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Transferring Control of the Mand to the Motivating Operation in Children with Autism

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Few studies have made use of B. F. Skinner's (1957) behavioral analysis of language and precise taxonomy of verbal behavior when describing the controlling variables for the mand relation. Consequently, the motivating operation (MO) has not typically been identified as an independent variable and the nature of a spontaneous mand has been imprecisely described. The purpose of this study was to develop procedures to bring the mand response under the control of the relevant MO and therefore free it from the multiple controls that are more easily identified by practitioner's who rely on Skinner's analysis and taxonomy. Using a rolling time delay and prompt fade procedure both participants' mand repertoires were successfully transferred to the relevant MO and a listener and described within the context of a behavioral analysis of language.

Key words: verbal behavior, motivating operation, mand, autism.

The importance of developing an effective mand repertoire for children with autism and other developmental disabilities has been well documented in current literature concerning language training (Michael, 1988; Sundberg, 1993; Shafer, 1994; Charlop-Christy, Carpenter, LeBlance, & Kellet, 2002; Sundberg & Michael, 2001). Mand training offers a number of benefits including reductions in inappropriate behavior (Carr & Durand, 1985; Shafer, 1994; Charlop-Christy, et al., 2002) and increased effectiveness of language training for other verbal operants (Carroll & Hesse, 1987; Arntzen & Almås, 2002). Perhaps most significantly, however, a strong mand repertoire allows persons with developmental disabilities to effectively control their social environment by increasing access to unconditioned and conditioned reinforcers and by increasing the value of interacting with other members of the verbal community.

In his book *Verbal Behavior,* Skinner defined the mand as ". . . a verbal operant in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive stimulation" (1957, pp. 35–36). Keller and Schoenfeld (1950) later termed these conditions as establishing operations, and as Skinner's (1957) definition of the mand suggests, they function as a controlling variable for the mand (p. 35). The control exerted by the establishing operation over the mand distinguishes it from other primary verbal operants in which control is determined by an antecedent discriminative stimulus (Michael, 1988). The concept of the establishing operation was later refined by Michael (1993, 2000). He defined it as any stimulus, condition, or event that (a) momentarily alters the value of some stimulus as a reinforcer and (b) evokes all responses that have produced that reinforcer in the past (Michael, 1993). The term *establishing operation* was later replaced with *motivating operation* (MO) to more accurately describe the bidirectional effects of establishing and abolishing the value of reinforcement, and the resultant evoking or abating of the relevant behavior (Laraway, Snycerski, Michael, & Poling 2003).

As with other behavioral variables, such as discriminative stimuli and consequences, the MO may be manipulated to alter the frequency of some behavior and should therefore be considered an independent variable to be studied in terms of its control over behavior (Sundberg, 2005). Analysis of the MO as an independent variable is necessary in order to determine its exact effect on the occurrence or nonoccurrence

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of behavior and its application to the development of effective procedures to bring about change in behavior. This point is of particular importance when considering the mand repertoire of children with autism. Many children with autism develop mand repertoires that are multiply controlled, and they fail to exhibit spontaneous mands (Charlop, Schreibman, & Thibodeau, 1985; Charlop-Christy, et al., 2002; Sundberg, 2005). Multiply-controlled mands develop when both the MO and some other stimulus is present during acquisition and subsequently both stimuli in combination exert control over the response. These stimuli may include an echoic/mimetic stimulus presented for the purpose of modeling the correct topography of the mand, or the presence of an item that serves as reinforcement for the mand. Multiply-controlled mands may therefore be partially controlled by an echoic or nonverbal stimulus and the MO, or a combination of all three variables. Although useful, multiply-controlled mands reduce the effectiveness of a person's repertoire to control the environment under all conditions, specifically conditions in which the supplementary verbal or nonverbal stimuli are not present. In the absence of the supplementary stimuli, a multiply-controlled repertoire is ineffective in producing reinforcement regardless of the MO's value altering effect. Take for example a child who learns to effectively mand for a cookie under the stimulus control of both the cookie's presence and the MO. In conditions in which the cookie is present and some level of deprivation has increased the value of the cookie as a reinforcer, the child may mand frequently by saying "cookie." However, when placed in conditions in which the cookie is not present but deprivation has again increased the value of a cookie as a reinforcer, the child may not reliably mand for it. In both instances described above, the effectiveness of the cookie serving as a reinforcer did not change, however, the frequency of behaviors that have produced that reinforcer in the past (manding) decreased. This change should therefore be attributed, not to a change in the motivation for the reinforcer, but rather to the controlling influence of the response by the discriminative nonverbal stimulus. Many children with autism experience the difficulties described above and therefore have mand repertoires that do not include spontaneous mands or mands that occur solely under the control of the MO and a listener (Sundberg, 2005). Language training programs focusing on the development of the mand repertoire in children with autism should include procedures designed to increase spontaneous mand responses and to transfer stimulus control of multiply-controlled mands to the MO.

