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Assessing the Effects of Matched and Unmatched Stimuli on the Persistence of Stereotypy

A Thesis Presented

by

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The Department of Counseling and Applied Educational Psychology

In partial fulfillment of the requirements

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Abstract

Ahearn and colleagues (2003) demonstrated an effect predicted via the behavioral momentum metaphor with individuals who engaged in automatically-maintained stereotypic behavior. Rapp (2007) assessed the establishing and abolishing effects of matched and unmatched stimulation on the rates of stereotypic behavior with two participants. In the current study, the persistence of stereotypic behavior was analyzed in terms of behavioral momentum theory (Ahearn et al., 2003) and motivating operations (Rapp, 2007) as it pertains to the response deprivation hypothesis. Participants were four boys with an autism-spectrum diagnosis, who attended the same school and were referred for their excess of stereotypic behavior. During a competing items assessment, stimuli were selected on the basis of whether or not the stimulation produced by engaging with them matched (or did not match) the topography of the stereotypic behavior exhibited by the participants and whether the items competed with stereotypy. Two stimuli were selected for inclusion in the multiple schedule arrangement (one matched and one unmatched). Results varied within and between participants in the demonstration of behavioral persistence and in an analysis of motivating operations. With respect to behavioral momentum metaphor there was no difference between the persistence produced by matched and unmatched stimuli. The obtained motivative effects were not consistent with the response deprivation hypothesis.

Keywords: behavioral momentum, automatic reinforcement, resistance to change, motivating operations, response deprivation hypothesis, stereotypy, autism Assessing the Effects of Matched and Unmatched Stimuli on the Persistence of Stereotypy

The term response strength is traditionally thought of as the rate of responding produced by the schedule of reinforcement. Nevin (1974) examined response strength in a different way and suggested that the resistance of operant behavior to changes in contingencies may be a more appropriate measure of response strength. Using a multiple schedule arrangement with different VI schedules of food reinforcement, Nevin assessed the way in which responding changes when some parameter of the experiment is varied (e.g., extinction, response independent food deliveries). Results indicated that response strength was always greater, or responding persisted for longer in the presence of the disruptor, in components associated with higher rates of reinforcement. Furthermore, this finding was consistent when comparing differences in frequency of reinforcement per unit time, magnitude of reinforcement, delay of reinforcement, and contingencies on response rates at the time of reinforcement.

These findings led to the notion of behavioral momentum. Rate of responding and resistance to change, together, define behavioral momentum (Nevin, 1992; Nevin & Grace, 2000). In classical physics, momentum is the velocity of an object multiplied by its mass. Extended to behavior, rate of responding is analogous to velocity and overall obtained rate of reinforcement is analogous to mass.

Many studies in basic behavioral research have assessed resistance to change using multiple schedule arrangements (Nevin and Atak, 1983; Nevin and Grace, 2000; Shettleworth and Nevin, 1965). Resistance to change was found to be greater in schedules correlated with the higher amount of obtained reinforcement when compared to schedules correlated with lower amounts of obtained reinforcement. Some applied research has been conducted in the area of

behavioral momentum. Mace and colleagues (1990) assessed the momentum theory with two participants. They used a multiple schedule arrangement of different VI values of food reinforcement for silverware sorting. They presented an interesting video as a disruptor. Behavioral persistence was greater in the schedule correlated with the greater amount of obtained reinforcement in the presence of the disruptor. Similar results were obtained in other applied research when different responses and disruptor stimuli were used. Dube, , Mcilvane, Mazzitelli, & McNamara, (2003) used a multiple schedule arrangement and measured the behavior of clicking on images on a screen with 10 participants with developmental disabilities. They provided a disruptor stimulus in the form of an alternative source of reinforcement. They found that for all participants resistance to disruption was greater in the component with the higher reinforcer rate. Schedules of reinforcement correlated with higher rates of reinforcement generate responses that are more likely to persist in the face of a disruptor. These studies add to the literature on behavioral momentum in that they show that results of the basic literature can be replicated with human participants in applied settings.

Since the results of applied studies align with basic studies in the area of behavioral momentum, many clinical considerations arise. Added reinforcement in the context in which problem behavior has occurred, for instance with treatments consisting of non-contingent reinforcement (NCR), may decrease rates of problem behavior, but also increase its persistence (Ahearn, Clark, Gardenier, Chung, &Dube, 2003). Ahearn and colleagues sought to extend the research on behavioral momentum theory to this applied problem. NCR is widely used to decrease undesirable behavior apparently maintained by automatic reinforcement. Automatically reinforced behavior is maintained by operant mechanisms independent of the social environment (Vaughan & Michael, 1982). The external reinforcers added into a situation where problem

behavior occurs (in this case stereotypy) may compete with the problem behavior and decrease response rates. Furthermore, the added external reinforcers may supplement the automatic reinforcers and increase the persistence of the problem behavior.

In order to analyze this possibility Ahearn and colleagues (2003) developed a multiple schedule arrangement which measured the resistance to change of stereotypic behavior following enriched environments. Baseline, served as a control condition, in which the therapist did not interact with the participant. During the enriched reinforcement component, the participant was given three, 30-s access periods to a preferred toy (picture book). The access periods were determined via a VT schedule. Following the VT component, there was a test component. During the test component the participant had continuous access to a different preferred stimulus (cartoon videotape). Additionally a second four sequence component was conducted where two baseline sessions preceded the test condition. Added reinforcement reduced levels of responding but also increased resistance to change.

