An Examination of the Influence of the Motivating Operation on the Discriminative Stimulus for Behavior Maintained By Positive Reinforcement

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Abstract

We manipulated a series of motivating operations (MOs) to examine the effects that an establishing operation (EO) and abolishing operation (AO) may have on the ability of a discriminative stimulus to evoke challenging behavior. Two participants with developmental disabilities and challenging behavior participated. In Phase I, a functional analysis was conducted to identify the consequence maintaining challenging behavior. In Phase II, a discrimination between $S^D$ and $S^A$ was trained. In Phase III, pre-session MOs (i.e. EO and AO conditions) were manipulated to verify the influence of the MO on the target behavior. Finally in Phase IV, in addition to manipulating pre-session MOs, as in Phase III, the effects of the MO was examined, by placing the target behavior on extinction in both $S^D$ and $S^A$ conditions. In this way the direct effect of the MO on the $S^D$ was examined. Results indicated that in the context of extinction when pre-session EO and AO conditions were manipulated responding not only differentiated but that they were higher in both $S^D$ and $S^A$ conditions in the pre-session EO condition when compared to the pre-session AO condition.
Introduction

During the past 20 years, an increasing number of researchers have adopted methodologies derived from the basic study of operant behavior in an attempt to identify the environmental variables (i.e., reinforcing functions) that maintain behavior (Neef & Iwata, 1994). In recent years, there has been an increased interest in the application of antecedent variables to enhance instructional strategies and behavior management approaches with individuals with severe developmental disabilities (Wilder & Carr, 1998; Kennedy & O’Reilly, 2006). One class of antecedent variables that may have such an effect on challenging behavior is motivating operations (Michael, 1982, 1983, 1993a, 1993b). Motivating operations influence operant responding by: (a) altering the effectiveness of a consequence as a reinforcer/punisher, (b) altering the probability of behavior previously associated with that consequence, and (c) modifying the evocative effects of discriminative stimuli (Laraway, Snyerski, Michael, & Poling 2003).

A number of studies have examined the influence of motivating operations and how it may moderate the three-term contingency. Together these studies have shown that it is (a) possible to identify MOs via manipulation of antecedent variables (McCadam et al., 2005; North & Iwata, 2005; Carr, Smith, Giacin, Whelan, & Pancari, 2003; Gotschalk et al., 2000; Horner, Day, & Day, 1997; Kennedy & Meyer, 1996; O’Reilly, 1997; 1995; Vollmer & Iwata, 1991; Gerwirtz & Baer 1958); (b) performance during training/teaching sessions may be enhanced by scheduling “deprivation” of the reinforcer (Wilder, 2000); (c) constant access to the reinforcer may diminish its effectiveness, so that its true value to function as a reinforcer may not be optimized (McCadam et al., 2005; North & Iwata, 2005; Gotschalk et al, 2000); and (d) prior levels of reinforcement
can influence positively reinforced challenging behavior (Berg et al., 2000; O’Reilly, 1999).

However, most intervention research to date has focused on the reinforcer altering effects of antecedent operations. In other words, researchers have examined how antecedents influence the consequences maintaining responding. However, antecedents may also influence operant responding when consequences (reinforcement) are not available, and when the behavior is under extinction (Michael, 2000). Such research may have important implications for the assessment and treatment of challenging behavior in people with developmental disabilities (McGill, 1999). However, an understanding of behavior under different antecedent conditions (that is motivational operations), and their momentary behavior-altering effects, requires a more complex examination of behavior (Michael, 1993a & b).

The typical methodology employed by applied researchers to examine the influence of the MO has included a two-step process. The first step is to identify the contingencies maintaining the behavior (often using the analogue functional analysis methodology developed by Iwata, et al. 1982/1994). The second step is to hold the contingencies constant while systematically manipulating an MO. Aside from examining the influence of the MO on the discriminated operant, applied researchers have rarely attempted to empirically clarify additional functional properties of the MO. Such research may shed further light on the functional properties of the MO, and MO and S^D interaction effects, and possibly identify new applications of the MO in applied settings.

O’Reilly, et al., (2006) attempted to isolate the behavior altering effects of the MO for tangible-maintained and attention-maintained challenging behavior. They
employed a three-phase methodology. In Phase I, the operant function of challenging behavior was identified in a functional analysis (Iwata, et al., 1982/1994). In Phase II, putative MOs were isolated for the discriminated operant identified in the Phase I. This was accomplished by systematically controlling the levels of pre-session access to reinforcement under two conditions, (a) pre-session access (Abolishing Operation), and (b) no pre-session (Establishing Operation) (c.f. Vollmer & Iwata, 1991). Finally, in Phase III, the MO was systematically controlled as in Phase II while target behaviors were placed on extinction.

