An Evaluation of Conditional Manding Using a Four-Component Multiple Schedule

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Published online: 15 October 2018

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Abstract

Most verbal behavior curricula for children with autism spectrum disorder (ASD) focus on teaching multiple mands during the early stages of training (e.g., picture exchange communication system; Bondy & Frost, 1994). However, few, if any, of those curricula train children with ASD to differentially mand only for reinforcers that are reasonable for a caregiver to deliver in a given context (e.g., mands to cuddle at bedtime) and to refrain from manding for reinforcers that would be inappropriate to deliver in that context (e.g., mands to play outside at bedtime). In this study, we first taught a boy with ASD two initial mands. Immediately thereafter we brought those mands under the conditional discriminative control of a four-component multiple schedule with (a) S^1 correlated with one reinforcer available (i.e., edibles), (b) S^2 correlated with both reinforcers available (i.e., edibles or drink), (c) S^3 correlated with another reinforcer available (i.e., drink), and (d) S^Δ correlated with no reinforcer available. Following treatment, the child displayed conditionally discriminated manding in accordance with each of the four components of the schedule. We discuss these findings relative to the potential benefits of bringing mands under both evocative and discriminative control.

Keywords Autism spectrum disorder · Conditional discrimination · Mand · Multiple schedule · Verbal behavior

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The mand is the verbal operant evoked by an establishing operation (EO) and reinforced by a specific consequence (Skinner, 1957). Although EOs control mands, it is also important for mands to come under control of discriminative stimuli that signal the differential availability of various reinforcers. For example, consider a child for whom the EO for attention is high due to deprivation. Mands for Mom's attention are likely to produce reinforcement when Mom is watching a movie but not when she is working on an important document. In situations like these, when relevant discriminative stimuli are subtle, children with autism spectrum disorder (ASD) may have difficulty discriminating when their mands will and will not produce reinforcement (cf. Shamlan et al., 2016).

One option to address this problem is to bring multiple mands under the conditional discriminative control of a multiple schedule. Studies on functional communication training (FCT) have brought a single mand under successive discriminative control of a multiple schedule with mand reinforcement in the presence of the discriminative stimulus (S^D) but not the extinction stimulus (S^A) and problem behavior placed on extinction throughout (Betz, Fisher, Roane, Mintz, & Owen, 2013; Greer, Fisher, Saini, Owen, & Jones, 2016; see Saini, Miller, & Fisher, 2016, for a review). However, in the natural environment, individuals emit multiple mands that produce reinforcement or extinction at various times (e.g., mands to cuddle at bedtime are likely to produce reinforcement; mands to go outside at bedtime are not). Therefore, we sought to teach a child to emit two mands under the conditional control of a four-component multiple schedule that signaled when only the first mand, the second mand, both mands, or no mands produce reinforcement.

Method

Participant

Ethan, a 7-year-old male diagnosed with ASD, participated in this study. Ethan manded using word approximations (e.g., “ba”), a few manual signs (e.g., “more,” “please”), and gestures. Ethan would echo word approximations, and he had no known tact or intraverbal repertoire.

Setting and materials

We conducted 5-min sessions during 3-h appointments in a padded room (3 m × 3 m) equipped with a one-way observation window, a table, chairs, and session materials.

We created three response cards (12.5 cm × 7.5 cm) consisting of laminated pictures on beige construction paper illustrating the reinforcers (eating food, drinking from a cup). The control card consisted of black construction paper. We attached these cards to four differently colored background boards (56 cm × 71 cm), which served as the three S^D s and one S^A for the four-component multiple schedule (e.g., a yellow background signaled that only the edible card produced reinforcement; see Table 1).

We used stimulus fading (by card size) during training by creating identical sets of response cards at six different sizes (from 4 cm × 3.5 cm to 12.5 cm × 7.5 cm), with each size corresponding to one fading step (see Table 2).