The effects of providing additional stimuli can also be analyzed in terms of motivating operations, although it was not explicitly analyzed by the authors (Ahearn et al., 2003). In this study, the participant was free to engage in stereotypic behavior during the first and fourth components. During the second and third component of the behavioral momentum multiple schedule sequences additional access to a preferred stimulus was added on a VT schedule and then continuous access was provided. During the second component of the control multiple schedule sequences the participant was free to engage in stereotypic behavior. During the third component of the control multiple schedule sequences the participant was free to engage in stereotypic behavior. During the third component of the control multiple schedule sequences continuous access to an additional stimulus was given. When analyzing the motivating operations present there was a clear establishing effect observed following the removal of the preferred stimuli (baseline 1)

comparison to baseline 4) for 2 of the 3 participants. For the third participant there was no clear establishing or abolishing effect in place across components of the multiple schedule. One difference that may have accounted for this finding was that response competition was observed when items were present for the two participants' whose data showed an establishing effect, and very little response competition for the third participant. It may be necessary that the participant is engaging with the added stimulation in order for establishing or abolishing effects to be detected. It also may be that response competition plays an important role in the establishing or abolishing effects observed when adding and removing preferred stimuli. Additionally, the type of stimulation provided (matched vs. unmatched) was not analyzed in terms of motivating operations that occurred.

One common treatment for reducing levels of automatically maintained behavior is to provide access to alternative activities that compete with the problem behavior (Vollmer, 1994). That is, when presented with alternative activities, the participant is likely to engage with the activity than to emit problem behavior. Such procedures may also alter the motivating operations of these behaviors by providing alternative stimulation that matches the aberrant behavior (Rapp, 2006; 2007). The presumed effect of providing such stimulation would be that the aberrant behavior would be reduced following the removal of such stimulation because the similar consequence of the matched item would cause satiation for the consequences of the aberrant behavior. This would be an abolishing operation (Laraway, Snycerski, Michael, & Poling, 2003)

The response deprivation hypothesis states that restricting behavior (and the consumption of the reinforcer) below its free operant level of occurrence will produce a subsequent increase in behavior above its free-operant level when it is available (Rapp, 2007). Extended to

automatically reinforced behavior, the response deprivation hypothesis predicts that if behavioral reduction produced via NCR is a function of reinforcer substitution then the target behavior should not increase relative to pre-intervention levels of occurrence following the removal of NCR. Conversely, if behavioral reductions are a function of reinforcer competition, it is possible that NCR may impose deprivation for stimulation generated by the target behavior.

In 2007, Rapp investigated whether stimuli given non-contingently would decrease rates of stereotypy. His data suggest that following non-contingent access to a highly preferred stimulus, rates of stereotypy should not increase following the removal of a "matched" stimulus because the stimuli matched the sensory consequence of stereotypy. However, if, following non-contingent access to an unmatched highly preferred stimulus, rates of stereotypy may increase following the removal of the stimulus because the stimulation was functionally dissimilar. This would be an establishing operation (Laraway et al., 2003). Two participants whose stereotypy was automatically maintained participated in this study. Participants were first given a free-operant stimulus preference assessment to identify preferred objects that would either "match" or not "match" the hypothesized automatic function. Using a multiple schedule consisting of matched and unmatched stimuli presented non-contingently demonstrated that "matched" stimuli effectively reduces stereotypy through an abolishing operation yet unmatched stimulation produced varied results. These results are consistent with the response deprivation hypothesis.

The purpose of the current study was to systematically replicate the procedures of Ahearn et al. (2003) and extend them by looking at the effects of providing matched and unmatched stimulation in the context of the behavioral momentum metaphor. Additionally, we sought to extend the findings of Rapp (2007) by assessing the effects of matched and unmatched stimulation in terms of motivating operations.

Method

Participants

Four male students participated in this study. Clinical and educational providers referred participants for having levels of stereotypy that interfered with educational activities, and occurred at unacceptable rates. A professional not affiliated with their school had diagnosed the students with an autism spectrum disorder. AK, CC, and JK were all 8-year-old boys who attended a day school facility for children with autism and developmental disabilities. They engaged in motor stereotypy and communicated using signs and pictures to request items and interactions. HS was a 16-year-old adolescent who attended the same day school facility. He engaged in forms of motor stereotypy. HS communicated using words and phrases.

All sessions were conducted in a room (1.5m by 3m) equipped with a wide angle video camera, microphone, video recording equipment, materials needed to conduct the session, and a desk and two chairs.

Response Measurement and Interobserver Agreement

For HS, motor stereotypy was defined as any forward and backward rocking motion, occurring 2 or more times, of the limbs and/or torso that does not serve a functional purpose, and contortion of the hands or fingers in a way does not serve to manipulate objects in the way they were intended or to engage in activities. Examples included, HS moving his torso in a back and forth motion two or more times while holding his fingers apart in a contorted manner. Nonexamples included, HS manipulating objects in the way they were intended, or moving his torso to pick up an object from the floor.

For AK, motor stereotypy was defined as right to left head movements that occurred two or more times, and repeated manipulation of the hand including clapping and repetitive touching of objects or body parts. Examples included, AK shaking his head, while sitting alone, three times in a row, and AK tapping his finger two or more times on the desk. Non-examples included, AK manipulating objects in the way they were intended, or AK tapping his finger one time on the desk.

For CC, motor stereotypy was defined as repetitive tapping or touching of objects one or more times and moving the head and torso in a right and left motion one or more times. An example would include, CC touching the chair one or more times, or moving his torso back and forth in a non-contextual manner. Non-examples would include, CC tapping a drum or moving his body back and forth in the context of dancing to music.

