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The Use of a Stimulus Control Transfer Procedure to Teach Motivation-Controlled Mands to Children With Autism

Karen D. Ward, PhD[1] and Smita Shukla Mehta, PhD[1]

Abstract

Social participation of children with an autism spectrum disorder (ASD) in natural environments can be enhanced by teaching them to communicate spontaneously, at least in situations where they have the motivation to access specific items or activities by controlling the amount of access for these stimuli. The purpose of this study was to determine if mand training, using a stimulus control transfer procedure would promote acquisition and generalization of mands for specific activities or objects evoked by motivating operations. Measurement variables included the frequency of motivation controlled (MO) versus multiply controlled mands during discrete trial training on a variety of verbal operants. Using a concurrent multiple baseline design across participants, visual analysis indicated that MO mands for out-of-view items increased substantially with generalization across targets, staff, and environments for three of the four participants. One participant did not respond to intervention to the same extent as others.

Keywords

mands, multiply controlled mands, motivation controlled mands, stimulus control transfer, time delay

Interventions for children with an autism spectrum disorder (ASD) tend to focus on improving social communication skills and decreasing restricted and repetitive patterns of behavior, interests, or activities. Such interventions are particularly crucial for improving lifestyle outcomes for children with ASD. It has been estimated that up to 50% fail to develop functional, vocal, and verbal behavior (VB), which severely limits social participation (Hartmann & Klatt, 2005). Research has demonstrated that children who struggle or fail to develop a functional communication repertoire, often acquire an alternative, less conventional form for expressing their needs and wants, for example, crying, aggression, and/or self-injury. Furthermore, communication delays limit and often prohibit participation in social activities and experiences with peers (DeSouza, Akers, & Fisher, 2017).

Social participation in natural environments can be enhanced by teaching children with ASD to communicate more spontaneously, at least in situations where they have the motivation to access specific items or activities. Skinner (1957) described motivation in relation to the state of deprivation, satiation, and aversive stimulation, which appear to alter the value of a stimulus. VB, as described by Skinner (1957), 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) 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, 2013). Research has substantiated Skinner's original tenet of the functional independence of each verbal operant, while demonstrating their interrelatedness (Sautter & LeBlanc, 2006). Specifically, the acquisition of a manding repertoire has accelerated the acquisition of other verbal operants such as tacts (DeSouza et al., 2017).

[1]University of North Texas, Denton, USA

Corresponding Author:
Smita Shukla Mehta, Department of Educational Psychology, University of North Texas, 1155 Union Circle 311335, Denton, TX 76203-1335, USA.
Email: Smita.Mehta@unt.edu

Research suggests that the mand is the most appropriate operant to teach before other operants (Sundberg, 2004). As early as 1999, Drash, High, and Tudor used shaping, prompting, prompt fading, and manipulation of the MO (e.g., increased access to contingent and noncontingent reinforcement) to establish a manding repertoire in three nonverbal boys diagnosed with ASD. With the manding repertoire as a foundation, the authors were able to teach all participants an echoic repertoire and two participants also learned an initial tact repertoire. After determining the favorite items for each, access to these 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 VB. Simply put, responses controlled by variables related to one operant will not automatically come under the control of variables related to a different operant (DeSouza et al. (2017). 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 or she also possesses the ability to request the ball when he or she 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 motivating operation (MO) and the following consequence, that is, the contingent delivery of the item requested.

As defined by Michael (2007), a motivating operation is

> an environmental variable that (a) alters (increases or decreases) the reinforcing effectiveness or value 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)

Simply stated, depending upon the state of satiation (i.e., excessive exposure) and deprivation (i.e., restricted access), at any given point in time, the MO alters *how much* a person wants something. As a controlling variable, a strong MO must be present for manding to occur reliably. Therefore, it is extremely important for interventionists to continuously analyze the MO strength 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, 2013). Perhaps one of the most effective methods for determining the motivational state is to offer choices of items previously observed to be valued by the student. Once motivation for an item or activity is declared, mand training can be initiated. During mand training, it is extremely important for interventionists to continuously analyze the strength of an MO to ensure that the child has sufficient interest in an item, object, or activity to exert the effort required to produce a mand (Sundberg, 2013).