Although, the authors demonstrated differential control over challenging behavior by the antecedent/consequence arrangements in Phase I, no specific SD was either identified or manipulated in a way that clearly demonstrated their effects. Rather, contingencies that maintained challenging behavior were identified and manipulated in pre-session conditions. Further, no manipulation was conducted that supported an account of the effects of pre-session access on the behavior altering effect of any other antecedent stimulus. However, their analysis for the first time examined the behavior altering effects of the MO on operant behavior.

O’Reilly et al., (2007a) replicated the first study with a person with autism and developmental disabilities whose challenging behavior was maintained by access to attention. The results of this study seemed to indicate that no access to the reinforcer prior to extinction had a behavior altering effect (produced higher levels of responding) during extinction sessions. In another study, O’Reilly, et al., (2007b) examined the behavior altering effects of a motivating operation on challenging behavior during classroom instruction for a student with severe disabilities. The methodology used was similar to the
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previous two studies. Together, these three studies support a beginning trend in examining the behavior altering effects of motivating operations.

Another study by Horner and Day (1997) examined the use of neutralizing routines to reduce problem behaviors for behavior maintained by negative reinforcement. Utilizing an alternating treatments design they examined four conditions: (a) EO + SD, (b) SD only, (c) EO only, and (d) neither SD nor EO conditions. However as multiple stimuli were used both during the neutralizing routines and the instructional settings, and because instructions deferred from day to day, it was not clear if the participants in their study discriminated the SD. Regardless, their results supported the utility of MO manipulations when developing interventions.

Currently no known research to date has demonstrated the relation between the MO and the SD for behavior maintained by positive reinforcement. In order to examine the relationship between the MO and the SD, the SD in question must be clearly identified and systematically manipulated. Michael (2000), offers a conceptual model to do so, he says that an appropriate conceptual model to identify the behavior altering effect of the MO is to examine the direct relation between deprivation levels and the initial rate of responding or the total number of responses emitted during extinction. Klatt and Morris (2001), further state that the behavior altering effect should be demonstrated when other contingencies are not in effect during extinction or before the onset of the first delivery of the reinforcer. Furthermore, Laraway, et al., (2003) pointed out that, MOs influence discriminative stimuli (a) by making reinforcement and punishment possible, and (b) by changing the control over behavior exerted by previously established SDs. The authors
further stated that once a $S^D$ has been developed, the behavioral effects of that stimulus will be seen only when the relevant MO is in effect (Laraway, et al., 2003).

Therefore, in order to evaluate the interaction between a MO and the $S^D$, it would be necessary to first demonstrate or establish a discriminative relationship, and then compare response measures from conditions during which no reinforcement is presented contingent on the target response and in which, (a) the $S^D$ is present and the Establishing Operation (EO) is present, (b) the $S^D$ is present and the Abolishing Operation (AO) is present, (c) the $S^A$ is present and the EO is present, and (d) the $S^A$ is present and AO is present. These manipulations (a-d) need to be conducted in the context of extinction.

Results of such a manipulation would then examine any direct effect of the MO on the $S^D$. If the data were to indicate that responding did indeed occur, in the presence versus absence of the $S^D$ under extinction, one may then be able to extrapolate that responding was a function of the presence of the MO (establishing operation). This would be evidenced by the differentiation in response measures in the presence (establishing operation) versus absence (abolishing operation) of the MO when the $S^D$ was held constant. In effect, the purpose of this study was to verify one way in which the MO enters into a functional relationship with the discriminated operant.

Method

The study comprised of four phases. In Phase I, an FA was conducted to identify the contingency maintaining the target behavior. In Phase II, discrimination training was conducted under two conditions 1) $S^D$ and 2) $S^A$ for the contingency identified in Phase I.
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In Phase III, pre-session levels of satiation and deprivation were manipulated in the presence of the $S^D$, in order to identify the MO, whilst within session target behavior was reinforced on a fixed ratio (FR) 1 schedule. In Phase IV, the MO identified in Phase III was manipulated in the presence of both $S^D$ and $S^\Delta$, while the target behavior was placed on extinction. The response measurement and target behaviors for all phases were the same.

