Effects of Continuous Versus Intermittent Schedules of Reinforcement on Functional Analysis Outcomes

A Thesis Presented

by

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Abstract

Functional analyses are used to aid in the assessment and treatment of problem behavior; however, if the behavior occurs infrequently, the results may not be clear. One way to increase occurrence of behavior is to manipulate the schedule of reinforcement. This study assessed the effects of continuous and intermittent schedules of reinforcement on occurrence of problem behavior during functional analyses. Beginning the study was a series of extended alone conditions, followed by alternating attention, escape, and play conditions that utilized a continuous schedule, and then an intermittent schedule of reinforcement. Results were analyzed to determine if schedule manipulations were effective in increasing target behavior. For one participant, the intermittent phase reduced occurrence of the target behavior, while the continuous phase increased problem behavior during one condition. For the other participant, behavior remained stable and low across both functional analysis phases. Limitations and suggestions for future research are included.
When determining the appropriate intervention for challenging behavior, it is important to assess the behavior to identify its function. There are many varieties of assessments that can be used to determine the function of behavior. Indirect assessments offer information about the behavior without observation of its occurrence, which can make it difficult to identify establishing operations or consequences that are present when it happens. Direct observation of behavior requires the experimenter to observe the behavior, and also any antecedent or consequent events that may also occur at that time. With an experimental analysis, or functional analysis, the experimenter manipulates the environment so that certain motivating operations and consequences are present. If behavior occurs more under certain conditions (e.g. the presence of a specific establishing operation and/or consequence for behavior), the hypothesis is that there is a functional relation between those conditions and the behavior and that those conditions can be manipulated during treatment of the behavior to produce desired outcomes (Iwata, Dorsey, Slifer, Bauman, Richman, 1994).

One problem with functional analyses is that results are not always clear. Therapists may find that behavior occurs at rates so low that responding is essentially undifferentiated and function cannot be identified. One way that researchers have addressed this issue is to run sessions just after the behavior has occurred (Tarbox, Wallace, Tarbox, Landaburu, & Williams, 2004). Their results showed that this approach yielded clear outcomes for all three subjects; however, it’s not clear that this strategy would be practical for regular use: it requires that the therapist be available to run sessions immediately following occurrences of the behavior. Also, if the behavior occurs infrequently, it may take a long time to complete the assessment. Another
way that researchers have assessed low-rate behavior during functional analyses is by running longer sessions (Kahng, Abt, Schonbachler, 2001). By increasing session duration, the behavior is exposed to the relevant establishing operations for a longer amount of time, which may increase the probability of the behavior occurring. Longer session duration may also capture more occurrences of the behavior, as well, leading to increased opportunities for the behavior to contact the putative reinforcer. Although this method has been helpful for behaviors that occur at a low rate, it requires a large time commitment from both the therapist and participant.

A different approach to the issue of low-rate problem behavior during assessment is to modify the schedule of reinforcement. When studying the effects of continuous and intermittent schedules of reinforcement on extinction, Lerman, Iwata, Shore, and Khang (1996) showed that problem behavior occurred at higher rates when reinforcement followed an intermittent schedule (both fixed and variable), as opposed to a continuous one. Thus, it may be valuable for researchers to examine the effects of intermittent reinforcement on the results of functional analyses in which low rates of behavior are occurring.

There are a limited number of studies that have used intermittent schedules of reinforcement during functional analyses. In 1996, Lalli and Casey assessed the aggressive behavior of a young boy with a functional analysis that utilized a variable schedule of reinforcement. A descriptive assessment identified that the boy’s aggression was reinforced after about every two to five occurrences, thus, reinforcement during the functional analysis followed a variable schedule and was applied after about every two (VR2) or five (VR5) occurrences depending on condition. Using the results of the analysis, a functionally-related treatment was successful in decreasing the occurrence of aggression. Mace and Lalli (1991) also used an
intermittent schedule of reinforcement during their functional analysis of bizarre speech in an adult participant. Following their functional analysis in which bizarre speech was reinforced following a VR2 schedule, a functionally-related treatment decreased the occurrence of bizarre speech. These two studies provide some precedent for the use of intermittent schedules of reinforcement during functional analyses; however, these studies never directly compared continuous and intermittent schedules of reinforcement.