For JK, motor stereotypy was defined as repetitive tapping of objects or body parts one or more times and contorting or flapping the hands in a nonfunctional manor that did not serve to manipulate objects. Examples included, JK tapping the chair one or more times or holding his hands and fingers in front of his face in a contorted manner. Non-examples include, JK tapping his teacher and signing eat.

During the functional analysis and behavioral momentum sequences, motor stereotypy was assessed using a continuous duration time sampling method. The total number of seconds of stereotypy in each session was divided by the total number of seconds in the session (300 s) and multiplied by 100 to calculate the percentage of the session in which stereotypy occurred. During the competing items assessment, engagement and motor stereotypy were assessed using a 10-s momentary time sampling method. The number of intervals with both engagement and motor stereotypy were calculated and divided by the total number of intervals then, multiplied by 100.

Occurrence agreement scores were calculated for a minimum of 33% of all sessions across participants, and the mean agreement was 98% (range, 86.6% to 100%).

For participant HS, agreement was calculated for a total of 33% of sessions during the competing items assessment. Mean agreement score for engagement during the competing items assessment was 99.5% (range, 96.7%-100%). Mean agreement score for occurrence of stereotypy during the competing items assessment was 93% (range, 87%-100%). During the functional analysis of stereotypy occurrence agreement was calculated for 33% of sessions and the mean agreement score was 98% (range, 97%-100%). During the behavioral momentum sequences occurrence agreement was calculated for 33% of sessions, and the mean agreement was calculated for 33% of sessions, and the mean agreement score was 96% (range, 88%-100%).

For participant AK, agreement was calculated for a total of 33% of sessions during the competing items assessment. Mean agreement score for engagement during the competing items assessment was 98% (range, 88%-100%). Mean agreement score for occurrence of stereotypy during the competing items assessment was 96% (range, 75%-100%). During the functional analysis of stereotypy occurrence agreement was calculated for 33% of sessions and the mean agreement score was 97% (range, 95%-100%). During the behavioral momentum sequences occurrence agreement was calculated for 33% of sessions, and the mean agreement score was 93% (range, 83%-99%).

For participant CC, agreement was calculated for a total of 33% of sessions during the competing items assessment. Mean agreement score for engagement during the competing items assessment was 96% (range, 70%-100%). Mean agreement score for the occurrence of stereotypy during the competing items assessment was 100%. During the functional analysis of stereotypy occurrence agreement was calculated for 33% of sessions and the mean agreement score was 96% (range, 90%-100%). During the behavioral momentum sequences occurrence

agreement was calculated for 33% of sessions, and the mean agreement score was 98% (range, 975-100%).

For participant JK, agreement was calculated for a total of 33% of sessions during the competing items assessment. Mean agreement score for engagement during the competing items assessment was 93%% (range, 63%-100%). Mean agreement score for occurrence of stereotypy during the competing items assessment was 90% (range, 50%-100%). During the functional analysis of stereotypy occurrence agreement was calculated for 33% of sessions and the mean agreement score was 93%(range, 87%-100%). During the behavioral momentum sequences occurrence agreement was calculated for 33% of sessions, and the mean agreement score was 96% (range, 82%-100%).

Procedures

Functional Analysis of Stereotypy. A functional analysis was conducted to ensure that stereotypic behavior exhibited by participants was not socially mediated. Procedures were similar to those of Roscoe, Carreau, MacDonald, & Pence (2008). Alone, attention and demand conditions were alternated in an AABAAC multi-element design until differentiation between conditions occurred. All sessions were 5 min in duration. During the alone condition, the participant was alone in the room and there were no programmed consequences for stereotypy. During the attention condition, the therapist was in the room and delivered brief attention, in the form of reprimands, contingent on the occurrence of stereotypy. During the demand condition, continuous demands were presented to the participant and a brief 30-s.break from demands was delivered contingent on the occurrence of stereotypy.

Competing Items Assessment. Following the functional analysis, an activity assessment was conducted to identify items associated with low levels of stereotypic behavior and high

levels of engagement (Piazza et al., 1998). Stimuli were assessed on whether or not they matched the sensory consequences produced by the stereotypic behavior of each participant. Matched items were theorized to produce similar sensory consequences as the stereotypic behavior. Unmatched items produced stimulation that was dissimilar to the stereotypic behavior (Rapp, 2007). The participants had continuous access to the item for 5-min. Engagement with the item and stereotypic behavior were recorded using a momentary time sampling of 10 s. Each stimulus was presented three times, and an average across the three sessions was used to display rates of engagement and stereotypic behavior associated with each stimulus.

For each participant, two items were selected for use in the study. One item was hypothesized to be a matched stimulus and one item was hypothesized to be an un-matched stimulus. These items were correlated with high levels of engagement and low levels of stereotypic behavior.

Behavioral Momentum Sequence. Using a multiple schedule arrangement, levels of stereotypic behavior were compared during three conditions. All conditions included four components (similar to Ahearn et al., 2003). The conditions consisted of an arrangement of the following components: baseline, VT-Exposure (matched or un-matched), a test condition, and baseline. The design used was an ABACABAC. Sequence A served as the control and consisted of baseline, baseline, test (unmatched), and baseline. Sequence B served as the VT-matched sequence and consisted of baseline, VT-Exposure (matched), test (unmatched), and baseline. Sequence C served as the VT-unmatched sequence and consisted of baseline, VT-Exposure (unmatched), test (unmatched), and baseline.

Baseline conditions were 5-min. The therapist was present in the room but did not interact with the participant. The participant was not given access to any stimuli and there were no programmed consequences for stereotypic behavior.

