’s teacher has a bachelor of arts degree in psychology and a master’s degree in special education (autism). She had completed the required coursework related to the board
certified behavior analyst certification. She had completed her seventh year of teaching students with special needs.

Daneesha’s teacher has bachelor of arts degree in psychology and a master of science degree in education with an emphasis in early childhood education and autism. She had attended numerous trainings related specifically to teaching children with autism, including a 3-day training (18 hours) with Dr. Vincent J. Carbone prior to initiating the study. She had completed her ninth year of teaching students with special needs.

Vanessa’s teacher has a bachelor of arts degree in sociology and is certified to teach special education (EC-12, Generalist EC-6). She had attended numerous trainings related specifically to teaching children with autism and had completed 2 years of teaching students with special needs.

Each classroom teacher (i.e., interventionist) was provided with specific training in the implementation of time delay combined with prompt fading procedures for the purpose of this study. In order to provide the interventionists with the necessary skills to implement the intervention with fidelity, a detailed script depicting the step-by-step procedures was used. Specifically, the interventionists individually received approximately 3 hours of training across three, 1-hour sessions in the week prior to intervention for each participant.

The training for each interventionist was conducted in his/her classroom by the lead investigator with a student who was not participating in the study. This training corresponded with the phase change for each participant from baseline to intervention. Each training session consisted of a review of the terminology and daily data collection procedures for their student, modeling of the time delay procedures, role play of the intervention procedures by the interventionists with the lead investigator, corrective feedback, and an opportunity for the
interventionists to practice the procedure following feedback. Each training opportunity ended with a required demonstration of the skills taught during the session to determine the skill level of each interventionist.

Interventionists were required to demonstrate 100% mastery in the implementation of the intervention procedure (i.e., prompt fade and time delay) as measured by successful completion of each step of the intervention protocol in the correct order across three consecutive training sessions. Training continued until all interventionists demonstrated mastery. Mastery was achieved after an average of two training sessions per interventionist.

Fidelity of Implementation

According to Cooper et al. (2007), the definition of treatment integrity is “the extent to which the independent variable is implemented or carried out as planned” (p. 235). Determining the degree to which an intervention is executed with fidelity is critical for demonstrating the effect of an independent variable on the dependent variable(s) and allows “more precise conclusions to be drawn” (Kennedy, 2005, p. 110). Within applied research, threats to intervention fidelity may result in lower levels of confidence in the obtained results and jeopardize the overall integrity of the study. To address these potential threats, Cooper et al. (2007, p. 235-237) suggest: (1) that all procedures be operationally defined with such specificity and detail that interventionists are capable of implementing and replicating the intervention with fidelity; (2) all interventions, when feasible, should be simple, straight-forward procedures that require a small amount of effort on the part of the interventionist; (3) provide interventionists with training and feedback regarding the implementation of the treatment protocol used in the study; and (4) collect data specific to treatment integrity.
Treatment integrity was recorded by the secondary observer and reliability sessions were conducted by the primary observer (or lead investigator) in order to minimize the probability of observer drift and bias. Observers viewed the videotaped data of DTT sessions and recorded interventionist behaviors as described in the script for implementation of intervention:

*Script to Ensure Fidelity of Implementation of Intervention (Stimulus Control Transfer Procedure)*

Session 1:

1. At the beginning of the first 15-minute Direct Instruction (DI) session conducted during the Intervention Phase, display any one of the previously selected targets (e.g., edible item, activity, or object) for 3 seconds (for a vocal count of three—*one thousand one, one thousand two, one thousand three*). Remove the target out of view of the participant by placing it under the desk.

2. Begin the DI session with scheduled instruction for the IEP objective. During any of the instructional trials:

   a. If the participant mands for the edible/object/activity (sign or vocal) within 15 seconds of the target being displayed (in Step 1), immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record the child’s behavior as a MC mand. Remove the target out of view of the participant by placing it under the desk.

   b. If the participant mands for the edible/object/activity (sign or vocal) after 15 seconds of displaying the target, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15
seconds) and record the child’s behavior as a MO mand. Remove the target out of view of the participant by placing it under the desk.

3. Following either a MC mand or a MO mand, set the timer for 2 minutes and begin the 2 minute time delay. Continue with DI session. The target is still out of view.
   a. If the participant mands for the edible/object/activity (sign or vocal) during the 2 minute time delay, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset timer for 2 minutes and start the next time delay.
   b. If the participant does not mand for the edible/object/activity (sign or vocal) during the 2 minute time delay, display the target again for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three) by raising it from under the desk to the eye level of the child. Following the display of the target, if the participant mands for the edible/object/activity (sign or vocal) within 15 seconds after the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record the child’s behavior as a MC mand. If the participant mands for the target after 15 seconds or more following the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset the timer for 2 minutes and start the next time delay.