The first mands acquired by children with ASD are usually multiply controlled (MC) mands (Sundberg, 2004). An MC mand is one where the motivating operation (MO) is present along with an additional stimulus (e.g., vocal prompt or presence of the highly preferred item), which controls the mand. In contrast, an MO mand is one where the motivation is present even when a highly preferred item is out of view; the child mands to gain access to the item and the behavior is reinforced by a listener (Sundberg, 2013; Sweeney-Kerwin, Carbone, O'Brien, Zecchin, & Janecky, 2007). Although both types of mands are useful, MO manding is considered to be a more advanced form of VB. By releasing control of the mand from multiple stimuli, the child may be able to request items or activities that she or he wants across a variety of settings and listeners, demonstrating more control over the environment (Bondy, Tincani, & Frost, 2004; Sautter & LeBlanc, 2006). MC mands limit access to highly preferred items if a child has to choose from a limited array of items. The most efficient way to make this process more naturalistic and encourage children to access reinforcers more frequently is to transfer control of the mand to the MO. However, it is likely that even properly controlled mands (i.e., mands that occur only in the presence of the relevant MO but that are not bound by the presence of the specific reinforcer) could also be MC (e.g., occasioned by the presence of a listener, teacher praise at the end of a discrete trial, etc.). That said, MO mands are more functional, socially valid, and similar to the natural requesting repertoires of typically developing children (Michael, 2007; Sundberg, 2004).

Motivation controlled mands do not typically develop in young children with ASD without intensive direct instruction. Although the lack of MO mands appears to be related to cognitive deficits, interventions that do not include prompt fading procedures combined with differential reinforcement are more likely to restrict spontaneity. To increase MO mands of children with ASD, research has documented the use of time delay to eliminate the need for prompts and transfer control from the prompt to naturally occurring stimuli by varying the time between the presentation of the prompt and the natural stimuli (Sweeney-Kerwin et al., 2007). In a study to teach MO mands to two young children with ASD, Sweeney-Kerwin et al. (2007) used a rolling time delay and prompt fading for MC mands. Results showed that both children acquired MO mands, but the rate across target items was highly variable. In addition, one participant showed stimulus generalization (i.e., trained responses occur in the presence of untrained but similar stimuli). However, neither showed response generalization (i.e., occurrence of untrained members of a response class in the presence of novel stimuli).

Table 1. Participant Developmental Profile.

Participant	Autism assessment	Cognitive/intellectual	Language/communication
Praveen	ADOS Module 1 ASRS–parent, teacher SRS–parent	DASI-II = 41 (*very poor*) DAYC ≤ 50 (*very poor*)	Receptive-expressive emergent language test-3 Receptive ≤ 55 (*very poor*) Expressive ≤ 55 (*very poor*)
Angel	ADOS SCQ	SBIC FSIQ = 44 (moderate impairment)	PLS-5 SS = 50 (severe delays)
Daneesha	ADOS Module 1 ASRS–parent, teacher	DASI–II = 46 (*poor*) DAYC ≤ 50 (*very poor*)	DAYC–communication subtest ≤ 50 (*very poor*)
Vanessa	ADOS Module 1 GARS–parent	DAYC = 70 (low) KABC-II = 40 (very low)	Not available

Note. ADOS = Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 2003); ASRS = *Autism Spectrum Rating Scales–Parent and Teacher* (Goldstein & Naglieri, 2010); SSRS = *Social Responsiveness Scale* (Constantino & Gruber, 2012); DASI-II = Developmental Activities Screening Inventory (Fewell & Langley, 1984); DAYC = Developmental Assessment of Young Children (Voress & Maddox, 1998); SCQ = Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003); SBIC FSIQ = *Stanford-Binet Intelligence Scales–Full Scale Intelligence Quotient* (Roid & Barram, 2004); PLS-5 = *Preschool Language Scales–Fifth Edition*; GARS = *Gilliam Autism Rating Scale* (Gilliam, 2014); KABC-II = Kaufman Assessment Battery of Children-II–Nonverbal Index (Kaufman & Kaufman, 2004).

The current study extends Sweeney-Kerwin et al.'s (2007) research in several ways: (a) whereas in their study, instructors and data collectors were professionals who worked at the same private clinic that offered intensive one-on-one teaching to participants, in the current study, classroom teachers served as interventionists and doctoral students were data coders. There was no communication between the interventionists and the secondary data coder because all video data were uploaded on a secure server accessed remotely by the secondary data coder who was truly blind to the purpose of the study, minimizing observer bias; (b) in Sweeney-Kerwin et al.'s study, all the targeted items were edibles (e.g., fries, lollipop, pretzels, chips, bacon and biscuit), in the current study, a wide variety of preferred toys (e.g., Play-Doh®, dinosaur, doodle, marbles), activities (e.g., puzzles, movie, markers), and food items (e.g., chip, chocolate, pretzel, candy) were used to increase the likelihood of response generalization, as long as the MO was present; and (c) the current study utilized more methodologically rigorous procedures by evaluating procedural fidelity, assessing interobserver agreement for procedural fidelity, measuring the magnitude of effect and conducting generalization assessment in natural school and activity contexts. The purpose of the current study was to determine the effectiveness of a mand training procedure and assess whether generalized mands would be associated with trained or untrained targets. Specific research questions include the following:

- **Research Question 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 MO mands for children with ASD?
- **Research Question 2:** Will a higher rate of MO mands be associated with trained or untrained targets during generalization assessment?