A number of studies have sought to overcome the problem of spontaneity by using fixed time delay procedures to eliminate teacher initiated vocal prompts. Halle, Marshall, and Spradlin (1979) used a time delay procedure to increase vocalizations of severely retarded children living in an institutional setting. The study was conducted during meal times and the response targeted for increase was meal request. During the baseline conditions, participants were called by a staff member to walk to a food counter and select one of several food trays placed on the counter. Requests for meals were not required during the baseline condition. During the experimental conditions, however, after the participants had been called by a staff member and approached the food counter, the delivery of food trays was delayed for 15 s or until a request for the meal occurred. If a request did not occur during the 15 s delay, a model of the appropriate meal request was provided and following the imitation of the response, the food tray was delivered. The researchers were able to effectively increase the vocalizations of three of the six participants in the study by simply implementing the time delay. Two of the six participants initially required a modeled prompt but were later able to ask for the items without the model, and one participant learned, after intensive training, to request the meal tray without prompting. The researchers concluded that the time delay was an effective procedure for increasing vocalizations if the targeted response was previously learned. A subsequent study by Halle, Baer, and Spradlin (1981) replicated these results in a different setting, with a shorter time delay, and across different motivational categories.

Another commonly used time-delay procedure involved gradually increasing the length of the time delay as a method of fading prompts and transferring the stimulus control of the response to MO control. Charlop, Schreibman, and Thibodeau (1985) used a gradual time delay procedure to teach children with autism to request items without an echoic prompt. The researchers gradually increased the time be-

tween the presentation of an item and the echoic prompt, and were able to successfully transfer the stimulus control of each child's vocalizations from the teacher's echoic prompt to the presence of the item. It was therefore concluded that a time delay procedure may be effective in transferring the stimulus control of mands initially prompted by some echoic stimulus to mands that are controlled by the item's presence. Time delay procedures have also been used to effectively transfer the stimulus control of other types of vocalizations, including verbalizations of affection (Charlop & Walsh, 1986), social pleasantries (Matson, Sevin, Fridley, & Love, 1990; Matson, Sevin, Box, & Francis, 1993), task appropriate speech during play (Ingenmey & Van Houten, 1991), and social greetings (Charlop & Trasowech, 1991; Matson, et al., 1993).

Most of the studies cited have failed to define their terms according to Skinner's classification of verbal operants and the variables that control each. This set of circumstances has led to imprecise descriptions of the controlling variables. For example, the failure to identify the role of the MO as an independent variable has led to terminological confusion about how to define a spontaneous mand. The authors of most of these studies have treated "requests" that occurred without vocal prompts in the presence of the item desired to be spontaneous. These types of "spontaneous" responses may actually be part tact and part mand and may not occur in the future without the control exerted by the nonverbal stimulus. On the topic of spontaneous mands, Sundberg (2005) states, ". . . to be optimally useful a mand should occur in the absence of the object or condition that is reinforcement for the mand; it should occur primarily under the control of the MO" (p. 14). Sundberg and Michael (2001) indicated that there are substantial benefits to be gained from discussing language training in terms of the specific controlling variables that account for each of the verbal operants and identifying the operants according to the terms B. F. Skinner suggested in his book *Verbal Behavior* (1957). Notwithstanding these advantages, only a few studies have described methods that have brought the mand response primarily under the control of the MO and a listener and therefore appropriately defined the meaning of spontaneous responding. One such study was conducted by Carr and Kologinksy (1983) in which the researchers asserted that effective sign repertoires should not be brought under the control of stimuli such as objects or verbal questions but instead should be under the control of more broadly defined stimuli such as the presence of an appropriate audience. In accordance with this assumption, six children with autism were taught to use sign language to request reinforcers using imitative prompting, fading, and differential reinforcement in the absence of any verbal or nonverbal stimuli. A similar study by Carr and Durand (1985) taught developmentally disabled children to vocally request the attention of adults as an alternative to maladaptive behavior. These requests were taught during demand conditions under which the researchers had established that assistance or praise would serve as a reinforcer. An echoic stimulus was first used to prompt the appropriate response and was then systematically faded. Although both of these studies were able to effectively bring the mand repertoire solely under the control of the MO and a listener, neither study identified the responses according to Skinner's taxonomy of verbal behavior or identified the MO as an independent variable.

In studies designed to increase a spontaneous mand repertoire, only a few experimenters have explicitly defined their terms according to Skinner's analysis of verbal behavior and have systematically manipulated the MO in order to examine its effect over the mand repertoire. One such study was conducted by Hall and Sundberg (1987) in which the researchers were able to teach persons with developmental disabilities to mand under the control of the MO by arranging chains of responses that, when completed, resulted in the delivery of some terminal reinforcer. Each response in the chain was trained until the participant was able to complete the chain independently. The chains were then interrupted by removing an item necessary for the completion of the chain. The absence of that item subsequently increased the value of that item as a reinforcer and increased the frequency of behaviors that had produced that item in the past. The item was therefore established as a conditional conditioned reinforcer based on its relation to the completion of the response change and ultimately gaining access to some terminal reinforcer. The researchers trained the manual sign response for the missing item using an imita-

tive prompting and fading procedure. Upon completion of training, participants began manding under the control of the MO for the missing item under conditions in which that item would serve as a reinforcer. Hall and Sundberg (1987) therefore demonstrated that the control for the mand could be transferred to relevant MO or motivational variables. Similar results were obtained by Sigafoos, Doss, and Reichle (1989) using graphic symbols as the response form.

The purpose of this study was to replicate the findings of previous research related to mand training. The study was also designed specifically to extend the technology of mand training by testing a modified time-delay procedure to free the mand from the discriminative control exerted by the presence of the desired item. In addition, this study was designed to extend the findings of prior studies the treatment of children with autism and to develop procedures that could be easily implemented by teachers and instructors in educational settings. It was hypothesized that the addition of the terminological refinements brought about by including Skinner's (1957) classification of language and Michael's (1988) identification of the MO as the primary controlling variable for the mand would bring analytic and procedural clarity to the task.