4. Continue with this procedure for the duration of first 15-minute Direct Instruction (DI) session conducted during the Intervention Phase.
Session 2 and all subsequent intervention sessions:

1. Beginning with the second session, and all remaining sessions in the Intervention Phase, the target item will not be displayed for the first 5 minutes.

2. Begin DI session with scheduled instruction for the IEP objective. During any of the instructional trials:
   
a. If the participant mands for the target item during this 5 minute period:
      
i. Immediately deliver target (edible item = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds)
      
   ii. Record as MO mand

   iii. Continue with DI session

   iv. The target remains out of view for the remainder of the session

b. If the participant does not mand for the target during this 5 minute period:
   
i. Display the target at the end of the 5 minute period;

   ii. If the participant mands for the edible/object/activity (sign or vocal) within 10 seconds of the target being displayed, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MC mand. Continue with DI session with target out of view.

   iii. If the participant mands for the item/object/activity (sign or vocal) 15 seconds after the display of the target, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Continue with DI session with the target out of view.
3. Following either a MC mand or a MO mand, set the timer for 2 minutes and begin the 2 minute time delay. Target is out of view.
   a. If the participant mands for the edible/object/activity (sign or vocal) during the 2 minute time delay:
      i. immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds);
      ii. record as a MO mand;
      iii. reset timer for 2 minutes and start the next time delay.
   b. If the participant does not mand for the edible/object/activity (sign or vocal) during the 2 minute time delay:
      i. display the target again for 3 seconds (for a count of three—one thousand one, one thousand two, one thousand three);
      ii. following the display of the target, if the participant mands for the edible/object/activity (sign or vocal) within 15 seconds after the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds);
      iii. record as a MC mand;
      iv. If the participant mands for the target after 15 seconds or more following the display, immediately deliver target (edible = bite-size portion; object = allow access for 15 seconds; activity = allow access for 15 seconds) and record as a MO mand. Reset the timer for 2 minutes and start the next time delay.
4. Continue with this procedure for the duration of the session.
This script was converted into a fidelity checklist with notations made for whether or not the specific procedures were implemented accurately and sequentially by each interventionist (see Appendix B). When interventionists missed specific steps from the checklist (e.g., turning on the timer or limiting reinforcer access to 15-s), the lead investigator conducted retraining sessions. These prompts occurred during the early stages of the intervention. Treatment integrity data were recorded for approximately 30% of intervention sessions for each participant.

The outcomes for procedural fidelity are as follows: Praveen ($M = 95\%$; range = 88–100$\%$), Angel ($M = 94\%$; range = 64–100$\%$), Daneesha ($M = 95\%$; range = 75–100$\%$), Vanessa ($M = 100\%$). When fidelity of implementation rates dropped below 90% on any given session, the lead investigator conducted additional training with the interventionist. Additionally, consistent and frequent contact (e.g., emails, phone calls, text messages, classroom visits) between the lead investigator and the interventionists was maintained throughout the study to ensure procedural fidelity.

Social Validity

Social validity, as defined by Kennedy (2005) is “the estimation of the importance, effectiveness, appropriateness, and/or satisfaction various people experience in relation to a particular intervention” (p. 219). In order to determine the consumer satisfaction and acceptability of the intervention procedures from the perspective of stakeholders, a brief teacher and parent survey was administered after experimental sessions were completed. Social validity measures for teachers provided information on the extent to which they were satisfied with the technical aspects of the intervention and the relevance of the outcome for their students. Similarly, information from parents helped determine the extent to which they valued the outcome and whether or not spontaneous manding made any difference to the quality of life of
their children. A detailed response to the questions on the social validity measure is presented in Table 4.