Method

Participants and Setting

Four children with ASD and developmental disabilities were nominated for participation. The inclusion criteria was (a) an ASD diagnosis, (b) participants needed to possess three to 20 MC mands, but no MO mands in observed school settings, and (c) the individualized education plan (IEP) objectives required communication instruction, specifically MO mands to improve lifestyle outcomes. All participants were documented to have a developmental disability and ASD (see Table 1). An ASD diagnosis was based on a comprehensive review using ASD assessments, parent interviews, and school records including classroom observations. The research team was informed that all participants met Texas Education Agency's (TEA) eligibility criteria for ASD. The study was initiated after approval from the university's institutional review board.

Praveen (pseudonym) was a 7-year-old boy of east-Indian descent. He lived with his biological parents and an older sister. Initial teacher report indicated that he primarily communicated using single-word utterances to request and label items and activities. He indicated his motivation to gain access to preferred items by reaching for the desired item. According to teacher data and baseline observations, his manding repertoire consisted of six to eight 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. It took six to 10 trials for him to acquire new verbal operant targets.

Angel (pseudonym) was a 6-year-old Hispanic boy who lived with his biological mother and an older brother. Initial observations and teacher report indicated that he primarily communicated using a single sign to request and label items and activities. He indicated his motivation to gain access to an item or object by reaching for it. According to his teacher, his manding repertoire consisted of 15 to 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. It generally took three to five trials to acquire new verbal operant targets.

Daneesha (pseudonym) was a 5-year-old African American girl who lived with her biological parents and a younger brother. Teacher reports 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. Her manding repertoire consisted of three to five single signs for visible items (e.g., chocolate, movie, markers). In addition, 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., teacher positioning her hands) was required to produce the correct sign for what she wanted to access. Her direct instruction program was limited to matching and sorting pictures and objects. It took over a 100 trials to acquire new verbal operant targets.

Vanessa (pseudonym) was a 5-year-old Hispanic girl who lived with her biological mother and an older sister. Teacher reports indicated that she primarily communicated using single signs to request items and activities. She typically indicated her motivation to gain access to an item by reaching for it or leading a staff to the object if visible but out of reach. According to teacher data, her manding repertoire consisted of seven to nine 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. It took five to eight trials for Vanessa to acquire new verbal operant targets.

The study was conducted in four elementary public school classrooms in the South-Central region of the United States. Each classroom was approximately 20' × 20' and equipped with tables, chairs, computer workstations, and storage cabinets. The experimental sessions occurred in the classroom with the teacher and student across the table facing each other. Thus, each teacher was accountable for managing the classroom and providing instruction to other students as needed.

Instructional context. The instructional context for teaching MO mands constituted the use of discrete trial teaching (DTT), errorless learning, and a schedule of reinforcement.

DTT. DTT (Smith, 2001) consisted of an instructional session where trials specific to the IEP learning objectives were presented to the student (Thiessen et al., 2009). The learning objectives varied throughout the session, meaning the teacher presented a variety of tasks related to different verbal operants appropriate for each individual student. For example, a student had IEP objectives for tacting (labeling), intraverbals ("A cow says ____"), and manding (requesting). In addition, 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). In effect, a dense schedule of reinforcement abolishes the motivation to engage in escape-maintained problem behavior (Michael, 2007).

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 S^D (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 study to retain the motivation value of the reinforcers (Michael, 2007).

Schedule of reinforcement. Because reinforcement (S^R+) is an integral component of the DTT process, it was critical that the amount and type of S^R+ be consistent for each student across all experimental phases, including baseline. This was to ensure that the amount or type of S^R+ would not be a confounding variable. The number of opportunities to mand (followed by S^R+) during baseline 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 student 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 too.

Dependent Variables

Motivating operation–controlled (MO) mands. A motivating operation controlled mand was defined as (a) an unprompted request (i.e., vocal, sign, gestures or pictures) made for a specific item or activity when it or its picture/symbol was not physically present or visible to the student (e.g., request candy stored in the refrigerator while seated at the table) and (b) the child had to first *engage* with the item when reinforced with access following a mand (e.g., eat the piece of chocolate; i.e., demonstrate motivation). If a child manded for an item, but did not engage or consume it, then it was treated as a tact or an error and not recorded as MO mand (e.g., requested candy but not eat when delivered, i.e., no motivation). MO mands were measured through frequency of occurrence during the 15-min instructional session. 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 s of the presentation of the item or prompt.