Method

Participants and Setting

There were two participants in this study. Both participants were enrolled for five, 3-hour sessions per week at a private educational setting offering one-on-one intensive teaching in the form of discrete trial training interspersed with teaching in the natural environment facilitated through play based activities. Both children were selected as participants for this study due to their lack of a mand repertoire primarily under motivational (MO) control.

Martin was a 3-year-old male diagnosed with autism in the moderate range of disabilities. He demonstrated an echoic repertoire and had acquired over 100 multiply-controlled vocal mands. His articulation was poor but was improving through differential reinforcement of better word approximations. His tact and intraverbal repertoires were limited but developing. When denied access to a reinforcer or transitioned from a highly preferred to less preferred activity, Martin would sometimes engage in problem behavior in the form of crying, whining, or flopping.

Jeff was a 7-year-old boy diagnosed with autism in the moderate to severe range. Jeff had a poor echoic repertoire and therefore manual sign language was chosen as his verbal response form. He had begun to vocally approximate some words, but due to poor articulation the use of manual sign was still required. His tact and intraverbal repertoires were weak. When denied access to a reinforcer, Jeff would engage in problem behavior in the form of hitting, yelling, or pinching.

Response Definitions

The dependent variable in this study was the frequency of MO-controlled mands. MO-controlled mands were defined as any mand that occurred at least 15 s after the desired item had been displayed and consumed and any mand that occurred without the desired item ever having been displayed to the participant throughout the session. For example, if 15 s or more elapsed since a desired item had last been displayed, this mand was recorded as MO controlled. If however, another mand occurred in less than 15 s since the last display of a desired item, this mand was recorded as multiply controlled. This time interval was chosen because 15 s was the approximate time required for each participant to receive and consume the reinforcer from the time of its display. Any response prior to the 15 s elapsing was recorded as multiply controlled because the reinforcer would likely still be visible to the participant.

Recording Procedure and Calculation of Inter-observer Agreement

The participants' instructors served as the data recorders throughout the experiment. The primary data recorder was seated next to the child, either at a table or on the floor, with a data sheet on a clipboard. A tally mark was recorded in the appropriate column on the data sheet for responses that were judged to be controlled by the MO, or multiply controlled according to the response definition above. Data were also recorded on the times that the response was prompted by the display of the targeted item. The frequencies of MO-controlled

and multiply-controlled mands were tallied after each session and plotted on the graphs shown in Figures 1 and 2.

Additional instructors were trained to record observations of the dependent variables independently for the purposes of inter-observer agreement (IOA). For purposes of calculating IOA the data recording of the primary recorder was compared to that of the secondary recorder. An agreement occurred when both recorders recorded the observed response as evoked by the same controlling variable, either multiply controlled or MO-controlled. A disagreement occurred when one observer recorded the occurrence of a behavior that the other observer did not record, or the observers did not record the same controlling variable for a particular response. The IOA was calculated by dividing agreements by agreements plus disagreements and multiplying by 100. Reliability observations were conducted for about 15% of sessions across all conditions. The IOA was 100% for all sessions.

Design

A multiple baseline design across behaviors was used to verify the effectiveness of the independent variables (Baer, Wolf, & Risely, 1968).

Pre-baseline

For several weeks prior to the baseline condition every mand response was recorded during the daily 3-hour sessions to determine mand responses that were MO and multiply controlled. Several mand responses related to food items occurred for both participants at high rates under the multiple control of the item's presence and the MO. Mand responses for these items were occurring dozens of times per day for many weeks prior to the experimental conditions. None of the mand responses occurred solely under the control of the MO and a listener during this period. For Martin, four items frequently manded for under the control of the item's presence and the MO were identified and selected as targets for inclusion in this study. Targeted items included fries, lollipop, pretzels, and chips. Two items frequently manded for under the control of the item's presence and the MO were identified and selected as targets for inclusion in this study for Jeff. The targeted items selected were bacon and biscuits.

Baseline

During baseline, targeted items were removed from the participants' view and the occurrence of MO-controlled mands for each item was recorded during 3 hour teaching sessions each day between 9:00 a.m. and 12:00 p.m. No other edibles were made available to either participant during baseline and all experimental sessions so as not to compete with the value of the targeted items. During the baseline and experimental conditions, teaching sessions consisted of discrete trial training and natural environment teaching. During discrete trial training access to preferred videos, action figures, and other toys were used to reinforce correct responding. During natural environment teaching, both participants participated in various preferred activities such as games, arts and crafts, puzzles, videos, and outdoor activities. Opportunities to mand for these preferred items and activities during both discrete trial training and natural environment teaching were continuously contrived and encouraged. Parents of both participants were asked to withhold access to the targeted items immediately prior to each experimental session; however, access to all other food items was not controlled and each participant was typically fed breakfast prior to each teaching session. Multiply-controlled mands did not occur during this phase because the removal of all targeted items prevented any multiply-controlled mands from occurring.