There is one study in the literature that utilized both continuous and intermittent schedules of reinforcement during a functional analysis. In their analysis of aggressive behavior for a participant named George, Paisley, Whitney, and Hislop (1991) modified the schedule of reinforcement used during his functional analysis from a fixed-ratio 1 (FR1) to a fixed-ratio 3 (FR3) because rates of behavior were so high that providing reinforcement following each occurrence of behavior was difficult. After completing the functional analysis, a function for George’s behavior was clearly identified. Although these authors used both types of reinforcement schedules during their functional analysis, results are displayed using bar graphs, which make it impossible to determine whether or not the change in schedules affected the rate of aggression.

The current study seeks to evaluate effects on the rate of behavior following changes in the schedule of reinforcement applied during functional analysis. An extended alone condition will first be used to rule out participants for whom behavior could be automatically maintained. Because a therapist isn’t able to control access to the reinforcers for behavior maintained by automatic reinforcement (e.g., sensory stimulation), participants with behavior maintained by automatic reinforcement will be excluded from this study. Running an extended alone phase will
help identify participants whose behaviors are sensitive to social reinforcement; subsequently, schedule manipulations will be during the attention and escape conditions during the functional analysis. Next, a functional analysis utilizing a continuous schedule of reinforcement will be conducted, followed by a functional analysis utilizing an intermittent schedule of reinforcement. Analysis of the rates of problem behavior across the two different schedules of reinforcement will determine whether intermittent schedules are helpful in increasing low rate behavior and differentiating outcomes during assessment.

Method

Participants, Setting, and Experimental Design

Our participants were residential students attending a private, year-round school specializing in Autism and related disorders, and were selected based on the mildness of their target behavior and availability to participate in the study. Because we were trying to increase behavior by manipulating schedules of reinforcement, participants whom had a history of severe problem behavior (e.g. aggression, self-injury) had specific safety-termination criteria created by their clinical team. If at any point during the study termination criteria were met, the current session was to be terminated and the participant’s involvement in this study would be reviewed with his clinical team. Individuals whom had recently engaged in severe problem behavior were excluded from participation. Sessions took place in a 1.5x3m analogue research room located inside the school, and were 10 minutes in duration unless student-specific safety termination criteria were met. Materials available during sessions included a table, chairs, and session-related items like magazines and picture cards. Sessions were conducted up to four times a day and between three to five days per week.
Jim was a 19-year-old male with a diagnosis of Autism. Jim was referred to the study by his clinical team for his spitting behavior which typically resulted in disposal of food- and drink-related products in the environment, and periodic attention from residential staff and peers. Jim was verbal, with good expressive and receptive language.

Paul was a 14-year-old male with a diagnosis of Autism. Paul was referred for this study by his clinical team based on the occurrence of sexualized behavior, hands-to-pants, that would occur throughout the day regardless of environment. An intervention to ignore this behavior was in place; however, it was noted that the response continued to occur at unacceptable levels.

A multiple baseline across participants with an embedded alternating treatments design following the first extended alone phase was used. Progression of the test conditions during the alternating treatments design was identical for both participants. Design of the variable-ratio schedule used during the intermittent reinforcement functional analyses followed a quasi-random order and was identical for each session of that phase.

Response Measurement and Interobserver Agreement

For Jim, spitting was defined as any instance of saliva passing the planes of Jim’s lips. Spitting was measured using frequency recording. For Paul, hands-to-pants was defined as any contact between Paul’s hands and his groin for more than one second. Hands-to-pants was measured using a partial interval time sample. Therapists recorded data on occurrence of the target behavior as well as other participant and therapist behaviors (i.e. compliance, instructions, cessation of demand) that occurred during sessions. Sessions were divided into 15-second intervals. Rate of spitting was determined by adding up all occurrences observed and dividing that sum by the total number of minutes in the session. Percent of intervals with hands to pants
was determined by taking the sum of intervals during which hands-to-pants was observed and dividing that sum by the total number of intervals in that session.