MC mands. MC mands were defined as verbal or signed requests for a specific item, object, or activity when the item or any associating symbol was present and visible to the student, serving as a prompt. An 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 (e.g., request to jump on the trampoline after entering a room where the trampoline was visible). An MC mand was also measured via frequency of occurrence during the 15-min session if occurred within 15 s of availability or presentation of a prompt.

Procedures for Data Collection

Equipment and materials. DTT sessions with each participant were recorded by using a digital video camcorder. A digital timer was used to record the duration of time delay that was implemented during intervention. The teacher was responsible for setting the timer for each time delay procedure according to the scripted instructions provided to maintain procedural fidelity.

Direct observation. Each DTT session was divided into trial-based intervals. For each trial, video data were recorded on the (a) number of opportunities to mand, (b) number of times a participant manded, (c) number of MC and MO-controlled mands, (d) type of targets (e.g., edible, object or activity) for which the student manded, and (e) number of times a participant contingently received access to manded items. The first author was the primary data coder.

Interobserver agreement (IOA). IOA was collected for 30% of all observations spread equally across all experimental conditions for each participant. A secondary data coder was a doctoral student and a Board Certified Behavior Analyst® (BCBA), but naïve to the purpose of the study. Data collected by both observers were compared on a trial-by-trial basis for each 15-min session to calculate IOA. The duration of each trial varied based on whether the target was for acquisition or mastery. 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 one observer noted MC and another noted MO during the same trial. IOA was calculated by dividing the agreements by the sum of agreements plus disagreements and multiplying by 100 to generate a percentage. IOA for MO 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%).

In addition, to assess the degree of agreement between observers on MO and MC mands, Krippendorff's alpha (α) and percent agreements were calculated for each participant and overall. The overall Krippendorff's α indicated high agreement (range = .95–.99; percentage agreement range = 94.7–95.3). Similarly, agreement for individual participants was also high (range = .85–1.00; percentage agreement range = 84.8–97.3).

Research Design and Procedures

A concurrent multiple baseline design across participants was used.

Baseline. Teachers typically conducted informal preference assessments immediately prior to initiating a baseline session, which involved participants selecting items by name rather than a conventional point or pick-up selection response. For confirmation on whether participants could mand for each high-preference item, some combination of both high (e.g., Play-Doh®, movie, car, puzzle, chip, chocolate, candy, drink) and low-preference (e.g., nuts, marbles, markers, doodle, dinosaur) items were visible (1–2 of each type) in each assessment. Prior to baseline, teachers conducted multiple-stimulus preference assessment without replacement. Subsequently, the participant was allowed to access low-preference items for 1-min, while the teacher removed all high-preference items from view prior to initiating baseline.

During the session, initially the teacher asked a participant, "What do you want?" following a correct response. However, as baseline continued, some participants manded for a visible item present at the table as soon as the teacher said "Yes!" or "Good job!" or nodded her head at the end of a trial. In other words, students asked for a visible item present at the table even without the teacher prompt. After participants responded to the initial contingency, the teacher withheld access to reinforcers upon manding and moved to the next trial. When a child gave an incorrect response, the teacher did not reinforce mands until error correction procedures resulted in a correct response. For example, if the teacher presented a picture of a banana for the participant to tact, but the participant said "chip," the teacher concluded the trial by presenting a vocal model "banana" and praising imitation before giving a chip. When a participant manded for a visible item, it was recorded as an MC mand. All mands occurred for visible items only. Time required for participants to consume or engage with requested reinforcers (i.e., 15 s per mand) did not count toward the 15-min teaching session. With parent cooperation, access to high-preference target items was limited to experimental sessions to retain their reinforcing value.

Intervention (stimulus control transfer procedure). At the beginning of the first session, a single most highly preferred target item (e.g., car, iPad, video, puzzle, drink or cookie) was shown to the student for 3 s (for a count of three—1,001; 1,002; 1,003) to indicate its availability as a reinforcer. As soon as the item was removed from the participant's view, the DTT session commenced. When a student responded correctly during a trial, the teacher held up the same highly preferred item for about 3 s without an accompanying verbal prompt. If she or he manded for it within 15 s, a small amount was delivered immediately (e.g., view a cartoon for 15 s) and a MC mand was recorded. Following delivery of the requested item, the teacher implemented a 2-min time delay during which time the target item was removed from the child's view, but the DTT session continued as usual.