VT-Exposure (Matched) sessions were 6.5-min. The therapist was present in the room and did not interact with the participant other than to deliver a matched stimulus 3 times throughout the session on a quasi-random variable time (VT) schedule. The VT-exposure (unmatched) component was similar to the VT-matched component with the exception of the presentation of an unmatched stimulus. Any stereotypic behavior that occurred during the access periods during VT-Exposure sessions (both matched and un-matched) were not included in the assessment in order to equally compare rates of stereotypy that occurred across components. The access periods were subtracted from the total session time so that each session consisted of 5 min in which high-preference items were absent.

Test sessions were 5-min in duration. The therapist was present in the room but did not interact with the participant. The participant was given continuous access to a highly competing moderately preferred item (the un-matched stimulus) during this component. The final baseline session was identical to the initial baseline session.

Results

Functional Analysis

The results of the functional analysis for HS (Figure 1) indicated higher levels of responding in the alone condition. Mean response rate during the alone condition, attention condition, and demand condition were 40%, 4%, and 9% respectively. Higher levels of stereotypic behavior in the alone condition indicate that HS's stereotypic behavior was automatically maintained.

The results of the functional analysis for AK (Figure 1) indicated generally higher levels of responding in the alone condition. Mean response rate during the alone condition, attention condition, and demand condition were 55%, 34%, and 28% respectively. Higher levels of stereotypic behavior in the alone condition indicate that AK's stereotypic behavior was automatically maintained.

The results of the functional analysis for CC (Figure 2) indicated generally higher levels of responding in the alone condition. Mean response rate during the alone condition, attention condition, and demand condition were 39%, 14%, and 9% respectively. Higher levels of stereotypic behavior in the alone condition indicate that CC's stereotypic behavior was automatically maintained.

The results of the functional analysis for JK (Figure 2) indicated higher levels of responding in the alone condition. Mean response rate during the alone condition, attention condition, and demand condition were 14%, 5%, and 4% respectively. Higher levels of stereotypic behavior in the alone condition indicate that JK's stereotypic behavior was automatically maintained.

Competing Items Assessment

Throughout the competing items assessment participant HS was given access to 15 stimuli, 3 times per stimulus, for a duration of 5 min. Stereotypic behavior and item engagement that occurred during these access periods was averaged across the 3 five-min exposure periods (Figure 3). Of the 15 stimuli, 2 stimuli were selected for inclusion in the following behavioral momentum sequence. For HK, the koosh ball was selected as the stimulus that matched the topography of his stereotypic behavior and possibly the sensory consequences maintaining the behavior. The library book was selected as a stimulus that did not match the topography of his

stereotypic behavior. HS engaged with the koosh ball an average of 100% and the library book an average of 98%. Levels of stereotypy that occurred during access to the koosh ball averaged 13%, and 8% with the library book.

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Throughout the competing items assessment, participant AK was given access to 13 stimuli, 3 times per stimulus, for a duration of 5 min. Stereotypic behavior and item engagement that occurred during these access periods was averaged across the 3 five-min exposure periods (Figure 4). Of the 13 stimuli, two stimuli were selected for inclusion in the following behavioral momentum sequence. For AK, the koosh ball was selected as the stimulus that matched the topography of his stereotypic behavior and possibly the sensory consequences maintaining the behavior. Oreo cookie was selected as a stimulus that did not match the topography of his stereotypic behavior. AK engaged with the koosh ball an average of 100% and the oreo cookie an average of 100%. Levels of stereotypy that occurred during access to the koosh ball averaged 7%, and 11% with the oreo cookie.

Throughout the competing items assessment, participant CC was given access to 8 stimuli, 3 times per stimulus, for a duration of 5 min. Stereotypic behavior and item engagement that occurred during these access periods was averaged across the 3 five min exposure periods (Figure 5). Of the 8 stimuli, two stimuli were selected for inclusion in the following behavioral momentum sequence. For CC, the pin toy was selected as the stimulus that matched the topography of his stereotypic behavior and possibly the sensory consequences maintaining the behavior. Musical globe was selected as a stimulus that did not match the topography of his stereotypic behavior. CC engaged with the pin toy an average of 100% and the musical globe an average of 78%. Levels of stereotypy that occurred in during access to the pin toy averaged 6%, and 6% with the musical globe.

Throughout the competing items assessment participant JK was given access to 13 stimuli, 3 times per stimulus, for a duration of 5 min. Stereotypic behavior and item engagement that occurred during these access periods was averaged across the 3 five-min, exposure periods (Figure 6). Of the 13 stimuli, two stimuli were selected for inclusion in the following behavioral momentum sequence. For JK, the slinky was selected as the stimulus that matched the topography of his stereotypic behavior and possibly the sensory consequences maintaining the behavior. Nutter Butter and peanut butter cups was selected as a stimulus that did not match the topography of his stereotypic behavior. JK engaged with the slinky, nutter butter, and peanut butter cup an average of 100% of sessions. Levels of stereotypy that occurred during access periods to the slinky averaged 10% of sessions, 7% of sessions with the nutter butter, and 13% of sessions with the peanut butter cup.

Behavioral Momentum Sequence

Figures 7-9 shows the percentage of sessions with stereotypic behavior during all experimental conditions for each participant. Each phase shows the sequence of four sessions in either the behavioral momentum (matched and unmatched) or control sequences. The first and fourth bar in each phase shows the stereotypic behavior that occurred in the first and fourth baseline sessions. The second bar shows the level of stereotypic behavior in the second session. In the behavioral momentum sequence this would be the level of stereotypic behavior that occurred during VT exposure sessions with matched or unmatched items, respectively. During control sequences the second bar represents the level of stereotypic behavior during a second baseline condition. The third bar shows the level of stereotypic behavior that occurred during the test condition when the unmatched item was continuously available.