Rolling Time Delay

During the first experimental session for each participant, one targeted item was displayed at the beginning of the session, while the other items were maintained in baseline. If the participant manded for the item by saying the name, a small bite-size portion or equivalent of the item (a piece of pretzel, a lick of a lollipop, a piece of biscuit, etc.) was delivered immediately and the response was recorded as a multiply-controlled mand. A 2-min time delay then occurred, during which the targeted item remained out of view of the participant. If the participant manded for the item within this time interval, but at least 15 s after the display of the item, the response was recorded as MO controlled and the mand was reinforced by the delivery of a bite-size portion of the item. The

time delay interval timer was reset and the next 2-min time delay interval began. If, at the end of any two minute interval, an MO-controlled response had not occurred, the item was displayed again as a prompt for the mand. If a response occurred it was reinforced with the delivery of a bite-size portion of the item and the next rolling 2-min time delay began.

Beginning with the second session and all subsequent sessions in this phase, during the first 30 min of the session, each participant was given the opportunity to mand for the target item without it being displayed. This component of the treatment was implemented to probe for stimulus-control transfer across sessions which also crossed days. This procedure guarded against providing visual prompts for the response when they may not have been necessary and therefore reducing dependency on the visual stimulus. Stimulus-control transfer from a multiply-controlled mand to an MO-controlled mand was said to have occurred if the participant manded at least once solely under the control of MO and a listener during this 30-min period at the start of each session. If the participant manded for the item during this daily probe the mand was reinforced and recorded as MO controlled. In addition, the item was never displayed for the remainder of the 3-hour session and therefore only MO-controlled mands could occur during these sessions. If a mand did not occur during the probe the item was displayed at the end of the 30-min period and the rolling time delay and prompt fade procedures described above were implemented for the remainder of the session.

When MO-controlled manding began occurring during the treatment condition at levels substantially greater than during baseline, a second item was then subjected to the independent variable. Criterion for introduction of a new item to the treatment conditions was not established, since mand rates are under the control of ever changing motivational operations. The procedures described above continued until all items underwent treatment.

Generalization and Response Maintenance

Generalization across instructors and response maintenance over time was assessed for one of the two participants (Martin). Jeff left the program to return to his home outside of the United States before the generalization and response maintenance data could be assessed. To determine generalization across instructors, Martin's sessions were conducted by four different instructors. These instructors conducted Martin's sessions using the procedures implemented during the baseline phase. Again, all items were removed from view and the occurrences of MO-controlled mands were recorded. The absence of the target items from the participants' view prevented the opportunity for multiply-controlled mands to occur. The rolling time delay procedure was never implemented during the generalization and response maintenance session. The frequency of MO-controlled mands was recorded by each instructor. Data were collected over a 3-month period during which time the targeted items were never displayed. Consequently, maintenance of the MO-controlled mands over time was also assessed.

Results

Baseline and treatment for all of Martin and Jeff's targeted responses are displayed in Figure 1 and Figure 2 respectively. In addition, Figure 1 displays Martin's generalization and maintenance data. In each figure, two data points are displayed along the data path. Both closed and open circles indicate the number of MO-controlled mands that occurred during the session. However, a closed circle indicates that an MO-controlled mand did not occur during the 30-min probe session and therefore all of the MO-controlled mands for that 3-hour session occurred after having seen the item at least once at the end of the 30-min probe. Open circles indicate that an MO-controlled mand did occur during the 30-min probe period and therefore each MO-controlled mand during the remainder of the session occurred without having seen the item since at least the end of the last session during the previous day. The open data points represent MO-controlled mands that occurred during a session when the targeted item was never displayed.

As shown in Figure 1, MO-controlled mands by Martin for the first item, fry, occurred during the first experimental session. The frequency of MO-controlled mands for fry ranged from 0 to 78 per treatment session. That is, from 0 to 78 times per MO-controlled mand, the mand was prompted from 0 to 78 times by displaying the required item. (These numbers do not appear on the figure.) This is in compari-

son to a baseline level of zero occurrences throughout the phase. The mand for fry was prompted an average of about 10 times per session. However, MO-controlled manding for fry occurred without any prompts throughout the session beginning with session 12 and only 1 session in more than 50 subsequent sessions required any prompt at all. This response had been freed from the control of the nonverbal stimulus and was now occurring solely under the control of the MO and the listener. Mands for fry occurred without prompting for 80% of all the experimental sessions.

Baseline responding for the second item, lollipop, remained at zero spontaneous mands per session during the implementation of treatment for the first item. However, immediately upon subjecting the response to the experimental variables, the frequency of the mand for lollipop increased. The frequency of MO-controlled mands for lollipop ranged from 0 to 25 during this phase compared to zero during baseline. The mand for lollipop was prompted an average of about 38 times per session (not shown on the figure). MO-controlled mands for lollipop required more frequent display of the item as compared to the response for fry. After the first treatment session, MO-controlled manding for lollipop occurred without prompting for only 10% of all additional experimental sessions. While the increase in frequency of MO-controlled mands was functionally related to the implementation of the treatment, it was not as robust as compared to the effects upon the other responses. For example, during only four of the experimental phases did MO-controlled mands occur without any prompting throughout the session.

Baseline responding for the third item, pretzel, remained at zero MO-controlled mands per session during the implementation of treatment for the first two items. For pretzel, the frequency of MO-controlled mands ranged from 1 to 24 per session as compared to zero during all sessions in the baseline condition. Pretzel was only prompted an average of about two times per session. MO-controlled manding for pretzel required only one session with the display of the item to evoke unprompted manding for all the subsequent experimental conditions. In other words, after the first session MO-controlled manding for pretzel occurred without prompting for all 21 of the experimental sessions that followed for this item.

