Effects of Simultaneous Script Training on Use of Varied Mand Frames by Preschoolers with Autism

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Abstract Young children with autism may fail to mand using a range of frames (e.g., “I want,” “May I have,” “Please give me”). We examined the effects of simultaneous script training and script fading on acquisition and maintenance of varied mand frames with six preschool children with autism. For participants who did not demonstrate increased mand variability under fixed-ratio (FR) 1 conditions, we assessed the effects of post script-training extinction on response variability. Following training of up to four different mand frames, three of six participants emitted more varied mands under FR1 conditions relative to baseline. Posttraining extinction resulted in increased mand variability for two of the three remaining participants. Results are discussed in terms of considerations for both establishing and ensuring the persistence of varied verbal behavior among children with autism.

Keywords Autism · Mand · Mand frames · Response variability

Researchers have documented that individuals with autism engage in rigid language use and far less varied responding than typically developing peers (Boucher 1977; Frith 1972). It is well established that variability is an operant controlled by discriminative stimuli and operant processes such as reinforcement and extinction (see Neuringer 2002). Researchers have demonstrated the efficacy of procedures such as extinction (Grow et al. 2008) and lag schedules (Esch et al. 2009; Lee et al. 2002; Lee and Sturmey 2006; Lee et al. 2007) to produce response variability. In addition, researchers have produced response variability by differentially reinforcing novel or different

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responses while placing repeated responses on extinction (Goetz and Baer 1973; Harding et al. 2004; Neuringer et al. 2001). Readers are directed to two recent review articles for further examination of factors contributing to invariance, reasons why lack of varied responding can be problematic for individuals with autism, and recommendations for practitioners and researchers (Rodriguez and Thompson 2015; Wolfe et al. 2014).

Varied responding may be particularly critical for certain verbal operants, such as mands, which are considered essential for young children with autism (Sundberg and Michael 2001). A child's failure to emit varied mands (e.g., all requests take the form "I want [item] please") may reduce overall access to reinforcement, and invariant mand frames could potentially result in extinction of those mands over time. In a recent study, Betz et al. (2011) evaluated the effects of extinction and direct training of new mand frames on mand variability with preschool-aged children with autism. The researchers first evaluated the effects of extinction and failed to demonstrate increased mand variability for any of the three participants. Next, the researchers attempted to isolate the effects of teaching scripted mand frames in a serial fashion (i.e., each frame was trained to mastery before training was initiated on the next frame). Results indicated that increasing the participants' mand repertoires alone was also insufficient to produce response variability in subsequent extinction and return to baseline-like phases. Two participants demonstrated varied manding only after all three mand frames were trained and extinction was applied. The third participant required an additional intervention involving ongoing visual cues to produce posttraining variability.

It seems feasible that teaching a single mand frame to mastery before introducing another mand frame, as in Betz et al., may actually strengthen invariant responding. Conversely, it is possible that teaching multiple mand frames simultaneously may serve to establish a history of reinforcement for varied responding that will be sufficient to increase mand variability, if temporarily, under posttraining conditions (e.g., an FR1 schedule). Posttraining increases in use of varied mand frames may provide a window of opportunity to strengthen that variability.

The purpose of the current investigation was to assess the effects of simultaneous script training (SST) on increased mand variability and subsequent maintenance in young children with autism. For some participants who did not demonstrate post-SST maintenance of varied mand frames, we evaluated the effects of posttraining extinction.

Method

Participants, Setting, and Materials

Participants included six children recruited from a university-based intensive behavior analytic preschool for children with autism. All six participants were diagnosed with autism and met the inclusion criteria of reliably emitting only one full mand frame (i.e., used one full sentence to request, such as: "I want ____") and communicating vocally in three to five word phrases or sentences. Participants' ages, at the start of the study, were 3 years (Michelle and Olivia), 4 years (Bart and Nico), and 5 years (Tasha and Brody).