The questionnaires completed by all four interventionists and indicated strong agreement with the acceptability and the ease of implementation of intervention procedures. Agreement and strong agreement was indicated by the interventionists in the areas related to increased access to reinforcement by the participants and use of these procedures with other students in the future (see Appendix C). The questionnaires completed by the parents of two participants indicated agreement and strong agreement regarding the acceptability and outcomes of the study. Perhaps most importantly the results of the questionnaire indicated that the parents believed that their child’s participation in the study had improved their life, either directly or indirectly (see Appendix D; see Appendix E for Detailed Methodology).
APPENDIX F

UNABRIDGED RESULTS
The video data were coded, graphed and analyzed concurrently with data collection for each participant using the scientific principles of visual analysis typical of single subject research methodology. Visual analysis was used to determine the existence of a functional relation between the independent and dependent variables and to specifically determine the stability of the behavioral pattern, change in the level of performance and the direction of the trend line. Additionally, effect size was computed to obtain a measure of the magnitude of effect of the intervention on the dependent variable. Results are discussed in relation to the specific research questions.

Stimulus-Control Transfer Procedure and Rate of Spontaneous Manding

Overall, the intervention (i.e., stimulus control transfer procedure) was expected to increase the frequency of spontaneous manding (MOs) for the participants when compared to baseline rates. It was also predicted that the rate of MC mands would be higher during baseline but decrease or remain the same until MO mands generalized to untrained targets.

As predicted, baseline data for Praveen showed zero rates of spontaneous manding across five consecutive sessions. Given a stable behavioral pattern, intervention was initiated with Praveen starting Session 6. Data showed that he did not immediately respond to intervention and demonstrated a variable pattern of behavior. However, starting Session 17 (i.e., 12th intervention session), Praveen showed a steady increase in the level of MO mands in spite of variability in the pattern. It should be noted that Praveen was absent from school for 10 days during the intervention phase due to ill health. During intervention, Praveen was taught to spontaneously mand with two targets (i.e., marble, nut). In addition to these two trained targets, Praveen spontaneously manded for nine (82%) untrained targets (i.e., car, ball, train, play doh, movie, puzzle, airplane, water, popcorn, cookie, and chip) for the first time during intervention.
When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 6.4; \text{Mdn} = 5; \text{range} = 0–19$) was observed during the intervention phase. Overall, the stability envelope indicated that higher than 80% of the intervention data were within 20% of the median indicating overall stability (Gast, 2010). The percentage of overlapping data was minimal ($POD = 14%; PND = 86%$) and not observed after Session 13. Overall, Praveen’s data ($M = 6.4$ MOs per 15-min session) appear to indicate an increase in spontaneous manding as a function of the intervention.

The data on MC mands for Praveen indicated a higher rate during baseline ($M = 9.2; \text{Mdn} = 9$) when compared to the rate of MO mands ($M = 0$). Conversely, following the introduction of intervention, data indicated a reduction in the rate of MC mands ($M = 6.5; \text{Mdn} = 6$) while a concurrent increase in MO manding ($M = 6.34; \text{Mdn} = 5$) was observed.

Following an increasing trend in response to intervention for Praveen, intervention was initiated with Angel. Data showed that he did not immediately respond to intervention either, demonstrating a variable pattern of behavior for the first few sessions. However, starting at Session 24 (i.e., sixth intervention session), Angel showed a steady increase in the level of MO mands in spite of variability in the pattern. Angel was taught to spontaneously mand during intervention using one target (i.e., doodle). However, as early as the third intervention session, Angel spontaneously manded for untrained items (i.e., iPad, book) and continued to emit MO mands for nine other untrained targets (i.e., coke, puzzle, chip, play doh, song, yellow, headphones, cracker, candy) during this phase. All of the untrained targets (100%) were requested for the first time during the intervention phase. When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 9.7; \text{Mdn} = 11; \text{range} = 0–23$) was observed during intervention. The minimally overlapping data ($POD = 10%; PND = 90%$) and a steadily
increasing trend indicated the effectiveness of the intervention. A slight decrease in the rate noted in Session 26, may have been due to the occurrence of negatively reinforced (i.e., escape) problem behavior.

Angel’s baseline data demonstrated higher rates of MC mands ($M = 10.7$; $Mdn = 11$) when compared to rate of MO mands ($M = 0$). During intervention, an increase in MO mands ($M = 9.7$; $Mdn = 11$) resulted in a corresponding decrease in the rate of MC mands ($M = 2.6$; $Mdn = 0$).