Participants & Setting

Two participants, Alex 16 years old and Josh 37 years old took part. Alex was diagnosed with pervasive developmental disability not otherwise specified (PDD-NOS) and severe mental retardation. He was functioning at a 2-year-old level on the daily living skills domain of the Vineland Adaptive Behavior Scales – Interview Edition (Sparrow, Balla, & Cicchetti, 1984) and scored in the severe range on the Gilliam Autism Rating Scale (Gilliam, 1995). He was nonverbal and communicated mainly through facial expressions, gestures, a few manual signs (i.e., more, cracker, cookie), screaming, and by guiding an adult’s hand to objects. His challenging behaviors consisted of tantrums that included screaming, dropping to the floor, hand mouthing, and stomping. However, during sessions only a mild form of hand mouthing was observed. Alex attended the school program at a residential treatment facility. Josh functioned at a 3-year old level on the Vineland Adaptive Behavior Scales – Interview Edition (Sparrow, Balla, & Cicchetti, 1984) and scored in the moderate to severe range on the Gilliam Autism Rating Scale (Gilliam, 1995). He engaged in bizarre speech, shouting loudly while making special comic book sound effects with his mouth, e.g., “KaaPow.” He would frequently take on the persona of certain comic book characters e.g., Batman, and World Wrestling.
Federation wrestling characters, e.g., Hulk Hogan. Occasionally he would display aggressive behaviors (slamming and hitting) others. However, these behaviors were not observed during sessions. Target behaviors for Alex was mild handmouthing, while the target behavior for Josh was bizarre speech. Caregivers reported that both participants enjoyed participating in sessions and would look for the experimenter on days that sessions were not in progress.

All sessions were conducted in a room at the treatment facility that was equipped with a round table, chairs, and other session materials. Session materials included, color pens, paper, identified tangibles (for example, cheese crackers for Alex), one red and one green bowl, and three five-digit re-settable mechanical counters. Sessions were conducted two to five times a day, one to three days a week.

Implementation, Procedural Integrity and Data Coding

Three advanced doctoral students in Special Education, including the first author implemented the procedures (i.e., conducted the functional analysis, the preference assessment, discrimination trials, the MO manipulations and extinction trials.) Two additional advanced graduate students trained by the first author conducted data coding. All sessions were videotaped. A fifth advanced graduate student who was blind to the mechanisms of the study independently scored a third of the videotapes.

Standardized observation times were utilized in order to compare session trends in the occurrence and non-occurrence of behavior. Therefore, two examples for Alex are (a) all sessions were 5 minutes in length and, (b) in Phase II during the pre-session AO sessions, he had free access to tangibles for 15 minutes. Session order was randomized according to a multi-element treatment design to control for sequencing effects.
Data coders were given definitions of target behaviors, coding sheets and were trained on identifying the occurrence of the target behavior on mock trials until they reached above 90% reliability before coding the sessions for 3 consecutive trials. If the coders had any questions in respect to the coding, the first author answered them, until agreement was reached.

The first author trained the doctoral students who participated in implementing the sessions till they performed the procedures exactly and according to protocol. Session order was predetermined, randomized and counterbalanced, and data sheets were provided. If any sessions were not implemented correctly due to the session being interrupted or because protocol was not followed correctly, then that session was not included in the study. Only one session was discarded due to the session being interrupted and no sessions were found to have been implemented incorrectly.

**Interobserver Agreement**

Target behaviors were measured using a 10-second partial interval recording procedure for all sessions and phases. All sessions were video taped using a Sony DV digital camera. A second observer independently coded target behaviors during 78% of sessions, and a third observer who was blind to the mechanisms of the study independently coded 40% of the sessions. Interobserver agreement (IOA) was calculated according to the Interval-by-Interval method (Hawkins & Dotson, 1975). IOA for Phase I was 98.1% (Range 83.3%-100%), Phase II, 96.6% (Range 86.6%-100%), Phase III, 93% (Range 86.6%-100%). Third party reliability IOA ranged from 90%-100%. In addition, Cohen’s kappa coefficient (Cohen, J. 1960) was used to calculate reliability between the primary observer and the secondary observer. Kappa was calculated by hand by using the
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formula \( k = \frac{(Oa - Ea)}{(N - Ea)} \). Phase I, Kappa was 0.94, Phase II, Kappa was 0.838, Phase III, Kappa was 0.852 and Phase IV Kappa was 1.