During the second and all subsequent sessions, the target item was *not displayed* for the first 5 min of the 15-min DTT session (i.e., inserted time delay + prompt fading as noted by Sweeney-Kerwin et al., 2007). This provided each child the opportunity to emit MO mands. If she or he manded for the target item during the 5-min prompt delay, the response was reinforced and the target item remained out of view unless the child emitted another MO mand. If she or he manded for a visible low-preference item (e.g., marbles, doodle), that item was delivered and recorded as a MC mand. If the child did not mand during the first 5 min, the same highly preferred item was displayed for 3 s. MO mand instruction was conducted for two targets for Praveen (i.e., marble and nuts), one target for Angel (i.e., doodle), seven targets for Daneesha (i.e., markers, playdoh, drink, puzzle, candy, chip), and one target for Vanessa (i.e., dinosaur). Two high-preference items were shown and removed from view for each child: Praveen (car and movie), Angel (iPad and Play-Doh®), Daneesha (chocolate and movie), and Vanessa (cookie and drink).

Generalization. If a participant learned to emit MO mands at a rate of at least 50% higher than baseline, generalization assessment was conducted. Generalization was assessed in a natural setting during which the participants were engaged in different activities (e.g., art project, speech therapy) or whole class routines (e.g., morning snack conducted by the paraprofessional). This was to evaluate the extent to which participants spontaneously manded for trained or untrained targets. No instruction to any teacher/staff was implemented in this phase to assess for response generalization. In all cases, the teacher (i.e., interventionist) was not present in the setting for any student at any time.

Fidelity of Implementation

Treatment integrity was recorded by the secondary observer and data reliability assessed by the first author to minimize observer drift and potential bias. Observers viewed the videotaped data and recorded teacher behaviors as stated in a script, which was converted into a fidelity checklist. Notations were made for whether or not the specific procedures were implemented accurately and sequentially. When a teacher missed a specific step (e.g., providing more than 15-s access to a reinforcer), or procedural fidelity dropped below 90% for any session (as observed during the early stage of intervention), the teacher was retrained by the first author. Treatment integrity was recorded for approximately 30% sessions for each participant with notable outcomes: Praveen (M = 95%; range = 88%–100%), Angel (M = 94%; range = 64%–100%), Daneesha (M = 95%; range = 75%–100%), and Vanessa (M = 100%). In addition, IOA on procedural fidelity was computed for 30% sessions for all participants at varied points during intervention, showing high agreement across observers (M = 97%; range = 88%–100%).

Social Validity

After the study was completed, a brief Likert-type survey was administered to teachers and parents to assess their satisfaction. Four teachers and two parents responded. Both parents indicated that intervention resulted in the child being able to request out-of-view items, which has increased access to reinforcement. They found the procedures to be acceptable (as described in the Informed Consent letter) and highly valued the outcomes based on children's use of MO mands at home. Results of teacher perspectives are presented in Table 2.

Results

Stimulus Control Transfer and Rate of Manding

Baseline data for Praveen showed zero MO mands. He did not respond to intervention until the 12th session after which he 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 intervention due to ill health. He acquired MO mands with two trained targets (i.e., marble, nut) and nine (82%)

Table 2. Social Validity Ratings by Teachers.

Teacher statements	SD	D	U	A	SA	Teacher comments
Learning to request items that are not present has resulted in increased access to reinforcement for student	0%	0%	0%	50%	50%	"Now that he can ask for things out of view, rate of manding has increased." "She isn't limited to just items on the table."
The procedures used in the study are acceptable to me on a personal and professional level	0%	0%	0%	0%	100%	"Same types of procedures I'm already using just in a different combination." "I felt very comfortable implementing these procedures."
The procedures used in the study were easy to understand and implement	0%	0%	0%	0%	100%	"Very easy!" "They fit right into my DI sessions."
I will use these procedures with other students in the class not included in the study	0%	0%	0%	50%	50%	"Absolutely!" "I have at least 2 others I can't wait to use this with."

Note. SD = strongly disagree; D = disagree; U = undecided; A = agree; SA = strongly agree.

untrained targets (i.e., car, ball, train, Play-Doh®, movie, puzzle, airplane, water, popcorn, cookie, and chip). Compared to baseline ($M = 0$), a higher level of MO mands ($M = 6.4$; $Mdn = 5$; range = 0–19) was noted during intervention. Percent overlapping data were low (POD = 14%; PND = 86%) and not observed after Session 13. Overall, MO mands for Praveen ($M = 6.4$ MOs per 15-min session) appear to be functionally related to intervention.

Similarly, data show that Angel responded to intervention on the sixth session and showed a steady increase in the level of MO mands. He learned to mand with one target (i.e., doodle), however, as early as the third intervention session, MO mands for untrained items (i.e., iPad, book) and nine other untrained targets (i.e., coke, puzzle, chip, play doh, song, yellow, headphones, cracker, candy) increased. All (100%) untrained MO mands occurred for the first time in this phase at a higher rate ($M = 9.7$; $Mdn = 11$; range = 0–23) compared with baseline.