Following an increasing trend in the pattern of spontaneous mands for Angel and zero rates for Daneesha during baseline, intervention was initiated with her. Following the introduction of the intervention, rates of spontaneous manding increased slightly ($M = 1.6$; $Mdn = 1$) over baseline rates ($M = 0$). Even though a dramatic increase in MO mands was observed during the first session of the intervention phase, Daneesha did not maintain high rates of spontaneous manding during this phase, showing a high percentage of data overlap (POD = 43 %). The rate of MC mands ($M = 16.6$; $Mdn = 15.5$) was significantly higher than MO mands ($M = 0$) during baseline. Following intervention, the rate of MC mands decreased ($M = 5.9$; $Mdn = 5.6$) but MO manding rates ($M = 1.6$; $Mdn = 1$) did not concurrently increase as predicted. Because Daneesha did not reach the criterion for acquisition rate of MO mands (i.e., 50% higher than baseline), intervention was discontinued with her, the generalization phase was not evaluated either, but intervention was initiated with the last participant, Vanessa.

Vanessa did not immediately respond to intervention as demonstrated by a variable pattern of behavior. However, starting in Session 64 (i.e., the sixth intervention session), she showed a steady increase in the level of MO mands in spite of a variable pattern. During intervention, Vanessa was taught to spontaneously mand on one target (i.e., dinosaur). However,
Vanessa began to spontaneously mand for six (71%) other untrained targets (i.e., people, candy, chocolate, cookie, drink, spider) for the first time during intervention. When compared to baseline ($M = 0$), a higher level of spontaneous manding ($M = 9.1$; $Mdn = 3.5$) was observed during intervention. The minimal amount of overlapping data ($POD = 29$%; $PND = 71$%) and an increasing trend appear to indicate the effectiveness of the intervention.

Baseline data for Vanessa demonstrated a higher rate for MC mands ($M = 7.7$; $Mdn = 7$) compared to MO mands ($M = 0$). Following the introduction of intervention, the manding rates were reversed ($MC, M = 4.3$; $Mdn = 4$; $MO, M = 9.1$; $Mdn = 3.5$).

Trained and Untrained MO Mands During Generalization

As predicted, participants began to spontaneously mand for untrained targets at a higher rate when compared to relatively lower rates for trained targets (see Table 5).

During generalization, Praveen manded for both trained and untrained targets, providing a demonstration of response generalization. Additionally, stimulus generalization was demonstrated through spontaneous mands across multiple environments (i.e., classroom and speech therapy) and instructors (i.e., teacher, speech therapist, and paraprofessional). According to the classroom teacher, Praveen continued to spontaneously mand for trained and untrained targets with multiple staff members long after the study concluded. At the beginning of the next school year, Praveen’s teacher reported that he had maintained the ability mand for items out of view following the summer break during which time he received no formal intervention. Finally, the generalization data for Praveen demonstrated lower rates of MC mands ($M = 0$) while rates for MO mands continued to increase ($M = 7.8$; $Mdn = 8$).

Data for Angel showed response generalization in the form of spontaneous mands for untrained targets and stimulus generalization in the form of manding with multiple staff
members (i.e., classroom teacher, paraprofessional). His classroom teacher reported that Angel
continued to request a variety of items that were out of view in the classroom environment.
Finally, data during the generalization phase indicated the rate of MO mands ($M = 7; \text{Mdn} = 6$)
remained higher than the rate of MC mands ($M = 1.2; \text{Mdn} = 0$).

Along with response generalization (i.e., manding for untrained targets), Vanessa also
demonstrated stimulus generalization by spontaneously manding for trained and untrained targets
across multiple instructors (i.e., teachers, paraprofessional) during generalization. Vanessa
attended a special education summer school program between the conclusion of the study and the
beginning of the next school year. Her summer school teacher reported that Vanessa
spontaneously manded for items out of view with a variety of staff members. Additionally,
when taught a new mand for unfamiliar items she was often observed to spontaneously use the
new mand to gain access to the item when out of view. During generalization, MC manding
rates ($M = 1.25; \text{Mdn} = 1$) continued to decrease and MO manding rates ($M = 9.6; \text{Mdn} = 8.5$)
increased.

Effect Size of the Magnitude of Intervention on Spontaneous Mands

Effect size, recently recognized as a critical component of single-subject research in
determining magnitude of effect (Horner & Kratochwill, 2012; Kratochwill et al., 2012), was
calculated for spontaneous mands for all participants across baseline and intervention phases
using Cohen’s $d$ index. The effect size for three participants are large [Praveen ($d = 1.94$); Angel
($d = 2.2$); and Vanessa ($d = 1.4$)], whereas the outcome of intervention for Daneesha ($d = 0.98$)
indicated moderate effect. However, the overall ($d = 1.15$) outcome demonstrated a large effect
(see Appendix F for Unabridged Results).


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