**Dependent Variables**

The target behavior for Alex was challenging behavior. Challenging behavior for Alex were, a) mild head hitting, b) hand mouthing, and c) stomping, and two forms of aggression, a) hitting others, and b) hair pulling. The later behaviors of hitting and hair pulling were occasional. These target behaviors were scored independently and data were collapsed to form the composite challenging behavior. The target behavior for Josh was bizarre speech. Bizarre speech was defined as any words or speech that were non functional or irrelevant to the topic of conversation.

**Experimental Design**

Individual participant multielement designs were used to demonstrate experimental control in each of the four experimental phases (Kazdin, 1982). Sessions were counterbalanced and randomized to account for any sequential effects. However, the data is presented in either session-by-session format or cumulative frequency format in different phases (Phase I-IV) of the study to facilitate interpretation of the results.

**Phase I**

In Phase I, the operant function of the target behavior was identified using an analogue functional analysis (FA) based on the procedures described by Iwata et al., (1982/1994). Participants were exposed to four or five conditions. For Alex, attention, play, tangible and demand and for Josh, attention, play, alone, tangible and demand conditions. An alone session was not included for Alex as it was reported that he never engaged in challenging behavior while he was alone. A preference assessment conducted
for Alex indicated that he exclusively selected Ritz brand cheese crackers. These were used for the tangible assessment for Alex while the tangible sessions for Josh utilized his top three preferred edibles from his preference assessment i.e. Almond M & M, Peanut M & M and popcorn. Sessions of each of the functional analysis conditions were 5 minutes in length for Alex, and 10 minutes in length for Josh.

Phase II

In Phase II, discrimination training was conducted. Discrimination training was based on the results of Phase I. The FA results for Alex indicated that his behavior was maintained exclusively by access to food items. Functional analysis results for Josh indicated that his behavior occurred almost exclusively during the attention condition and was maintained by access to social attention.

Discrimination was trained in Phase II under two conditions, 1) $S^D$ and 2) $S^\Delta$ for the social-positive reinforced behavior (i.e. tangible for Alex and attention for Josh). Only the FA conditions that were identified in Phase I as the maintaining contingency for the target behaviors were examined in Phase II (i.e. tangible condition for Alex and attention condition for Josh). All other conditions of the FA described in the previous section were excluded.

The tangible FA condition for Alex was identical to the tangible FA condition in Phase I with the exception of discrimination training. In order to train discrimination a green bowl functioned as the $S^D$ and a red bowl functioned to signal the $S^\Delta$ condition. Both bowls were equipped with similar quantities of food. When the green bowl ($S^D$) was present and the participant engaged in the target behavior reinforcement was provided on a Fixed Ratio (FR) 1 schedule by giving the participant access to a small portion of food
in the bowl. Each time the participant consumed the food the bowl was refilled with a similar portion. When the red bowl ($S^\Delta$) was present and the participant engaged in the target behavior reinforcement was not provided. If the participant tried to grab the food item response blocking was used to restrict access to the food item.

The first author conducted all discrimination sessions during both conditions for Alex. Therefore the stimulus to signal discrimination was restricted to the presence of either the green or the red bowl. Sessions were terminated when the response strengths in $S^D$ and $S^\Delta$ gradually drew apart, with prolonged extinction taking place in $S^\Delta$ (Millenson, 1967).

The attention FA condition for Josh was identical to the attention FA condition in Phase I with the exception of discrimination training. Two female experimenters conducted all training sessions and alternated serving as $S^D$ and $S^\Delta$. This was done so that the stimulus for discrimination was restricted to the diverted attention ($S^\Delta$) condition or the expectant attention ($S^D$) condition and not possible experimenter preference by Josh. In order to train discrimination, in the $S^D$ condition the experimenter turned facing toward the participant and looked at him expectantly. In the $S^\Delta$ condition, the experimenter pretending to read a book so that the experimenter’s attention was diverted. In the presence of the $S^D$ if the participant engaged in the target behavior, reinforcement was provided as in Phase I, in the form of attention delivered on a FR 1. When $S^\Delta$ was present and the participant engaged in the target behavior reinforcement was not provided. A diverted attention condition was selected as the $S^\Delta$ condition rather than a
designated experimenter to rule out possible MO interactions effects (e.g., prior associations with the experimenter, preference of one experimenter over the other etc.,).

Sessions were terminated when the response strengths in $S^D$ and $S^A$ gradually drew apart, with prolonged extinction taking place in $S^A$ (Millenson, 1967).