Baseline responding for the fourth item, chip, remained at zero MO-controlled mands per session during the implementation of treatment for all other items. During the experimental phase the frequency of MO-controlled mands for chip ranged from 1 to 20 per session. Chip was prompted an average of about five times per session. Chip began occurring without any prompting after only one treatment session and a prompt was never required to maintain the responding during the 10 subsequent treatment session.

Generalization and maintenance data for Martin are displayed in Figure 1. Probes for generalization across instructors were conducted by four different experimenters over the course of a three month period. The data in this phase represent the frequency of MO-controlled mands aggregated across all four instructors but presented by response topography. During this period MO-controlled mands occurred from 0 to 11 per times session for all targeted items. While the effects were not as large as in the treatment condition when the same instructor acted as the listener each day, the responses did occur more frequently than baseline across instructors and over time.

Figure 2 presents the frequency of MO-controlled mands during baseline and treatment conditions for Jeff. MO-controlled manding by Jeff for the first item, bacon, occurred during the first experimental session. The frequency of MO-controlled mands for bacon ranged from 4 to 429 per treatment session as compared to zero occurrences of the mand during all sessions of the baseline condition. The mand for bacon was prompted an average of about two times per session. After only four treatment sessions the mand for bacon occurred without prompting in all but one of the subsequent 71 treatment sessions. This meant that MO-controlled manding for bacon occurred without prompting for 96% of the additional experimental sessions. When a second item underwent treatment, MO-controlled manding for bacon was maintained for 55 sessions.

Before the second response, biscuit, was subjected to the experimental condition, Jeff manded under the control of the MO for it only once. The frequency of MO-controlled mands for biscuit ranged from 0 to 60 per session as compared to zero during all baseline sessions. Biscuit was prompted an average of about 28 times per session. MO-controlled manding for

biscuit occurred without prompting for 52% of the additional experimental sessions.

DISCUSSION

The results of the current study met the requirements of the multiple baseline design across behaviors leading to the conclusion that the rolling time delay and prompt fading procedures were effective in establishing an MO-controlled manding repertoire for both learners in this study. As shown in Figures 1 and 2, baseline levels of MO-controlled manding for both participants remained stable at zero mands per session for all items. Following the implementation of the rolling time delay procedure MO-controlled mands began occurring for both learners either within the first session or after only one experimental session, and increased at various frequencies for all targeted items. These results suggest that by systematically fading the presence of the items, we were able to transfer the stimulus control of the participants' manding repertoire from the multiple control exerted by a discriminative stimulus and an MO to the control exerted by the MO and a listener. The participants' motivation for the targeted items was established during the pre-baseline condition of this study during which multiply-controlled mands in the presence of the targeted items occurred at high frequencies. When the baseline condition was implemented, however, and the targeted items were removed from the participants' view, all mands for these items ceased. Manding only occurred again after the items were reintroduced during the experimental condition and stimulus-control transfer from multiply-controlled mands to mands controlled solely by the MO and a listener had occurred. These results provide at least indirect evidence that the learner's motivation for the targeted items existed throughout the baseline condition. Ultimately, during the rolling-prompt delay conditions the additional control exerted by the nonverbal stimulus (item) had an additive effect and therefore the response was evoked only when both controlling variables were present. It appears that the multiply-controlled mand may have actually been part tact, and the transfer of stimulus-control procedures may have freed it from the variables that control the tact, such as the presence of a nonverbal stimulus.

Previous studies have defined spontaneous manding as mands that occur without a vocal prompt (Halle, et al., 1979; Halle, et al., 1981; Charlop, et al., 1985; Matson, et al., 1990; Matson, et al., 1993). The current study extends the previous research findings on this topic by using both Skinner's analysis of verbal behavior and the literature concerning the MO (Michael, 1993; Laraway, et al., 2003) to define spontaneous manding as MO-controlled mands, or mands that occur solely under the control of the MO and a listener. In addition, prior research has demonstrated that the control of the manding repertoire can be transferred from an echoic prompt to a prompt by the nonverbal stimulus (Halle, et al., 1979; Halle, et al., 1981; Charlop, et al., 1985; Matson, et al., 1990; Matson, et al., 1993) but have failed to demonstrate transfer from the non-verbal stimulus to the MO. The current study adds to the research findings that a manding repertoire can be brought primarily under the control of the MO and supports Michael's (1988) and Sundberg's (2005) contention that the MO serves as an independent variable in the development of language in the form of the mand response.

Further analysis of the results shows that only a few prompts in the form of the visual display of the targeted item were necessary to produce MO-controlled mands. Both learners began manding solely under the control of the MO after no more than one experimental session for all items. In addition, for the majority of targeted responses, transfer from multiply-controlled mands to MO-controlled mands occurred within only a few experimental sessions. With the exception of the lollipop response, MO-controlled mands began occurring within the first experimental session for Martin for all targeted items. In addition, once MO-controlled mands began occurring, stimulus-control transfer from a multiply-controlled mand to an MO-controlled mand occurred for the responses fry, pretzel, and chip within no more than 12 experimental sessions. For pretzel and chip responses, stimulus-control transfer occurred after only one experimental session. For Jeff, MO-controlled mands also began occurring after no more than one experimental session, and during the majority of experimental session a display of the targeted item was not required, indicating that stimulus-control transfer from multiply-controlled mands to MO-controlled mands had occurred. These results