Upon intervention for Daneesha, rates of MO mands increased slightly ($M = 1.6$; $Mdn = 1$) over baseline ($M = 0$). However, a high percentage of data overlap (POD = 43%) across adjacent phases was noted. The rate of MC mands ($M = 16.6$; $Mdn = 15.5$) was significantly higher than MO mands ($M = 0$) during baseline. During intervention, MC mands decreased ($M = 5.9$; $Mdn = 5.6$), but MO mands ($M = 1.6$; $Mdn = 1$) did not increase concurrently. Her responses were observed to be erratic and unrelated to stimulus conditions. Because she did not reach the criterion for acquisition of MO mands (i.e., 50% higher than baseline), the intervention was discontinued, generalization not assessed and intervention was initiated with the last participant, Vanessa. Inability to document intervention effect for Daneesha is a limitation of the study.

Vanessa also responded to intervention starting the sixth session and showed a steady increase in the level of MO mands. She learned MO mands on one target (i.e., dinosaur), but began to mand for six (71%) other untrained targets (i.e., people, candy, chocolate, cookie, drink, spider) for the first time during intervention. Compared to baseline ($M = 0$), a higher level of MO mands ($M = 9.1$; $Mdn = 3.5$; range = 0–29) was observed during intervention.

Conversely, the rate of MC mands for three children decreased as MO mands increased (Praveen, $M = 6.5$; $Mdn = 6$; Angel, $M = 2.6$; $Mdn = 0$; Vanessa, $M = 4.3$; $Mdn = 4$; see Figure 1). However, MC mands for Daneesha decreased too (from $M = 16.6$; $Mdn = 15.5$ in baseline to $M = 5.9$; $Mdn = 5.6$) and MO mands did not concurrently increase as predicted.

Trained and Untrained MO Mands During Generalization

Praveen manded for both trained and untrained targets (as early as the fifth intervention session), demonstrating response generalization. In addition, stimulus generalization was demonstrated through MO mands across multiple environments (i.e., different classroom and in speech therapy) and instructors (i.e., different teacher, speech therapist, and paraprofessional). According to his teacher, he continued to use MO mands for trained and untrained targets with multiple staff long after the study ended. At the beginning of the next school year, Praveen's teacher reported that MO mands for items out of view had maintained in spite of summer break when no formal intervention occurred. Finally, generalization data for Praveen showed lower rates of MC mands ($M = 0$) and increasing rate for MO mands ($M = 7.8$; $Mdn = 8$).

Data for Angel showed response generalization in the form of MO mands for untrained targets (starting the third session) and stimulus generalization across multiple staff (i.e., another teacher, paraprofessional). His teacher reported that Angel continued to request a variety of out-of-view items in the classroom and cafeteria. Finally, generalization data indicated the rate of MO mands ($M = 7$; $Mdn = 6$) remained higher than the rate of MC mands ($M = 1.2$; $Mdn = 0$).