**Phase III**

In Phase III, by manipulating the pre-session conditions for each FA (tangible condition only for Alex, Attention condition only for Josh) session, MOs for the target behaviors were isolated. This phase was conducted to empirically demonstrate an MO for the target behavior for each participant. For tangible-maintained and attention-maintained target behavior, tangible and attention conditions prior to the commencement of each Phase III sessions were systematically controlled for deprivation levels (EO) and satiation levels (AO).

For Alex, in order to take advantage of natural levels of deprivation, EO sessions were conducted 30 minutes prior to lunch. The pre-session AO condition was conducted immediately after lunch to take advantage of natural satiation levels. Additionally, Alex was given free access to food for 15 minutes after lunch. The FA sessions were conducted immediately following this condition.

For Josh, the pre-session EO condition consisted of placing the participant alone in a room with mid range preference items (newspaper, pen, paper) for 15 minutes prior to the commencement of the attention session. Pre-session AO sessions consisted of engaging the participant in continuous social interaction (every 5 seconds) for 15 minutes immediately prior to the commencement of the attention session.
As in Phase II, Phase III sessions for Alex were 5 minutes and attention sessions for Josh were 10 minutes in duration. Within the session contingent upon target behavior, tangibles (for Alex) or attention (for Josh) was delivered on a FR 1 schedule.

**Phase IV**

In Phase IV, in addition to Phase III conditions (i.e. EO and AO sessions), 1) no consequences were delivered during the tangible and attention conditions (extinction was in effect), and 2) sessions were held in both $S^D$ and $S^A$ conditions. As in Phase III, the pre-session MOs were manipulated in the same manner. For example, for attention maintained behavior the pre-session EO condition consisted of placing the participant alone in a room with preferred items for 15 minutes prior to the FA session. The pre-session AO condition consisted of engaging the participant in continuous social interaction (every 5 seconds) for 15 minutes immediately prior to the FA session. Within session, both when the $S^D$ was present or $S^A$ was present, regardless of the MO condition (EO or AO) reinforcement was always absent. In other words, in all four conditions the behavior was placed on extinction.

**Results**

**Phase I Results For Alex**

Phase I, consisted of a FA, with four conditions i.e. attention, demand, tangible and play. Results of Phase 1 for Alex indicated that are presented in figure 1. As can be noted challenging behavior occurred almost exclusively in the tangible condition of the FA for Alex. The percentage of intervals with challenging behavior for demand and play were 0.0% while in the attention condition challenging behavior occurred in 1 interval in 1 of the 7 sessions with the mean range of occurrence at 0.00%-0.33%. In the
tangible condition challenging behavior occurred in 10 of 14 sessions (range 0.00%-40%).

Phase I results for Josh

Results of Phase 1 for Josh indicated that bizarre speech challenging behavior occurred during all of the eight sessions (range 26.66%-60.00%), 7 of these sessions in which all ten sessions had bizarre challenging behavior speech occurring ≥ 26.66% of intervals for that session. Bizarre speech did not occur in any of the alone, demand and play sessions. Bizarre speech occurred only in 1 interval in 1 session of a total of 4 tangible sessions (range 0.00%-0.33%). Figures depicting FA results for both Alex and Josh can be obtained by contacting the first author.

Phase II Results for Alex

As is illustrated in figure 1A, by the overlapping values for both SD and SΔ the target behavior is initially not under stimulus discrimination. In fact responding is slightly higher in the SΔ condition when target behavior was not reinforced and all attempts were placed on extinction. During session 10, responding in the SD is higher than the SΔ condition. As sessions continue, the response strengths of the target behavior gradually grows apart and stimulus control is achieved as the target behavior occurs under SD and not under SΔ.
Phase II Results for Josh

Figure 24, presents the Phase II results for Josh. Unlike Alex, Josh showed differentiation in responding in session 1 (see methods section for a detailed description on how sessions were conducted). Results indicate that as sessions continued Josh’s data indicated greater discrimination, with total discrimination resulting in session 8, when responding occurred in $S^D$ and not in $S^A$.

Phase III Results for Alex

The results for Alex are presented in figure 35. In Phase III, pre-session access to tangibles were manipulated by either providing pre-session access (AO) or withholding pre-session access (EO). Results indicate that when the AO was present and the $S^D$ was present he had lower rates of challenging behavior during the sessions. When the EO was present and the $S^D$ was present he had higher rates of challenging behavior occurring during each session.