Table 1 Correct and incorrect responses for the multiple schedule

Schedule component	Available reinforcer	Discriminative stimulus	Correct response	Incorrect response
Component 1	Edible only	S^1 = Yellow	Exchanging the edible response card	Exchanging either the drink response card or the control card
Component 2	Both	S^2 = Green	Exchanging either the edible response card or the drink response card	Exchanging the control card
Component 3	Drink only	S^3 = Blue	Exchanging the drink response card	Exchanging either the edible response card or the control card
Component 4	Extinction	S^Δ = Brown		Exchanging any card

The participant selected the edible (e.g., chips) and drink (e.g., juice) used for each session from two edible options and two drink options offered prior to each session. The chosen edible and drink remained in the participant's sight throughout each session (e.g., in the presence of the yellow stimulus, the participant could see both the edible and drink). We dispensed edibles in 1-cm $\times$ 1-cm portions and drinks in 5-ml portions.

Dependent measures

Trained data collectors recorded data on laptop computers. We defined a correct mand as exchanging a given card in the presence of its corresponding S^D (e.g., exchanging the edible card in the presence of the yellow poster; see Table 1). We scored an incorrect mand if the participant attempted to or exchanged (a) the control card, (b) a response card that did not correspond with the available reinforcer, or (c) any card during the S^Δ . We calculated the percentage of correct mands for each session by dividing the frequency of correct mands by the total number of mands and converting the resulting quotient to a percentage. We also recorded instances of aggression (e.g., hitting, scratching), self-injury (e.g., self-scratching, head hitting), and disruptions (e.g., hitting the table, throwing materials) and converted the count to a rate.

To obtain interobserver agreement (IOA), a second independent observer collected data during 42% of sessions. To calculate IOA coefficients, we divided sessions into

Table 2 Fading card sizes for the incorrect comparison stimuli

Fading step	Size of card
1	No incorrect cards
2	4 cm $\times$ 3.5 cm
3	5.5 cm $\times$ 4 cm
4	7 cm $\times$ 5 cm
5	8.5 cm $\times$ 6 cm
6	8.5 cm $\times$ 6.5 cm
7	12.5 cm $\times$ 7.5 cm

successive 10-s intervals and scored an agreement if both observers recorded the same number of target responses during an interval. We divided the number of agreement intervals by the total number of intervals within the session and converted the resulting quotient to a percentage. Mean IOA for aggression, self-injury, and disruptions exceeded 99% (range 93.3%–100%). Mean IOA for correct mands equaled 88.1% (range 76.7%–100%), and mean IOA for incorrect mands equaled 97.8% (range 83.3%–100%).

Procedure

Mand pretraining All pretraining sessions involved ten 30-s trials. Throughout pretraining, we placed destructive behavior and other mand topographies (e.g., signing “more”) on extinction. Initially, we taught each mand in isolation (i.e., with only the correct card on the table). Before the initiation of each trial, we placed the edible or drink on the table within Ethan’s sight but restricted access until he exchanged the correct card. Following the card exchange, Ethan received access to the reinforcer for the remainder of the 30-s trial. We initially used a progressively delayed physical prompt but later replaced the physical prompt with a modeled prompt (i.e., pointing to the correct card).

Once Ethan consistently manded when we presented either the edible response card or the drink response card in isolation, we introduced the control card. We quasi-randomly rotated the right and left locations of the mand card (edible or drink) and control card, and we no longer provided prompts. Correct mands produced reinforcement, and exchanging the control card resulted in removal of both cards for the remainder of the trial. After 30 s without a response, we removed and re-presented both cards as a new trial.

Once Ethan reliably exchanged only the mand card, we presented all three cards (i.e., edible, drink, and control) positioned on the right, on the left, and in the middle (rotated quasi-randomly across trials). We attached the three cards to the background S^D that signaled that mands for edibles or drinks would produce reinforcement on a fixed-ratio (FR) 1 schedule (i.e., the green poster). Exchanging either the edible card or the drink card produced its corresponding reinforcer, and exchanging the control card resulted in removal of all cards for the remainder of the trial. After 30 s without a response, we removed and re-presented the three cards as a new trial.