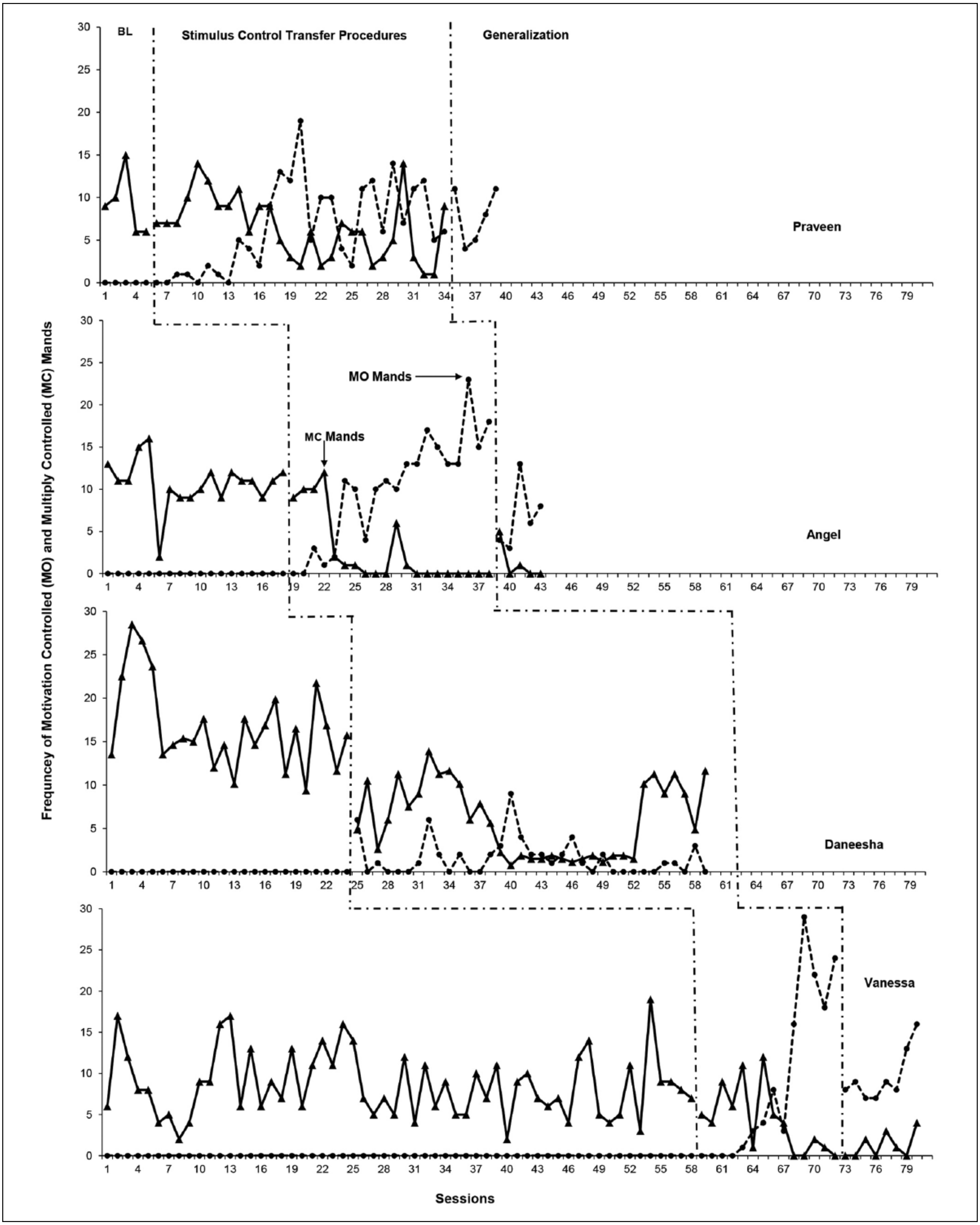

Figure 1. Frequency of motivation controlled (MO) and MC mands.
Note. MC = multiply controlled.

Along with response generalization (i.e., manding for untrained targets), Vanessa also showed stimulus generalization through increased MO mands for trained and untrained targets (starting the seventh session) across multiple instructors (i.e., other teachers, paraprofessional). She attended summer school where her teacher reported that she spontaneously manded for items out of view with a variety of staff. In addition, when taught a new mand for unfamiliar items, she was often observed to spontaneously use the new mand to gain access to out-of-view items. Her MC mands decreased (M = 1.25; Mdn = 1) and MO mands increased (M = 9.6; Mdn = 8.5).

In addition to visual analyses that addressed the functional relation between stimulus control transfer procedure and the rate of trained versus untrained MO mands, effect sizes (ES) were computed to determine the magnitude of intervention effect (Parker, Vannest, & Davis, 2011). Although the utility of ES for autocorrelated data are still questionable, ES was calculated for MO mands for all participants across baseline and intervention using nonoverlap of all pairs (NAP; Parker et al., 2011). NAP is considered to be robust because it individually compares all data points in baseline and intervention by identifying positive pairs (i.e., no overlap), negative pairs (i.e., overlap), and tie (i.e., identical across phases). It yields the percentage of improvement data across phases making it "a complete index" (Parker et al., 2011, p. 312). NAP is "scaled from 50% to 100%, where 50% is a chance-level result" (Parker et al., 2011, p. 312). The magnitude of effect was 93% (Praveen), 95% (Angel), 79% (Daneesha), and 86% (Vanessa).

Discussion

Results demonstrated that three participants used MO mands consistently after skill acquisition. Endicott and Higbee (2007) also reported that participants acquired mands quickly, which generalized across items, settings, and people, perhaps due to their functional utility. Besides the use of behavior analytic procedures, the presence of a strong MO is crucial. A manding repertoire necessitates the presence of motivation, thus, it requires the interventionist to ascertain both the presence and strength of the MO during instruction (Sundberg, 2013).

The current study documented response generalization for three of the four participants by targeting MO mands not just for food but also leisure (e.g., train, iPad, headphones, spider [toy]). Data showed that, collectively, the three participants manded for a large number of untrained targets including toys (e.g., car, ball, train, airplane, spider), activities (e.g., yellow Play-Doh®, book, iPad, movie, headphones, song), and edibles (e.g., cracker, coke, water, popcorn). When compared with the study by Sweeney-Kerwin et al. (2007) who reported a lack of response generalization, it is possible that the three children demonstrated stimulus and response generalization because of the use of multiple exemplars and a learning history where a functional class of responses generated the reinforcers in the presence of the MO (Bondy et al., 2004).