<Insert Figure 35 here>

Phase III Results for Josh

In Phase III, the consequence maintaining bizarre speech identified in Phase I, in pre-session FA (attention for Josh) was manipulated by either providing pre-session access (AO) to the same or by withholding pre-session access (EO) prior to the commencement of each session (see Methods section for a detailed description). The results for Josh are presented in figure 46. Results indicate that when the AO was present and the $S^D$ was present he had lower rates of challenging behavior during the sessions.
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When the EO was present and the $S^D$ was present he had higher rates of challenging behavior occurring during each session.

<Insert Figure 46 here>

Phase IV Results for Alex

Results of Phase IV for Alex is presented in Figure 52. Results in Phase IV indicated that when extinction was in effect that responding occurred at high rates when the EO was present both in $S^D$ and $S^A$ conditions. In session 1, the frequency of intervals with target behavior under $S^D$ when the EO present was 25 while the frequency of responding in $S^A$ when the EO was present was 5. This differentiation in responding in $S^D$ and $S^A$ continued till session 8. However, in session 8 for a brief period (session 8 & session 9) responding $S^A$ was higher than responding in $S^D$. However, as sessions continued responding in $S^D$ and $S^A$, differentiated yet again. The cumulative frequency of responding in $S^D$ was 105 and $S^A$ was 89. However, for both conditions ($S^D$ and $S^A$) responding was higher when the EO was present when compared to when the AO was present. When the AO was present, responding in both $S^D$ and $S^A$ were at near zero levels with responding in slightly higher in $S^A$. The cumulative frequency of responding in $S^D$ was 3 and $S^A$ was 4.

<Insert Figure 62 here>
Phase IV Results for Josh

Results for Josh are presented in figure 68. Results in Phase IV indicate that when extinction was in effect that responding occurred at high rates when the EO was present both in $S^D$ and $S^A$. In session 1, the frequency of intervals with target behavior under $S^D$ when the EO was present was 6 while the frequency of responding in $S^A$ was 9.

However, in session 8 for a brief period (session 8 & session 9) responding $S^A$ was higher than responding in $S^D$. However, in session 2, responding in $S^D$ was 19, and $S^A$ was 15. This differentiation continued till the cumulative frequency of responding in $S^D$ was 190, and $S^A$ was 114. Thus, for both conditions ($S^D$ and $S^A$) responding was higher when the EO was present when compared to when the AO was present. When the AO was present responding in both $S^D$ and $S^A$ were both at much lower levels with not much differentiation between $S^D$ and $S^A$. The cumulative frequency of responding in $S^D$ was 26 and $S^A$ was 27 with responding reaching extinction during session 13 for both $S^D$ and $S^A$.

In summary, Phase IV results indicated that when the EO was present rates of responding were higher in both the $S^D$ and $S^A$ for both Alex and Josh even when all attempts at responding were placed on extinction. However, results indicated that when the AO was present responding was lower in both $S^D$ and $S^A$ under extinction.

DISCUSSION
The results of Phase I, demonstrated the consequence maintaining the operant and in Phase II stimulus discrimination was demonstrated for both Alex and Josh. The results of these two phases by themselves are not noteworthy for an extensive discussion. The implications of identifying the consequence maintaining operant behavior as well as stimulus discrimination have been studied and reported extensively over the years by numerous researchers (Luiselli & Cameron, 1998). However, the results of Phases I & II were necessary to facilitate Phases III-IV. Phase III results indicated that the direct manipulation of the MO, had an effect on the responding of participants.

Results indicated that when reinforcement was contingent on target behavior responding was lower in AO conditions and higher in EO conditions. Phase III results are not novel and are consistent with previous studies that have examined the reinforcer altering effects of the MO (Gottschalk, et al., 2000; Vollmer & Iwata, 1991). Skinner (1953) proposed that when an organism is under deprivation (EO) for a given reinforcer, that responses maintained by the same reinforcer will be emitted at increased levels. Conversely, satiation (AO) will reduce responding even when the reinforcer is accessible. Michael (2000) proposed that the \( S^D \) is only effective when the relative EO is in effect. McGill (1999) asserted that for every class of maintaining consequences that there are parallel MOs that either establish or abolish the effectiveness for that class of reinforcement. While it is impossible to validate that McGill’s conceptual logic holds true for every class of maintaining consequences, Phase III results, do support his notion that parallel MOs have either establishing or abolishing effects for a class of reinforcement.