Figure 7 depicts the total percentage of sessions during all experimental conditions with stereotypic behavior for participant HS. Test sessions (black bars) had the lowest levels of stereotypic behavior. During VT exposure conditions (white bars), levels of stereotypic behavior were lower than during baseline conditions (gray bars) in 3 of the 4 comparisons. When comparing test conditions of the control sequences to test conditions of the behavioral momentum sequences, levels of stereotypic behavior were higher in 3 of the 4 comparisons during behavioral momentum test conditions. In terms of the behavioral momentum metaphor, for 3 of the 4 comparisons, behavioral persistence was greater in sequences with higher rates of obtained reinforcement (behavioral momentum sequences) when compared to the preceding control sequences.

Figure 7 depicts the total percentage of sessions, during all experimental conditions, with stereotypic behavior for participant AK. Test sessions (black bars) had the lowest levels of stereotypic behavior. During VT exposure conditions (white bars) levels of stereotypic behavior were lower than during baseline conditions (gray bars) across all comparisons. When comparing test conditions of the control sequences to test conditions of the behavioral momentum sequences levels of stereotypic behavior was higher in 1 of the 4 comparisons during behavioral momentum test conditions. In terms of the behavioral momentum metaphor, for 1 of the 4 comparisons behavioral persistence was greater in sequences with higher rates of obtained reinforcement (behavioral momentum sequences) when compared to the preceding control sequences.

Figure 8 depicts the total percentage of sessions, during all experimental conditions, with stereotypic behavior for participant CC. There was a lot of variability in levels of stereotypic behavior during test sessions (black bars). There were differing levels of response competition when the item used during test sessions (unmatched item) was continuously available. During

VT exposure conditions (white bars) levels of stereotypic behavior were lower than during baseline conditions (gray bars) in 2 of the 6 comparisons. There was variability in response competition during VT exposure conditions whether the items present were matched or unmatched. For participant CC, when comparing test conditions of the control sequences to test conditions of the behavioral momentum sequences, levels of stereotypic behavior was higher in 4 of the 6 comparisons during behavioral momentum test conditions. In terms of the behavioral momentum metaphor, for 4 of the 6 comparisons behavioral persistence was greater in sequences with higher rates of obtained reinforcement (behavioral momentum sequences) when compared to the preceding control sequences.

Figure 8 depicts the total percentage of sessions for the first behavioral momentum sequence analysis, during all experimental conditions, with stereotypic behavior for participant JK. There was a lot of variability in levels of stereotypic behavior during test sessions (black bars). There were differing levels of response competition when the item used during test sessions (unmatched item) was continuously available. During VT exposure conditions (white bars) levels of stereotypic behavior were lower than during baseline conditions (gray bars) in 1 of the 4 comparisons. There was very little response competition when both matched and unmatched items were available. For participant JK, when comparing test conditions of the control sequences to test conditions of the behavioral momentum sequences, levels of stereotypic behavior for 1 of the 4 comparisons behavioral persistence was greater in sequences with higher rates of obtained reinforcement (behavioral momentum sequences) when compared to the preceding control sequences.

Figure 9 depicts the total percentage of sessions, during all experimental conditions, with stereotypic behavior for participant JK's second behavioral momentum multiple schedule analysis. During this second analysis a choice of unmatched items (peanut butter cup or nutter butter) was given prior to VT exposure and Test components in order to possibly increase item engagement and response competition. The participant was also prompted to sit in the chair across all components because he often engaged in stereotypic behavior not included in the response definition when out of his seat. Overall there was variability in levels of stereotypic behavior across components. Generally, during test components (black bars), levels of stereotypic behavior were lower than preceding baseline and VT exposure sessions. During VT exposure conditions (white bars) levels of stereotypic behavior were lower than during baseline conditions (gray bars) in 2 of the 4 comparisons. For participant JK, when comparing test conditions of the control sequences to test conditions of the behavioral momentum sequences, levels of stereotypic behavior was higher in 2 of the 4 comparisons during behavioral momentum test conditions. In terms of the behavioral momentum metaphor, for 2 of the 4 comparisons behavioral persistence was greater in sequences with higher rates of obtained reinforcement (behavioral momentum sequences) when compared to the preceding control sequences.

To evaluate relative changes in behavior, levels of stereotypic behavior in the VT exposure and test sessions were expressed as a proportion of mean levels of stereotypy during baseline sessions within the same conditions. Proportional measures were calculated by dividing the percentage of sessions with stereotypy in the second (Figures 10-12) or third (Figures 13-16) session by the mean percentage for the first and fourth sessions. Tables 2.1-2.4 depict all proportional measures obtained for each participant.

The data shown in Figures 10-12 were obtained during the VT exposure sessions of the behavioral momentum sequence (gray bars) and during the baseline sessions of the control sequence with no item access (black bars). For participant HS (Figure 10) stereotypic behavior was reduced in varying amounts during VT exposure sessions in 3 of the 4 comparisons. For participant AK (Figure 10) stereotypic behavior was reduced during VT exposure sessions across all comparisons. However, levels of reduction range from approximately .1 to .6. For participant CC (Figure 11) there was little or no reduction in levels of stereotypic behavior. For participant JK (Figure 12) there was also little or no reduction in stereotypic behavior in both behavioral momentum multiple schedule analyses.