Sessions took place in a research room at the preschool containing a small table and two child-sized chairs. A trained undergraduate research assistant or a graduate student

researcher conducted all sessions. Sessions were 5 min in duration and occurred one to four times per day, three to 5 days per week. In an attempt to increase the likelihood that the relevant motivating operation was in place prior to each session, participants' access to edible items was limited from the time of their arrival in the morning until completion of the last experimental session of the day. All experimental sessions occurred prior to lunch.

Three snack items in clear plastic containers were placed in a straight horizontal line on the table, equidistant from each other and from the participant. Data collection materials (e.g., paper, pencil), a timer, a small video camera, and a tabletop tripod were also present. Scripts consisted of white card stock strips with text printed in black 16-point Times New Roman font.

Measurement

Participants' vocal responses were transcribed and tallied during each session; the primary dependent variable was the number of different mand frames emitted within each session. Like Betz et al. (2011), we defined different mand frames as complete sentences (i.e., a subject, a verb, and the name of one of the available edible stimuli) that differed—whether scripted or unscripted—from other mand frames already emitted in a given session by more than adding an adult's name, substituting nouns (e.g., swapping chip for marshmallow), adding/deleting “please,” or rearranging the word order. Default mand frames were defined as the mand frame that a participant emitted in baseline. Scripted mand frames were defined as those mand frames matching the language taught via the scripts word for word, with the exception of adding an adult's name, substituting nouns (e.g., swapping cookie for chip), and adding/deleting “please.” Scripted mand frames were scored as scripted regardless of whether the physical script materials were present. See Table 1 for a complete list of the default, scripted, and unscripted mand frames for each participant.

A trained independent observer collected interobserver agreement (IOA) data for an average of 45 % of sessions for all participants across all phases of the study. Interobserver agreement was calculated for each mand frame recorded in a session by dividing the lowest frequency by the highest frequency and averaging across mand frames in a given session. We then multiplied by 100 to obtain a percentage. Mean IOA percentages were 99 % for Nico, 99.3 % for Michelle, 99.5 % for Bart, 99.5 % for Tasha, 98.7 % for Olivia, and 99.4 % for Brody.

Independent observers collected treatment integrity data on correct implementation of procedures per session for an average of 36 % of sessions for all participants across all phases of the study (e.g., correctly setting out the materials, using the correct script, using the correct prompting procedures). Treatment integrity was calculated by dividing the total number of opportunities to engage in a response by the number of correct implementer responses and multiplying by 100 %. Mean treatment integrity was 96 % for Bart, 98 % for Tasha, 98 % for Brody, and 99 % for Michelle, Nico, and Olivia.

Experimental Design

We used a nonconcurrent multiple-baseline design across participants to evaluate the effects of the independent variables.

Table 1 Participants' default, scripted, and unscripted/altered mand frames

Participant	Default mand frame	Scripted mand frame	Unscripted/altered mand frame
Bart	"I want ____."	"I would like ____." "May I have ____?" "Please give me ____."	"May I have ____?" ^a
Brody	"I want ____."	"Can I please get ____?" "I would like a ____." "May I have some ____?"	"Can I have ____?" "Can I have some ____?" "Can you give me ____?" "Give me a ____." "I want another ____." "I want ____ again." "I want some ____." "I want some more." "May I please have some ____?" "Will you give me ____?"
Michelle	"I want ____."	"I would like ____." "May I have ____?" "Please give me ____."	"Give me ____ please." "I need ____."
Tasha	"Can I have ____."	"I would like a ____." "May I please get ____?" "Will you give me ____?"	"Can I have my ____?" "Can I have some ____?"
Nico	"I want ____."	"I would like ____." "May I have ____?" "Please give me ____."	"I want some ____ please."
Olivia	"I want ____."	"Can I please get ____?" "I would like a ____." "May I have some ____?"	<i>None used</i>

^a "May I have ____?" was scored as unscripted for Bart because it occurred in the initial baseline and extinction conditions before the scripts were taught

Procedure

Script Pretraining We used text scripts because they are well-established independent variables for teaching language skills to children with autism (Krantz and McClannahan 1993, 1998; MacDuff et al. 2007). Researchers probed participants' ability to read all of the words included in each script and taught any words that were not read correctly and independently. Words were taught in ten trial blocks using a vocal model and prompt fading. Mastery was reached when a participant correctly read all words independently with 90 % accuracy (9/10 trials) in two consecutive sessions. We taught and faded a nontarget script (a general statement approximately the same length as the target scripts, but containing none of the words that appeared in the target scripts) to verify that all participants could follow faded scripts. The nontarget script was faded from end to beginning.