Participants seem to have learned that they could mand for visible and out-of-view highly preferred items or activities not only during instruction, but also during other routines such as snack time, small group projects, and speech therapy. Angel even showed untrained extensions to the original mand (e.g., yellow Play-Doh® instead of just Play-Doh®). Generalization success could also be attributed to the fact that when participants emitted MO mands during downtime, their mands were reinforced with access to the requested item when appropriate. Thus, the presence of a listener is crucial for the MO mand to occur and maintain (Sautter & LeBlanc, 2006).

One additional finding as reported by the classroom teacher indicated an unplanned reduction in prompts used to evoke mands. A verbal prompt to indicate the opportunity to mand (e.g., "What do you want?") was present prior to collecting baseline data, but teachers noted that the need for the verbal prompts decreased as participants began to mand spontaneously. Teachers reported that they simply paused and participants manded, or when motivation was strongest they made the request before the pause occurred (Hartmann & Klatt, 2005; Sundberg, 2004).

One possible explanation for Daneesha's outcome is that the presence of low-preference items and corresponding MC mands might have competed with MO mands for items out of view. This account is supported by the decreasing frequency of MC mands after all preferred and nonpreferred items were completely removed from the instructional context from Sessions 39 to 52. Lack of responding 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 she was allowed access to the item from 15 s to 60 s still did not improve the rate of manding. Furthermore, procedural fidelity data showed that her teacher implemented the intervention with integrity (M = 95%; range = 75%–100%), suggesting that lack of clinical effect was not due to procedural infidelity.

In addition, Daneesha often "scrolled" through her repertoire of signs indicating either a weak manding repertoire or dependency on the teacher's prompt. These results may be attributed to various factors including (a) slow acquisition rate in spite of the highest number (35) of intervention sessions, (b) loss of motivation over time for any trained or untrained item due to circumstances outside of the experiment, and (c) possible motivation to avoid/escape instruction by "scrolling through the repertoire of signs," but not indicating interest in engaging with an item for more than 3 s to 5 s. Although evidence-based interventions offer the most reliable means to achieve improved outcomes, even viable interventions are often ineffective for some people.

Implications for Research and Practice

Strong MOs were established for three children throughout the study by limiting access to highly reinforcing items to intervention periods only. An implication is that during mand training, teachers may want to limit access to high-preference items to avoid satiation. Also, when children do not mand for visible, less preferred items during the first 5-min, they can be exposed to other high-preference items to signal availability. In addition, during any type of mand training, it is imperative that multiple exemplars be used from the start, and all teachers and staff are informed about communication targets. This way, students learn to mand for preferred items across teachers and settings, and are contingently reinforced when appropriate. In other words, planning for generalization should be the ultimate goal.

In the case of students such as Daneesha who learn at a slow rate or fail to maintain MO mands, teachers may focus on contriving a stronger MO, using visible and out-of-view items that produce nonsubstitutable reinforcers, or fading the physical presence of the item in a stepwise fashion for greater effect (Endicott & Higbee, 2007). When students are unresponsive to intervention, teachers tend to continue to use alternative strategies until one works. However, for such learners, perhaps assessing preference for alternative communication topographies seems to be the most important take-away message (DeSouza et al., 2017). Also, critical appraisal of student profiles are integral for determining who will benefit from specific interventions, and suggests that students who require fewer trials to acquire new skills and have a strong manding repertoire, are most likely to benefit from mand training used in this study.

Bridging the research to practice gap is always a valued outcome. 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.

Limitations

Even though staff in untrained natural settings (e.g., cafeteria) indicated no use of MO mands by children prior to intervention, the lack of formal generalization probes during baseline is a limitation. Also, participant mands during baseline may have been low because they had not learned to mand exclusively for high-preference targets. Thus, recommendations for future research are (a) conduct formal generalization probes in baseline if assessing generalization in natural settings and (b) for students who might be slow learners, train for items associated with a single MO per session (e.g., target a mand for food when child is hungry but no food is visible), and then target other mands (e.g., access to an activity during leisure time).

Finally, there is a remote possibility that MO mands as defined in this study could still have been MC during intervention and generalization. During intervention, the only stimulus transferred was the prompt. During generalization, despite a change in the setting and staff delivering instruction, some common stimulus properties in other classrooms could have been similar due to the school culture (e.g., presence of the paraprofessional even though she or he did not deliver the intervention). Thus, although less likely, it is possible that the presence of an MO may not be truly reflected in generalization contexts.

Conclusion

In conclusion, the ability to use MO mands to meet needs can significantly enhance the quality of life for children with ASD. Therefore, it is critical to continue this line of research in public school classrooms with special education teachers to determine the most efficient and effective components of skills-instruction, based on a critical appraisal of language and communication profiles of students with ASD.

Author's Note

Karen D. Ward is now at the Carrollton Farmers Branch Independent School District, Carrollton, TX, USA.

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