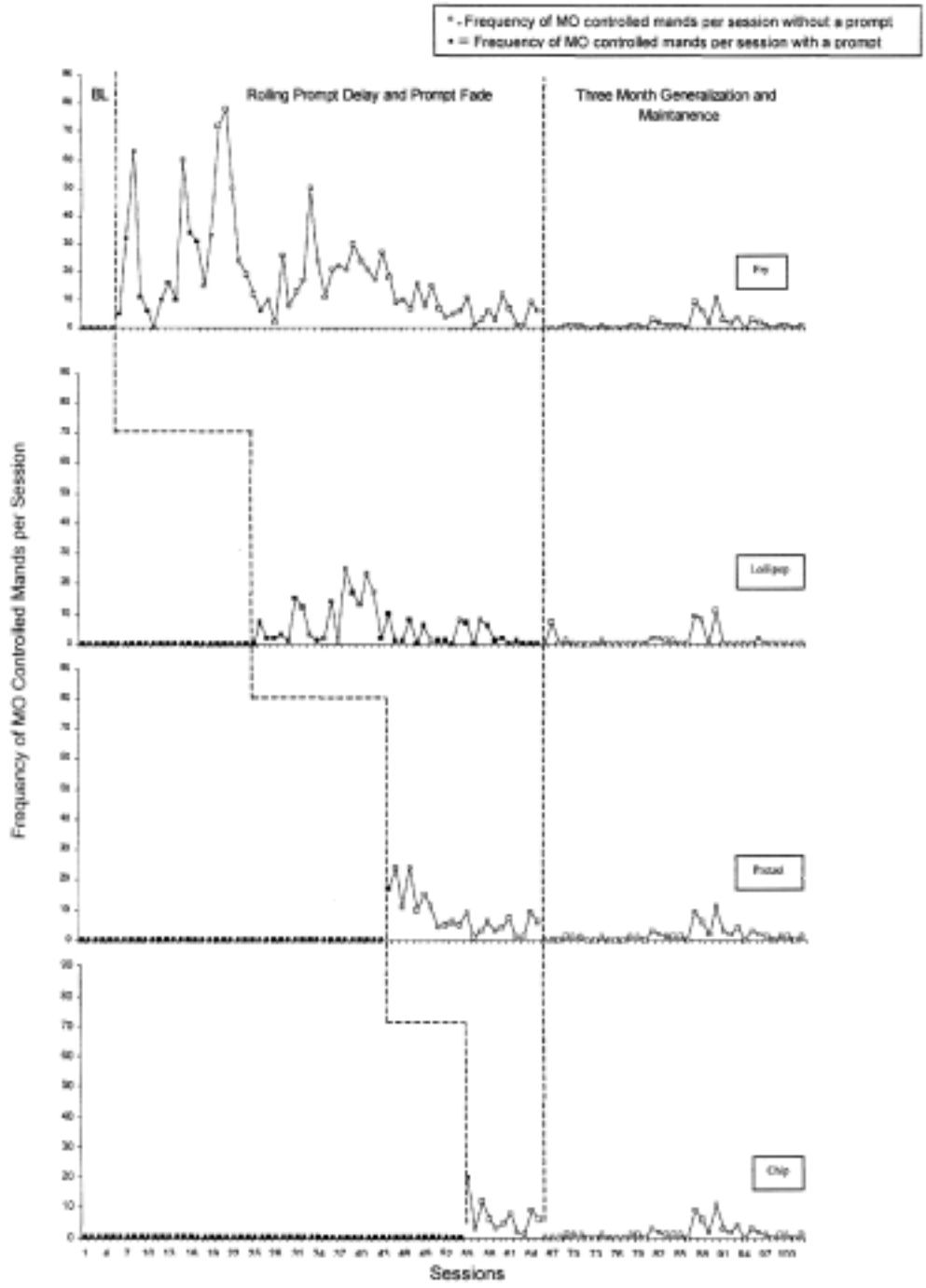

Figure 1. Frequency of MO-controlled mands per sessions during baseline (BL), treatment, and generalization and maintenance conditions for all targeted items for Martin.

further support the assumption that the motivation for the targeted items existed during the baseline condition but the control exerted by the MO alone was insufficient to evoke the response. Once implementation of the rolling-time delay and prompt-fade procedure had effectively transferred control to the MO, MO-controlled mands began occurring readily for