Experimental design We introduced the training procedures using a multiple-baseline across-schedule-components design. That is, we conducted four baseline conditions. In three of the baselines, we alternated in a quasi-random sequence between one component with reinforcement available and one component with reinforcement unavailable (see Table 1). In Baseline 1 (i.e., FR 1 [edible]; EXT), we alternated between Component 1 (i.e., edible reinforcer available) and Component 4 (i.e., no reinforcer available). In Baseline 2 (i.e., FR 1 [edible and drink]; EXT), we alternated between Component 2 (i.e., edible and drink reinforcers available) and Component 4 (i.e., no reinforcer available). In Baseline 3 (i.e., FR 1 [drink]; EXT), we alternated between Component 3 (i.e., drink reinforcer available) and Component 4 (i.e., no reinforcer available).

In Baseline 4 (FR 1 [edible]; FR 1 [edible and drink]; FR 1 [drink]; EXT), we alternated in a quasi-random sequence between all four components described in Table 1. We did not include this baseline in the multiple-baseline design. Rather, we conducted probe sessions in this baseline before and throughout training and used correct manding in this condition as our index of mastery.

Baseline 4 (four-component multiple schedule) All sessions lasted 5 min. During baseline sessions, each multiple-schedule component lasted 30 s. We did not prompt or block any responses. We reinforced correct mands on an FR 1 schedule and placed incorrect mands on extinction. After the participant exchanged a card, we replaced it and reordered all of the cards on the poster board. We set no limit on the number of mands Ethan could emit during each 30-s component, but we would have prompted him to chew and swallow if he filled his mouth with food, which never occurred during the study. We presented the four schedule components in a quasi-random order with the session always beginning with one of the three reinforcer-available components (i.e., Component 1, 2, or 3). We delayed changing components until 3 s elapsed without destructive behavior or an incorrect mand (i.e., 3-s changeover delay).

Baselines 1 to 3 (two-component multiple schedules) These sessions followed the same procedures described previously with the exception that we presented two schedule components (i.e., one reinforcer-available component and Component 4) rather than all four. We presented schedule components (e.g., Component 1 alternated with Component 4 during FR 1 [edible]; EXT) in a quasi-random order with the session beginning with the reinforcer-available component.

Conditional-mand training We implemented procedures identical to the aforementioned baselines except for the following changes. We decreased the length of Component 4 (i.e., S^Δ) to 2 s, blocked incorrect responses, and prompted correct mands using a 10-s prompt delay to physical guidance. In addition, we implemented systematic stimulus fading with the cards on the S^Δ during Component 4 of the multiple schedule. The size of the three cards during each reinforcer-available component (i.e., Components 1, 2, and 3) remained constant at Size 7 throughout the study.

The first step of the stimulus-fading progression involved response restriction (e.g., Fisher, Greer, Querim, & DeRosa, 2014) in which we removed all three response cards during Component 4 of the multiple schedule. The subsequent six fading steps involved providing increasingly larger response cards during Component 4 according to the sizes listed in Table 2.

We progressed to the next fading step after two sessions with at least 90% correct mands. After Ethan met this criterion, we conducted a baseline probe before proceeding to the next fading step. If the percentage of correct mands decreased to less than 90% during this probe, we moved to the next fading size. However, if Ethan emitted 90% or higher correct mands during the probe, we conducted additional baseline probes until his performance dropped below this criterion or stabilized at mastery level. If his performance dropped below mastery level, we proceeded to the next fading step. In addition, when Ethan's performance stabilized at or above the mastery level during the four-component multiple schedule (i.e., FR 1 [edible]; FR 1 [edible and drink]; FR 1 [drink]; EXT), we considered training complete for all of the multiple schedules.

Results and discussion

In this study, we taught a boy with ASD to emit two mands under the conditional discriminative control of a four-component multiple schedule. Throughout the study, Ethan rarely engaged in destructive behavior (data available upon request). The top three panels of Fig. 1 show the levels of correct mands for the three two-component multiple schedules, and the bottom panel shows the levels of correct mands during the four-component multiple schedule, which served as the index of mastery. As can be seen in the top three panels of Fig. 1, Ethan displayed moderately high levels of correct mands when we implemented baseline contingencies, but he never reached mastery levels in any baseline sessions.