The data shown in Figures 13-16 were obtained during the test sessions of the behavioral momentum sequences (gray bars) and control sequences (black bars) as a proportion of levels of stereotypic behavior during baseline sessions. For participant HS (Figure 13), behavioral persistence was demonstrated in 3 of the 4 comparisons. Behavioral persistence was demonstrated during both unmatched comparisons and in the second matched comparison. For participant AK (Figure 13), behavioral persistence was demonstrated slightly in 1 of the 4 comparisons (unmatched). For participant CC (Figure 14), behavioral persistence was demonstrated in 3 of 6 comparisons (matched 1 and 3; unmatched 3). For participant JK, during the first behavioral momentum multiple schedule analysis (Figure 15), behavioral persistence was not demonstrated in any of the comparisons. During the second behavioral momentum multiple schedule analysis (Figure 16), behavioral persistence was demonstrated in 2 of the 4 comparisons (matched 2 and unmatched 2).

Table 3.1-3.5 depicts the outcomes of the motivating operations analysis for all participants. Comparisons were made between levels of stereotypic behavior during baseline 1

and baseline 2 of the control conditions, baseline 1 and baseline 4 of the control conditions, baseline 1 and baseline 4 of matched conditions, and baseline 1 and baseline 4 of the unmatched conditions. According to the response deprivation hypothesis, non-restricted access to stereotypic behavior would have an abolishing effect from baseline 1 to baseline 2 of the control conditions. Following the removal of an unmatched stimulus (test to baseline 4), response deprivation hypothesis would predict that there would not be an abolishing operation because the stimulation provided did not match the sensory consequences of the stereotypic behavior. Therefore, during control, matched and unmatched comparisons of baseline 1 to baseline 4 there would not be an abolishing operation predicted, but an establishing operation may be present.

For participant HS (Figure 7; Table 3.1), levels of stereotypic behavior from baseline 1 to baseline 2 of the control condition decreased in 2 of the 4 comparisons as predicted by the response deprivation hypothesis (abolishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the control condition increased in 1 of the 4 comparisons as predicted by the response deprivation hypothesis (establishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the matched and unmatched condition increased in 1 of the 4 and 0 of the 4 comparisons respectively, as predicted by the response deprivation hypothesis (establishing operation). Out of 12 comparisons total, 4 confirmed the response deprivation hypothesis.

For participant AK (Figure 7; Table 3.2) levels of stereotypic behavior from baseline 1 to baseline 2 of the control condition decreased in 2 of the 4 comparisons as predicted by the response deprivation hypothesis (abolishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the control condition increased in 1 of the 4 comparisons as predicted by the response deprivation hypothesis (establishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the matched and unmatched condition increased in 0 of the 4 and 0 of the 4 comparisons respectively, as predicted by the response deprivation hypothesis (establishing operation). Out of 12 comparisons total, 3 confirmed the response deprivation hypothesis.

For participant CC (Figure 8; Table 3.3) levels of stereotypic behavior from baseline 1 to baseline 2 of the control condition decreased in 1 of the 5 comparisons as predicted by the response deprivation hypothesis (abolishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the control condition increased in 3 of 6 comparisons as predicted by the response deprivation hypothesis (establishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the matched and unmatched condition increased in 1 of 3 and 2 of 3 comparisons respectively, as predicted by the response deprivation hypothesis (establishing operation). Out of 18 comparisons total, 7 confirmed the response deprivation hypothesis.

For participant JK's first behavioral momentum analysis (Figure 8; Table 3.4) levels of stereotypic behavior from baseline 1 to baseline 2 of the control condition decreased in 1 of the 4 comparisons as predicted by the response deprivation hypothesis (abolishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the control condition increased in 2 of 4 comparisons as predicted by the response deprivation hypothesis (establishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the matched and unmatched condition increased in 1 of 2 and 1 of 2 comparisons respectively, as predicted by the response deprivation hypothesis (establishing operation). Out of 18 comparisons total, 5 confirmed the response deprivation hypothesis.

For participant JK's second behavioral momentum analysis (Figure 9; Table 3.5) levels of stereotypic behavior from baseline 1 to baseline 2 of the control condition decreased in 2 of the 4

comparisons as predicted by the response deprivation hypothesis (abolishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the control condition increased in 2 of 4 conditions as predicted by the response deprivation hypothesis (establishing operation). Levels of stereotypic behavior from baseline 1 to baseline 4 of the matched and unmatched condition increased in 1 of 2 and 2 of 2 comparisons respectively, as predicted by the response deprivation hypothesis (establishing operation). Out of 12 comparisons total, 7 confirmed the response deprivation hypothesis.

Discussion

In the current study, results varied within and between participants in the demonstration of behavioral persistence and in an analysis of motivating operations. With respect to behavioral momentum metaphor there was no difference between the persistence produced by matched and unmatched stimuli. With respect to the response deprivation hypothesis, predictions made by the hypothesis could not be supported by the obtained data.

Stereotypy was more resistant to change during the test sessions of the behavioral momentum sequence than in the control sequence in some of the comparisons for all of the participants. For participant HS, there was more behavioral persistence in 3 of the 4 comparisons. This participant's data align with the behavioral momentum metaphor and is consistent with results found in Ahearn et al. (2003). Also for HS, the stimuli selected generally competed with stereotypy. For participant AK, response competition was greater with the unmatched stimulus than the matched stimulus, and only 1 of 4 comparisons had greater behavioral persistence in test conditions of the behavioral momentum sequences than control sequences. Both participant JK and CC had varying levels of stereotypy across all conditions of the behavioral momentum analysis. For participant CC, 4 of 6 comparisons align with the

behavioral momentum metaphor. Levels of response competition varied with both the matched and unmatched stimulus. For JK, in total, 3 of the 8 comparisons align with the behavioral momentum metaphor. For this participant there were inconsistent levels of response competition with the unmatched stimulus.