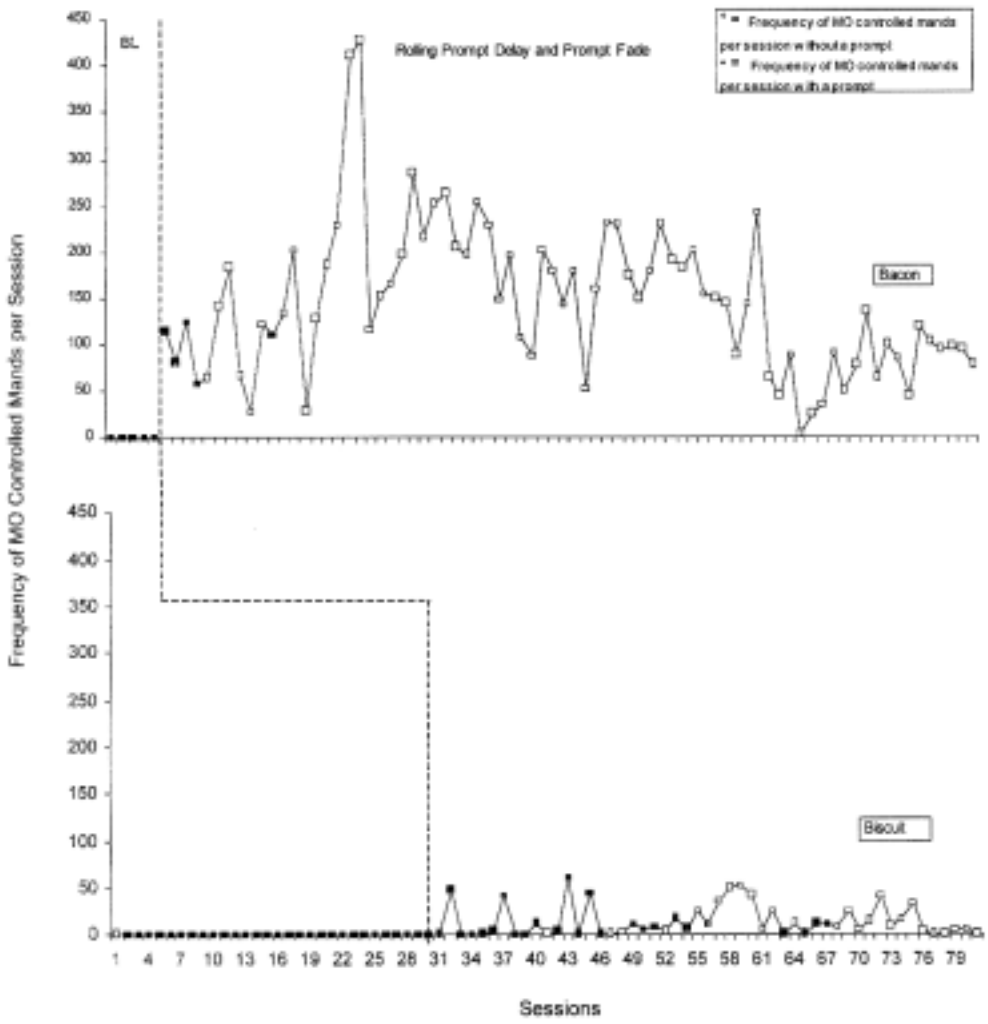

Figure 2. Frequency of MO-controlled mands per sessions during baseline (BL) and treatment conditions for Jeff.

both learners. The speed with which MO-controlled mands began occurring also speaks to the efficiency of the procedure tested and further verifies the overall effectiveness of the rolling-time delay procedure.

The variability in the frequency of MO-controlled mands as evidenced in Figures 1 and 2 can be explained by considering the nature of the MO as defined by Michael (1993, 2000). The MO is a stimulus, condition, or event that momentarily alters the value of some stimulus as a reinforcer and evokes all responses that have produced that reinforcer in the past. The key term in this definition when considering the variability in the data presented in Figures 1 and 2 is "momentarily." As Michael's (1993) definition suggests, the MO's establishing or abolishing effect may change the value of items as reinforcers and therefore change the frequency of any behavior that successfully produced that reinforcer in the past. The MO for any particular item or activity may be fleeting and motivation for multiple items may exist simultaneously, producing competing values of reinforcement. The differing rates of MO-controlled manding across sessions and items found in this study would therefore be expected, as the participants' motivation for different items shifted according to the values of additional and competing forms of reinforce-

ment. During the course of each experimental session, the participants were exposed to various putative reinforcers, such as games, toys, videos, and physical activities that may have competed with the value of the edible items targeted in this study and accounted for the some of the variability in frequency of MO-controlled mands.

Furthermore, the introduction of additional items into the treatment condition may also account for the changing frequency of MO-controlled mands for previously introduced items, and for the seemingly downward trend of MO-controlled mands over time. Newly introduced items may have competed with the value of previously introduced items and therefore altered that value of these items as reinforcers and decreased the MO-controlled responses that had produced these reinforcers in the past. As shown in Figure 1, the frequency of MO-controlled mands for lollipop during the treatment condition, though greater than during baseline, was low relative to the frequency of MO-controlled mands for fry. These results must be analyzed in terms of a number of variables. First, lollipop was introduced after MO-controlled mands had begun occurring for fry, which may have produced a competing reinforcer effect and therefore resulted in a lower frequency of MO-controlled mands for lollipop and a decrease in MO-controlled mands for fry. Once MO-controlled mands for lollipop began occurring, two additional items, pretzel and chip, were then subjected to the effects of the independent variable. With the introduction of each new item, MO-controlled manding for all items previously in the treatment condition decreased. These data suggest that the competing value of the introduction of the new items may have altered the value of the previous items as reinforcers and therefore decreased the occurrences of the MO-controlled responses for those items. Other variables outside the control of the experimenters (e.g., the amount of food each child consumed during a meal prior to the experimental sessions) may also have altered the value of the edible reinforcers selected for this study.

An alternative explanation for the gradual reduction in the frequency of MO-controlled mands across treatment sessions is that the deprivation of the targeted items during the baseline condition may have temporarily increased the value of these items as reinforcers. Consequently, when the items were initially reintroduced during the treatment condition high levels of MO-controlled mands occurred. As these items were delivered during the treatment sessions satiation may have occurred resulting in a decrease in the reinforcing value of the items and the gradual decrease in MO-controlled mands.