Both participants exhibited target behavior that differed in topography; challenging behaviors (Alex), and bizarre speech (Josh). These behaviors, when exposed
to presession AO conditions occurred at as much as 70% less than when compared to when the EO was present for the same behavior. These results indicate that it may be prudent to consider combining MO manipulations in the design of behavioral support plans in educational settings for behaviors that are maintained by positive reinforcement. This can be accomplished by programming in periods of satiation to the MOs identified for the target behavior. For example, in an classroom situation, programming in a rich schedule of attention prior to periods of time when it may not be possible to provide attention would have an abolishing effect and reduce the occurrence of challenging behavior for students whose challenging behavior is maintained by access to attention. Such an antecedent intervention would be useful for educational settings and easily implemented in settings wherein teachers are often juggling multiple tasks and do not always have time to devote to one-one interactions with students who engage in attention-maintained challenging behavior.

The failure of many interventions (such as the provision of non-contingent attention) to maintain in certain settings may be due to a poor ‘goodness of fit’ in the context in which they are implemented (Albin et al., 1996). The results of the current study suggest that a relatively brief intervention that involved manipulation of the relevant MO may provide a better ‘fit’ in applied settings.

Josh’s data indicated that challenging behavior is not restricted to self injurious or aggressive behaviors, but can include verbal behaviors such as bizarre speech, that are socially deemed unacceptable. Bizarre speech, while it may appear to be less challenging than aggression or self-injurious behavior is just as problematic, as it excludes the individual from being integrated in the community. Several studies have examined the
operant functions of bizarre speech. Most of these studies have identified attention as the maintaining consequence for bizarre speech (Lancaster, LeBlanc, Carr, Brenske, Peet, & Culver, 2004; Dixon, Benedict, & Larson, 2001). In a recent study, Lancaster, et al., (2004) examined the effects of non-contingent reinforcement (NCR) in the form of attention (attention delivered to participants on a fixed-time schedule) for bizarre speech with two participants. Prior functional analyses had identified bizarre speech was attention maintained for the participants. Their results indicated that exposing the participants to periods of non-contingent attention decreased bizarre speech. While Lancaster, et al., (2004) did not conceptualize non-contingent reinforcement as a possible abolishing operation their results however indicate that NCR may act as an AO. For example, in Phase III, when Josh was exposed to presession attention in the AO condition, results indicated that his bizarre speech was lower than in the EO condition. These results of Phase III support the idea that bizarre speech, often linked to biological variables (schizophrenia) and often viewed as communication difficulties (Lancaster, et al., 2004) can be reduced by MO manipulations.

Results of Phase IV, demonstrated the effect of the MO on the S^D and S^A in the context of extinction. Specifically, results indicated that, during extinction responding was higher in both the S^D and S^A conditions, when the EO was present than when the AO was present. While it was not possible to determine how long these results would last results indicated that in the context of extinction the MO had a momentary effect on the S^D and the S^A. Furthermore, results indicated that when deprivation was in effect in the EO condition that responding occurred under S^A even when the participants clearly
discriminated the $S^A$ condition in phase II, and extinction was in effect both under $S^A$ and $S^D$ conditions. These results add to a broader understanding of the three-term contingency, and $R=f(S, A)$ (Skinner, 1938) in the context of the interaction between operant behavior influenced by motivating operations. Results indicated that in the context of an EO (deprivation), that the organism operates on the environment even when reinforcement is clearly signaled as unavailable.

These results seem to suggest important implications for (a) using operant extinction in applied settings, (b) examining the effect of the MO and, (c) examining the effect of the MO on the $S^D$ and the $S^A$. Phase IV results may indicate ways in which an assessment methodology can identify the effect of the MO on the $S^D$. By identifying and controlling functional relations between the MO and the $S^D$, it may be possible to build experimental models of analyzing the three-term-contingency, in the context of not only the value-altering effects, but also the behavior-altering effects of the MO. For example, it may be prudent for future research to examine how MOs, such as health issues (including physical and mental health) may have on their associated $S^D$s.