Preference Assessment Researchers identified ten edible items for each participant from interviews with parents and teaching staff. Prior to each session, researchers conducted a brief three-trial preference assessment and used selected items in the subsequent session.

General Procedures Three edible items were placed on the table and the experimenter varied the position of the containers across sessions. The experimenter provided the general statement “Time for snack” to signal the start of the session; he or she then waited three to 5 s for the participant to mand for an item. If approximately 30 to 45 s passed with no manding, the experimenter gestured to the items and labeled them (e.g., “We have chips, cookies, and gummy bears”). Item access was not provided for participants’ gestures or incomplete sentences (e.g., single word mands). Researchers briefly responded to any socially appropriate statements or questions. The session ended when the full 5 min elapsed.

Baseline and FR1 All complete mand frames resulted in immediate access to the item requested. The purpose of the FR1 condition was to assess the effects of script training on maintenance of varied mand frames. Based on the two-step fading procedure described below, the first word of each script remained present on the table during FR1 sessions for Michelle. Script materials were absent from all FR1 and extinction sessions for the remaining five participants.

Simultaneous Script Training We taught participants three different scripts (Table 1). For three participants (Tasha, Brody, Olivia), a default mand frame was included as a fourth script in the training sessions. All complete mand frames resulted in delivery of the requested item.

Scripts were taught simultaneously, meaning that all scripts were introduced and trained concurrently rather than serially as in Betz et al. (2011). Within training sessions, each script was presented an equal number of times within a given session; however, scripts were either presented sequentially (Nico, Bart, and Michelle) or concurrently (Tasha, Brody, and Olivia). Sequential script presentation involved presenting scripts by placing them on the table one at a time in randomized order. Concurrent script training involved placing all of the scripts on the table at once and prompting participants to respond to each script in randomized order.

During SST, a participant had three to 5 s to mand independently before the experimenter prompted a response by placing the participant’s finger under the first word on the first text script. If the point prompt did not evoke a response, the experimenter provided another physical prompt and a vocal model (i.e., stating the full scripted frame). Mand frames, independent or prompted, resulted in delivery of the requested snack item. The experimenter then visually checked to ensure consumption. If a mand frame was not emitted within three to 5 s of consumption, the experimenter followed the procedures described above (i.e., presenting another script or prompting the next scripted response). If a participant independently began following a script once it was presented, but made an error or stopped reciting the script, the experimenter immediately provided a physical prompt and verbal model. If a participant independently used the same mand frame twice in a row, the researcher pointed to the next script. During training, each response that met criteria for a different mand frame was

counted as such, regardless of whether the mand was independent, prompted, scripted, or unscripted.

Script fading began once a participant followed all three scripts without prompts on 100 % of opportunities in one session. All scripts were faded from end to beginning. Participants experienced either a two-step fading process (Nico, Bart, and Michelle) or a four-step fading process (Tasha, Brody, and Olivia). In the two-step fading procedure, step 1 consisted of a script with the first two words (the last word was cutoff at the end) and step 2 consisted of a script with only the first word (the last two words were cut off). Script training for participants exposed to the two-step procedure ended after a participant independently used all three first word only scripts on 100 % of presentations for one session. For subsequent returns to the script-training phases for Nico and Bart, script fading started at step 2 (first word only scripts) and faded to the first letter of the first word.

In the four-step fading procedure, scripts were faded by replacing each word with “___.” In steps 1–3, words were removed from the end of the script and replaced by underscores, and in step 4 the script materials were removed entirely. The four-step fading process ended when participants independently used each scripted mand frame at least once in a session with no scripts present.