Mands that only occur under tightly circumscribed conditions such as presence of only one listener will be less beneficial to a speaker than a response repertoire that is controlled by many different listeners. Stimulus generalization across listeners and environments is imperative to the development of an effective mand repertoire. Generalization data for Martin are presented in Figure 1. During the generalization and maintenance condition, assessment of stimulus generalization across instructors was conducted. Although the frequency of MO-controlled mands decreased during this condition, MO-controlled mands did occur at higher frequencies than during baseline sessions. Moreover, these generalized responses occurred without programming for generalization. Although no formal measure of generalization across settings was conducted, it should be noted that MO-controlled mands occurred throughout the educational environment. Martin manded solely under the control of the MO and a listener in both instructional and play conditions, as well as in unfamiliar environments such as the staff kitchen and conference room. This suggests that in addition to generalization across instructors, generalization across settings may have also occurred. Unfortunately, due to circumstances beyond the control of the experimenters, the second participant, Jeff, left the study before his generalization and maintenance data could be gathered. It is important to note that incidental probes of stimulus generalization across instructors occurred over a 2-week period during which Jeff's primary instructor was on leave. During this time, his experimental sessions were conducted by various replacement instructors and MO-controlled mands for the targeted item, bacon, continued to occur during all sessions. In addition, Jeff manded solely under the control of the MO and a listener throughout the educational setting including instructional and play environments, as well as outside the building during outdoor activities.

Generalization across instructors and settings was most likely facilitated by the ease of implementation of the rolling-time delay and prompt-fade procedures which allowed for all experimental sessions to be conducted under naturally occurring conditions. All experimental sessions were conducted for the duration of the participant's teaching session and did not include any isolation or separation of the participant from the typical instructional environment, or any differentiation of routine. Generalization of MO-controlled mands across instructors and environments further supports the use of the rolling-time delay and prompt-fade procedures as effective interventions in the development of MO-controlled mand repertoires.

Although the results support the contention that generalization of MO-controlled mands occurred for Martin, the results indicated that *response generalization* did not occur. Response generalization in this study would have occurred if the participants began manding solely under the control of the MO and a listener for items that had not been subjected to the independent variable. Clearly, from the baseline data presented in Figures 1 and 2, neither participant's response repertoire was characterized by response generalization. It is conceivable that this effect would not be seen without the training with a greater number of exemplars.

With respect to the durability of the effect, the maintenance data collected for Martin over a 3-month period indicate that the MO-controlled responses continued to occur across all trained responses for more than 45 sessions after the experimental condition was discontinued. As shown in Figure 1, MO-controlled mands decreased during the generalization and maintenance condition relative to the treatment condition. All items targeted during this study were edible items and therefore the simultaneous change in MO-controlled mands for all targeted items may suggest that during sessions in which MO-controlled responses were low, the value of edible items in general may have been low. Again, maintenance data for Jeff were not collected, however, it should be noted that while biscuit was subjected to the independent variable, MO-controlled mands for bacon continued to occur without prompting and therefore this condition was tantamount to a maintenance probe condition.

The results of this study lend support to the concept of the functional independence of the verbal operants and that stimulus-control transfer procedures are effective and necessary to transfer control across operant classes. Skinner (1957) explained, "Classifications of responses are useful only in separating the various types of controlling relations, and some responses may show features of both mand and tact" (p.189). Both participants in this study initially emitted responses that had "features of both mand and tact." Skinner contends that we should not expect that the response will spontaneously transfer to a more pure form of mand, or tact for that matter, without contacting the conditions that account for the independent operant. In this study none of the responses spontaneously took on the features of the mand without the arrangement of conditions that account for the separate mand relation. Only after arrangement of the independent variable in the form of stimulus-control transfer procedures was the response transferred from a response that had features of both the mand and the tact to one that was more purely defined as a mand.

The results of this study have important implications for the use of selection-based responding. Programs that require the speaker to mand by selecting a picture of the desired item may produce a useful mand repertoire with children with autism. However, the very nature of the response form which requires the presence of a stimulus to be selected that has almost identical appearance to the item requested may in fact preclude the development of an MO-controlled mand repertoire. In this study, a non-vocal learner was taught a topography-based verbal response form, manual sign language, instead of a picture selection method for several reasons, but one consideration was the value of freeing the response from the presence of the item in the form of a picture or icon. Consequently, when choosing a response form that is either topography- or selection-based (Michael, 1985) for a non-vocal learner, the clinician may want to consider the findings of this study.

This study is limited by the fact that findings from only two participants are reported. Replication with additional learners with autism who have varying characteristics will be needed to determine the benefits of these procedures for a broad participant group. In addition, the inclusion of only edible items limits

the generality of the findings. MOs related to other reinforcers may react differently when subjected to the independent variables studied in this report.

In terms of practical significance the results of this research demonstrate that the occurrence of multiply-controlled mands may be an important issue to assess within language-training programs for children with autism. Moreover, in some learners it appears that multiply-controlled mands will require explicit and programmed stimulus-control transfer procedures to free them from the control of other stimuli. Therefore, programs designed to teach manding to children with autism may need to include procedures to systematically fade the stimulus control of reinforcing items from the presence of the item and the MO to the motivation for the item or condition and a listener alone.

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