One of the major contributions of the development of antecedent based treatments has been to provide alternatives to the use of aversive consequences, and a reliance on extinction for the treatment of challenging behavior (Smith & Iwata, 1997). Smith & Iwata (1997) conclude, that it may be possible to avoid using aversive consequences that produce negative side effects in extinction based treatments, if the MOs that establish challenging behavior as reinforcing could be controlled, or if the conditions under which challenging behavior is likely to be reinforced could be limited.
Results of Phase IV indicated that during extinction responding was lower in both the $S^D$ and $S^A$ conditions when the AO was present than when the EO was present. These results have important implications for interventions that may need to use extinction either to rapidly reduce challenging behavior or to implement differential reinforcement. It may be that it is not necessary to remove the $S^D$s that signal reinforcement from the environment when the relevant AO (satiation) is in effect. This finding may have important relevance for educational and applied settings where it is not always possible to remove the $S^D$s from the environment. For example, consider that challenging behavior for a child is maintained by access to tangibles in the form of savory snacks. It may not be always possible to remove savory snacks from the child’s environment (e.g., the parent may need to go the grocery store with the child, child may see a television commercial advertising savory snacks etc.). However, results of Phase IV indicate that when the relevant MOs are manipulated, (i.e. when the child has being satiated to snacks) then, during the period of time immediately following satiation, that even under extinction there may be reductions of challenging behavior. It would be important for future research to evaluate how long the effects of an AO i.e. levels of satiation would last for a particular individual. A systematic evaluation of the duration needed to reach satiation with pre-session access to controlled levels of reinforcement would greatly benefit the manipulation of AO levels in applied settings.

Conversely, responding in $S^A$ conditions, when the EO was present remained at high levels during extinction when compared to when the AO was present. This has significant implications for applied interventions. For example, treatment failure, in the context of extinction, may be a direct result of MO levels as opposed to stimulus control.
An Examination

It is likely that as we develop and refine technologies to better understand operant behavior that we are able to better design interventions to help improve the quality of life of individuals with developmental disabilities.

There are a number of limitations with this research that should be addressed in future work. The sample size in this study is quite small therefore this methodology needs to be replicated either directly or systematically with other participants. In addition, an attempt to isolate the effects of the MO on the reinforcing power of the consequences was not undertaken in this study. Such an examination would have broadened the scope of this study. However, this would have required a different methodology where the MO and the S^D are held constant while various parameters of reinforcing consequences are manipulated.

Additionally, the relationship between the MO and the S^D was examined only for social-positive reinforced behavior. However, MOs are also important when considering social-negative reinforced challenging behavior (e.g., Smith, Iwata, Hang-Leong, & Shore, 1995). Clearly, there is a need to examine how such antecedent variables influence negatively reinforced challenging behavior. Further research is needed to develop a methodology to clarify such antecedent functional relationships for negatively reinforced behavior. However, as it stands, the results of this study may help researchers understand how the MO enters into a functional relationship with the S^D for behavior maintained by positive reinforcement.
REFERENCES


Author Notes

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Figure Caption

Figure 1. Phase II: Cumulative frequency of intervals with challenging behavior.

Figure 2. Phase II: Cumulative frequency of intervals with bizarre speech.

Figure 3. Phase III: Cumulative frequency of intervals with challenging behavior.

Figure 4. Phase III: Cumulative frequency of intervals with bizarre speech.

Figure 5. Phase IV: Cumulative frequency of intervals with challenging behavior.

Figure 6. Phase IV: Cumulative frequency of intervals with bizarre speech.
Percentage of Intervals with Challenging Behavior

Sessions

Alex

Attention
Demand
Tangible
Play
Percentage of Intervals with Bizarre Speech

- Alone
- Attention
- Tangible
- Demand
- Play

Sessions

Josh
Cumulative Frequency of Intervals with Challenging Behavior

Sessions

Alex

SD
SA
Cumulative Frequency of Intervals with Bizarre Speech

Sessions

1 2 3 4 5 6 7 8

Josh

SD

SA
Cumulative Frequency of Intervals with Challenging Behavior

Sessions

MO Absent (FR 1)
MO Present (FR 1)
Cumulative Frequency of Intervals with Challenging Behavior

Sessions

Josh

MO Absent (FR1)

MO Present (FR1)
Cumulative Frequency of Intervals with Challenging Behavior

Sessions

MO Present_SD (Extinction)
MO Present_SD (Extinction)
MO Absent_SD (Extinction)
MO Absent_SD (Extinction)

Alex
Cumulative Frequency of Intervals with Bizarre Speech

- MO Present_SD (Extinction)
- MO Present_SA (Extinction)
- MO Absent_SD (Extinction)
- MO Absent_SA (Extinction)

Sessions

Cumulative Frequency of Intervals with Bizarre Speech

Josh