Extinction for Repeated Mand Frames Only the first occurrence of a given mand frame within a session resulted in reinforcement (i.e., access to the requested item) during extinction for repeated mand frames (EXT) sessions. Any subsequent use of a previously emitted mand frame resulted in extinction (i.e., no item delivered and no other programmed consequence). Script materials were absent in this condition.

Generalization Probes Generalization probes were conducted with Tasha, during which repeated mands were placed on extinction. Probes were conducted in the common area of the preschool at the horseshoe table during snack time with peers. All materials typically used for the snack activity were also present (i.e., students’ placemats, cups, paper towels, snack containers, a pitcher of water or juice).

Results

Two of six participants, Michelle and Brody, engaged in varied mand frames during posttraining FR1 phases (Figs. 1 and 2). Michelle engaged in more varied manding (0–3 mand frames) compared to the initial baseline (0–1 mands). Brody’s mand variability increased (0–5 mand frames) above initial baseline levels (1–3 mand frames). Olivia, Tasha, Nico, and Bart did not vary in an initial posttraining FR1 phase. A subsequent return to FR1 following additional SST produced only temporary variability for Olivia (three mand frames compared to one mand frame per session in baseline).

Because Brody engaged in his peak level of varied manding during the SST condition, we conducted a secondary analysis of his FR1 data to investigate what percentage of within-session manding was composed of scripted and

Fig. 1 Number of different mand frames for Olivia (*top*), Michelle (*middle*), and Brody (*bottom*). Script fading steps are indicated by “S#” and an *arrow*

unscripted mands. These data may shed light on variables that could have contributed to the post-SST increase in variability for Brody (i.e., learning new mand frames, contacting reinforcement for emitting varied mand frames, or some combination). The majority of Brody’s post-SST mand frames were scripted ($M=70\%$ per session; range, 32–100 %). Scripted mands in FR1 primarily consisted of his default mand frame, and unscripted mands were almost exclusively a modification of the default mand frame (“I want some”). Brody engaged in the most varied manding, including use of unscripted frames, in the SST condition when the experimenter prompted and reinforced use of varied mands. Brody’s results may suggest that direct training of novel mand frames (e.g., prompting, differential reinforcement of varied responses) may yield increased variability in previously mastered frames with some learners.

Of the three participants who did not emit varied mands during post-SST FR1 (Tasha, Nico, and Bart), additional SST followed by extinction was sufficient to produce a modest increase over baseline levels for Nico and

Fig. 2 Number of different mand frames for Tasha (*top*), Nico (*middle*), and Bart (*bottom*). Script fading steps are indicated by “S#” and an arrow

Tasha. Specifically, Nico used up to three different mands and Tasha emitted up to six different mand frames. Bart engaged in initial varied manding in FR1 as compared to baseline, but he soon returned to invariant responding. It is worth noting that Tasha did not experience pre-SST extinction; therefore, we cannot conclude whether extinction alone (pre-SST) would have produced similar levels of variability. In the generalization probe, Tasha used six different mand frames.

Discussion

Several findings from the current study may inform researchers and practitioners who wish to address varied verbal behavior with children with autism.

Overall, post-SST FR1 failed to show mand variability for three of six participants. These findings are consistent with those of Betz et al. (2011). As pointed out by Rodriguez and Thompson (2015), engaging in invariant responding is likely less effortful than emitting varied responses, and immediate prior reinforcement increases the likelihood that the same response will be emitted again. Post-SST FR1 conditions resulted in increases in varied manding over baseline for one participant (Brody) and fleeting increases for a second participant (Olivia). A third participant (Michelle) also demonstrated increases in mand variability during the FR1 condition. In summary, FR1 conditions resulted in increased use of different mand frames for three of the six participants. These data indicate that SST might be sufficient to produce modest, if temporary, increases in mand variability but that posttraining FR1 may tend to underestimate those effects. The variability produced in Michelle's posttraining FR1 and Brody's SST conditions are especially encouraging for cases in which extinction is contraindicated because a client exhibits an extremely restricted mand repertoire and may cease all responding (as with Michelle), or for clients who engage in dangerous behavior when reinforcement is denied or delayed.