Following the introduction of training, correct mands increased to high levels during the training steps, and correct mands during the baseline probes reached and stabilized at or above the mastery level after the sixth fading step for FR 1 (edible); EXT and after the fifth fading step for FR 1 (edible and drink); EXT. When we introduced training in FR 1 (drink); EXT, correct mands increased somewhat, but Ethan's performance continued to be variable and he did not meet mastery criterion with the second fading step in place until the 12th session of training. During the ongoing baseline for the four-component multiple schedule, Ethan's correct mands remained stable for the first 10 sessions. Once he met mastery criterion in two out of three two-component multiple schedules, Ethan's correct mands increased sharply in the final three sessions. We ended the evaluation after these three sessions because Ethan met our terminal goal for correct mands during the four-component multiple schedule.

Previous studies have demonstrated that children with ASD can acquire a single mand under successive discriminative control of a two-component multiple schedule signaling the availability and unavailability of a single reinforcer (e.g., Greer et al., 2016). However, to our knowledge, the current investigation represents the first study to show that a child with ASD can be taught conditional manding under the control of a four-component multiple schedule signaling when one, the other, both, or neither of two reinforcers is available.

Teaching children with ASD conditional mands is potentially important because this arrangement better approximates the natural environment. That is, over the course of a typical daily routine, one reinforcer may be available at some times, several reinforcers may be available at other times, and no reinforcers may be available at still other times. Bringing a child's manding under the conditional control of a multiple schedule teaches him or her to discriminate which reinforcers are available or unavailable at various times.

Because Ethan's primary treatment goals focused on reducing his destructive behavior, we matched his conditional discrimination training to his FCT treatment. In addition, to prevent resurgence of destructive behavior (which we did not observe), we (a) trained his mands in isolation, (b) did not conduct EO manipulations to test their effects on the mands, and (c) implemented stimulus fading only during the S^{Δ} component. Future researchers should evaluate this conditional-manding training procedure with individuals who do not display destructive behavior within a more typical mand-training paradigm that includes EO manipulations.

One limitation of the current study is that we demonstrated functional control of the training procedures for two of the two-component multiple schedules but not the third.

Fig. 1 The percentage of correct mands for Ethan. The open squares depict sessions in which baseline procedures were in place, and the closed squares depict sessions in which training procedures were in place. The numbers correspond to the stimulus-fading steps. The panel titles designate the components of the multiple schedule

In addition, Ethan met mastery criteria in the four-component multiple schedule before proceeding past the second fading step of FR 1 (drink); EXT. Future researchers may consider altering the experimental design (e.g., a multiple-baseline across-participants design) to ensure experimental control is demonstrated even if carryover effects from one condition to the next are observed.

Another limitation of the current study is the lack of EO manipulations. Because we did not include systematic manipulations (i.e., EO present and EO absent) to demonstrate that card exchanges were under the control of the EO, and because the items were always in sight, we cannot confirm that the responses were pure mands. Future research should include manipulations to determine the extent to which the responses brought under the conditional control of the multiple schedule function as pure mands.

Finally, future research should investigate the use of similar procedures in a more naturalistic setting in order to test for generalization. In the natural environment, the discriminative stimuli that signal the availability and unavailability of reinforcement may be less clear than in the present study. Future researchers should investigate similar procedures using more ecologically valid conditional stimuli.

In conclusion, the participant responded accurately to a four-component multiple schedule without displaying an increase in destructive behavior. This four-component multiple schedule more closely matches most natural environments where certain reinforcers are available at particular times, multiple reinforcers are available at other times, and no programmed reinforcers are available at still other times. As such, future research on promoting the acquisition of conditional-manding repertoires seems warranted.

Funding Grants 5R01HD079113 and 5R01HD083214 from the National Institute of Child Health and Human Development provided partial support for this research.

Compliance with ethical standards

Conflict of interest All authors declare they have no conflicts of interest.

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 the legal guardian for the child to participate in this study.

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