Inconsistent results may have been obtained due to lack of a stable baseline rate of stereotypic behavior. Participants CC and JK had varying levels of stereotypic behavior across baseline, VT exposure, and test conditions. Future research may include a control condition consisting of 4 baseline conditions in order to assess the natural fluctuations in rate of stereotypy.

Also, stereotypic behavior may include many topographies and it may be difficult to introduce matched stimulation that competes with all topographies of stereotypy. Participant JK often engaged in many forms of stereotypic behavior, some of which were observed later in the study and not included in the target response. Thus engaging in other forms of stereotypic behavior, not included in response definition, may have competed with stereotypic topographies that were included. This may have accounted for the inconsistent levels of stereotypic behavior presented in results.

It is also possible that behavioral persistence develops over time. For participant AK, it was the last comparison that demonstrated behavioral persistence. For participant JK, it wasn't until the last 2 comparisons that behavioral persistence was demonstrated.

In the current investigation, results were not consistent with the response deprivation hypothesis and the data reported in Rapp (2007), or in the analysis of motivating operations of the data reported in Ahearn et al. (2003).

Data reported in Rapp (2007) were consistent with the response deprivation hypothesis, in that, when unmatched stimulation was removed stereotypic behavior increased above previous baseline levels (establishing operation), and when matched stimulation was removed stereotypic behavior decreased below previous baseline levels (abolishing operation). In the current investigation, there were no consistent establishing or abolishing operations in effect following the removal of matched or unmatched stimulation across all participants.

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In a motivating operation analysis of data obtained in Ahearn et al. (2003), establishing operations were observed across all baseline 1 to baseline 4 comparisons for 2 of the 3 participants. This aligns with the response deprivation hypothesis in that unmatched stimulation was presented and following its removal rates of stereotypy increased in relation to previous baseline rates. In the current investigation, motivating effects differed between comparisons for all participants.

One factor that may have contributed to the inconsistencies in motivating effects is that response competition was not always consistent. In order to test the response deprivation hypothesis, response competition must occur. Future research may investigate the degree of competition necessary in order to detect motivating effects (changes in rates of stereotypic behavior) associated with matched and unmatched stimulation.

The behavior momentum metaphor may have great utility in applied contexts. In terms of skill acquisition, skills may be more persistent to change in the face of disruption if taught on a denser schedule of reinforcement. For example, if a skill is taught on a continuous schedule of reinforcement and is acquired, it is more likely that the skill will persist in the face of extinction or disruption than if a skill is only reinforced intermittently. In terms of problem behavior, an example of a treatment including DRA may arrange for a more dense reinforcement in the context in which problem behavior occurs. This implies that any such treatment may potentially decrease the rate of problem behavior while increasing its persistence. However, if distinctive

stimuli are added during these treatments, they may diminish the likelihood behavioral persistence.

In addition, clinicians should not count on problem behavior decreasing as a result of providing access to a hypothesized matched competing item. Our results suggested that there was no difference in either matched or unmatched conditions suggesting that a matched stimulus will not provide the same consequences as the problem behavior. Clinicians should be mindful that providing a competing item will be effective in reducing rates of stereotypy but should arrange to increase rates of reinforcement for appropriate behavior, such as play with that competing item.

As our results were varied, future research will attempt to strengthen our overall finding by including more participants into our study to assess the effects of behavioral persistence as well the prediction of an abolishing operation.

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Table 1.1

Stimuli selected from the competing items assessment for use in behavioral momentum sequences

Participant	Matched Stimulus	Un-Matched Stimulus
HS	Koosh Ball	Library Books
AK	Koosh Ball	Oreo Cookie
CC	Pin Toy	Musical Globe
JK	Slinky	Nutter Butter/ Peanut Butter Cup

Stereotypic Behavior Expressed as a Proportion of Baseline for HS

Sequence	Comp. 2/1	Comp. 3/1	Comp.2/Comps. 1 + 4	Comp.3/Comps. 1 + 4	
Sequence A	1.9	0.5	0.8	0.2	
Sequence B	0.6	0.0	0.3	0.0	
Sequence A	1.1	0.1	0.6	1.1	
Sequence C	0.6	0.3	0.3	1.2	
Sequence A	0.3	0.4	0.1	1.3	
Sequence B	1.2	0.7	0.4	0.3	
Sequence A	0.7	0.1	0.4	1.1	
Sequence C	0.5	0.2	0.3	1.1	

Stereotypic Behavior Expressed as a Proportion of Baseline for AK

Sequence	Comp. 2/1	Comp. 3/1	Comp.2/Comps. $1 + 4$	Comp.3/Comps. $1 + 4$	
					-
Sequence A	0.9	0.2	0.5	0.1	
Sequence B	0.5	0.1	0.3	0.1	
Sequence A	0.6	0.2	0.3	0.1	
Sequence C	0.4	0.0	0.2	0.0	
Sequence A	1.5	0.0	0.4	0.0	
Sequence B	0.6	0.0	0.3	0.0	
Sequence A	1.2	0.0	0.7	0.0	
Sequence C	0.2	0.1	0.1	0.0	

Stereotypic Behavior Expressed as a Proportion of Baseline for CC

Sequence	Comp. 2/1	Comp. 3/1	Comp.2/Comps. 1 + 4	Comp.3/Comps. 1 + 4	
Sequence A	0.6	0.1	0.4	0.1	
Sequence B	2.1	0.6	1.8	0.5	
Sequence A	1.5	0.4	1.0	0.3	
Sequence C	0.3	1.3	0.1	0.7	
Sequence A	1.22	0.5	0.4	0.2	
Sequence B	0.6	0.2	0.1	0.0	
Sequence A	1.7	0.3	0.5	0.1	
Sequence C	0.8	4.2	0.1	0.8	