It is difficult, based on the data obtained with three participants, to draw conclusions about the effects of extinction on mand variability. First, Tasha was not exposed to pre-SST extinction, so there is no way to know if extinction before training multiple mand frames would have increased variability. Given the formal similarity between Tasha's default mand frame ("Can I have") and her unscripted mand frames ("Can I have my" and "Can I have some"), it seems plausible that these mand frames could have emerged in a pre-SST extinction condition. However, based on the data from Betz et al. (2011) and the data from Nico and Bart, there is no indication that exposing young children with histories of invariant manding to extinction will reliably increase variability. Second, interpretation of our extinction-related results is further complicated by a failure to replicate effects of post-SST extinction between the two participants for whom we conducted pre-SST extinction assessments.

One interesting question for future research is whether we can sequence or covary schedules of reinforcement (e.g., extinction, FR1) to maximize the level and durability of different mands. For example, varied responding for Nico and Bart, consistent with participants in Betz et al. (2011), increased in the second post-SST extinction condition. This may indicate that repeated exposure to SST or training to a higher mastery criterion was necessary for the success of extinction (Rodriguez and Thompson 2015).

In a recent study, Peters and Thompson (2015) employed behavioral skills training (BST) to teach multiple conversation targets (e.g., tacting when listener was uninterested, asking questions, and shifting the topic) and then exposed the participants to extinction to assess the degree to which the participants would vary responses when the first response did not contact reinforcement. Contacting extinction produced varied responding for two of four participants, whereas the remaining two participants required further training to vary their behavior. Teaching children multiple mand frames and subsequently scheduling some frames for extinction might be two critical steps to produce sustained variability under relevant conditions outside of training.

Another possibility for future researchers is to use signaled changes in schedules of reinforcement (i.e., multiple schedules) to promote varied responding. Researchers have demonstrated that multiple schedules with visual cues can be effective for teaching preschool children when to recruit teacher attention (Cammilleri et al. 2008). Researchers have also used visual stimuli (colored placemats), lag schedules, and script fading to teach preschool children with autism to emit either varied or repetitive mand frames, depending on the stimulus conditions (Brodhead et al. [in press](#)). Clinicians could use SST to produce initial varied responding and then seek to strengthen those responses under conditions more typical of the natural environment (e.g., the listener is attending to another speaker and only reinforces mands including “excuse me” or “please,” the listener begins to clean up snack materials and only reinforces mands of the form “May I have one more ___?” or time-sensitive mands such as “Potty”). Post-SST training conditions should replicate natural conditions under which a single mand might not contact reinforcement; the goal is to have the child persist in attempting to access reinforcement using a sufficient range of mand forms.

A critical limitation to the current investigation is that we did not record the full range of sub-criterion variations in mand behavior. We did not record occurrences of single word mands or responses such as participants pointing, touching the containers, making eye contact, or placing the researcher’s hand on a snack container. Future researchers who study behavioral variability are urged to include more robust data collection methods to capture potential changes in the variability of secondary or nonverbal dimensions of responding.

The current evaluation demonstrates that SST alone may produce modest and temporary increases in varied manding for some young children with autism. For other learners in this population, post-SST extinction may be necessary to produce varied manding. Furthermore, it is possible that the mastery criterion for SST (i.e., one session of unprompted, scripted mands) resulted in new responses that were relatively weak. Researchers and practitioners might consider requiring demonstration of mastery for longer periods of time, or providing repeated exposure to brief maintenance evaluations followed by return to training conditions. Future researchers should consider identifying and describing conditions in which mand variability is advantageous versus unnecessary for young children; researchers and clinicians could then focus on increasing mand variability in those relevant conditions. For instance, manding for edible items during a structured school-based snack activity might not require mand variability to maximize reinforcement. However, varied manding to a peer for shared play materials may be more effective and less stigmatizing. It may be important for researchers and clinicians to focus on identifying and evaluating contexts under which varied responding allows the individual to maximize access to reinforcers and to minimize experiences with extinction or punishment.

Compliance with Ethical Standards

Ethical Approval “All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.”

Informed Consent “Informed consent was obtained from all individual participants included in the study.”

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