Stereotypic Behavior Expressed as a Proportion of Baseline for JK

Sequence	Comp. 2/1	Comp. 3/1	Comp. 2 /Comps.	Comp.3/Comps.
			1 + 4	1 + 4
Sequence A	3.4	4.5	1.1	1.5
Sequence B	1.0	0.2	0.5	0.1
Sequence A	3.5	1.8	1.8	0.9
Sequence C	0.0	0.0	1.5	4.4
Sequence A	9.0	0.0	0.8	0.0
Sequence B	1.3	0.0	0.5	0.0
Sequence A	0.4	1.2	0.2	0.6
Sequence C	0.3	0.7	0.2	0.6
Second Behaviord	ıl Momentum Analy	sis		
Sequence A	0.1	3.5	3.9	0.8
Sequence B	0.5	0.4	0.2	0.2
Sequence A	0.7	0.1	0.6	0.1
Sequence C	0.2	0.5	0.0	0.1
Sequence A	1.6	1.3	0.3	0.3
Sequence B	1.8	0.2	1.2	0.1
Sequence A	0.2	1.1	0.1	0.7
Sequence C	2.1	4.3	0.8	1.6

Comparison	Prediction	Confirm Response Deprivation Hypothesis	Disconfirm Response Deprivation Hypothesis
Control Sequence: BL 1 to BL 2	Abolishing Operation	2	2
Control Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	3
Matched Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	1
Unmatched Sequence: BL 1 to BL4	No Abolishing Operation or An Establishing Operation	0	2
Summary:		4	8

Motivating Operations Hypothesis Predictions and Outcomes for participant HS

Comparison	Prediction	Confirm Response Deprivation Hypothesis	Disconfirm Response Deprivation Hypothesis
Control Sequence: BL 1 to BL 2	Abolishing Operation	2	2
Control Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	3
Matched Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	0	2
Unmatched Sequence: BL 1 to BL4	No Abolishing Operation or An Establishing Operation	0	2
Summary:		3	9

Motivating Operations Hypothesis Predictions and Outcomes for participant AK

Comparison	Prediction	Confirm Response Deprivation Hypothesis	Disconfirm Response Deprivation Hypothesis
Control Sequence: BL 1 to BL 2	Abolishing Operation	1	5
Control Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	3	3
Matched Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	2
Unmatched Sequence: BL 1 to BL4	No Abolishing Operation or An Establishing Operation	2	1
Summary:		7	11

Motivating Operations Hypothesis Predictions and Outcomes for participant CC

Comparison	Prediction	Confirm Response Deprivation Hypothesis	Disconfirm Response Deprivation Hypothesis
Control Sequence: BL 1 to BL 2	Abolishing Operation	1	3
Control Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	2	2
Matched Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	1
Unmatched Sequence: BL 1 to BL4	No Abolishing Operation or An Establishing Operation	1	1
Summary:		5	7

Motivating Operations Hypothesis Predictions and Outcomes for participant JK's Behavioral Momentum Analysis 1

Comparison	Prediction	Confirm Response Deprivation Hypothesis	Disconfirm Response Deprivation Hypothesis
Control Sequence: BL 1 to BL 2	Abolishing Operation	2	2
Control Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	2	2
Matched Sequence: BL 1 to BL 4	No Abolishing Operation or An Establishing Operation	1	1
Unmatched Sequence: BL 1 to BL4	No Abolishing Operation or An Establishing Operation	2	0
Summary:		7	5

Motivating Operations Hypothesis Predictions and Outcomes for participant JK's Behavioral Momentum Analysis 2



Figure 1. Total duration of stereotypy across functional analysis conditions for participants JK and AK.



Figure 2. Total duration of stereotypy across functional analysis conditions for participants CC and JK.



3. Percentage of stereotypy (gray bars) and item engagement (black bars) during the competing items assessment for participant HS. Stimuli are along the x axis and percentage of responding is along the y axis.



Figure 4. Percentage of stereotypy (gray bars) and item engagement (black bars) during the competing items assessment for participant AK. Stimuli are along the x axis and percentage of responding is along the y axis.



Figure 5. Percentage of stereotypy (gray bars) and item engagement (black bars) during the competing items assessment for participant CC. Stimuli are along the x axis and percentage of responding is along the y axis.



Figure 6. Percentage of stereotypy (gray bars) and item engagement (black bars) during the competing items assessment for participant JK. Stimuli are along the x axis and percentage of responding is along the y axis.



Figure 7. Percentage of sessions with stereotypy across all components of the behavioral momentum multiple schedule analysis for participants HS and AK.



Figure 8. Percentage of sessions with stereotypy across all components of the behavioral momentum multiple schedule analysis for participants CC and JK.



Figure 9. Percentage of sessions with stereotypy across all components of the second behavioral momentum multiple schedule analysis for participant JK.



Figure 10. The levels of stereotypic behavior during the second session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participants HS and AK.



Figure 11. The levels of stereotypic behavior during the second session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participant CC.



Figure 12. The levels of stereotypic behavior during the second session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participant JK.



Figure 13. The level of stereotypic behavior during the test session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participants HS and AK.



Figure 14. The level of stereotypic behavior during the test session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participant CC.



Figure 15. The level of stereotypic behavior during the test session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participant JK's first behavioral momentum analysis.



Figure 16. The level of stereotypic behavior during the test session of each condition as a proportion of the mean of the first and fourth baseline sessions across successive comparisons for participant JK's second behavioral momentum analysis.



Figure 17. Percentage of sessions with item engagement for all participants across all test and VT-exposure components.