A second observer scored session videos for both the preference assessment and functional analysis sessions to collect interobserver agreement (IOA) and procedural integrity (PI). Data were collected in the same manner as the primary data collector and were assessed on an interval-by-interval basis. IOA and PI were calculated by determining the number of intervals during which both observers agreed and dividing that number by the total number of intervals and multiplying by 100. Agreement was collected for at least one third of each participant’s sessions and was 93.41% (range, 68% to 100%) for Jim, and 99.38% (range, 95% to 100%) for Paul. PI was also collected for at least one third of each participant’s sessions and was 91.67% (range, 72.5% to 100%) for Jim, and 86.25% (range, 60% to 100%) for Paul.

Preference Assessment

To identify preferred activities to include in the play condition, teacher interviews and two free operant preference assessments (Roane, Vollmer, Ringdahl, & Marcus, 1998) were conducted for each participant. Preference assessment sessions were five minutes in duration. Each session was divided into 10 second intervals, during which engagement with each of the items was recorded using a momentary time sample. Percent engagement was calculated by dividing the number of intervals during which engagement was observed, and dividing that number by the total number of intervals and multiplying by 100. Preference assessment results are summarized in Tables 1 and 2.

Functional Analysis
The functional analysis contained three phases. The first phase was a series of extended alone conditions. The second phase included the attention, demand, and play conditions, where consequences were delivered on a continuous schedule (CRF). The third phase included the same attention, demand, and play conditions; however, consequences were delivered on an intermittent schedule (INT).

*Extended Alone.* The first phase was a series of extended alone conditions. During this phase, the participant was brought into the analogue room and instructed by the therapist to take a seat in the chair and wait there for the therapist to return. The therapist then left the room and observed the participant through a one-way mirror. The room was empty, aside from a table and chair, and the participant was allowed to move freely about the room. There were no programmed consequences for problem behavior during these sessions. This phase was used to screen for behavior that could be automatically maintained. The next phase would begin if the participant showed low rates or a decreasing trend in target behavior.

*Continuous Reinforcement (CRF) FA.* The second phase of the study included the attention, demand, and control conditions of the functional analysis. During this phase, consequences for the target behavior were delivered following a continuous fixed-ratio 1 (FR1) schedule. During the attention phase, the participant sat at the table while the therapist assumed the appearance of reading over paperwork. The therapist provided brief physical and social attention following each occurrence of the target behavior (i.e. “Jim, don’t spit - that really is gross and I’ll have to clean it up!”). Additional occurrences of the target behavior prolonged therapist attention. Following the brief attention, period the therapist turned away and resumed reading. During the demand phase, the participant was asked to sit down at the table and
complete moderately difficult discrimination trials. The participant was praised for completing the task appropriately with or without prompting. The therapist cleared the table and briefly terminated all demands following each occurrence of the target behavior. Like the attention condition, additional occurrences of the target behavior during the demand condition prolonged escape. Following brief escape, the therapist resumed demands. The play condition served as a control condition created to mock an enriched environment in which the target behavior was unlikely to occur. During this condition, the student was asked to sit at the table with preferred leisure items available. The therapist sat in the room with the participant and allowed him/her to move freely about. The therapist periodically presented the participant with a leisure item, but with no demand. The therapist also provided praise and/or physical contact contingent upon appropriate behavior at least once every 30 seconds. Occurrence of the target response was ignored, and praise would be withheld for at least 5 seconds to assure the behavior was not reinforced. Phase 3 would begin following three cycles of the above conditions if behavior occurred at a low rate, or was not clearly differentiated.

*Intermittent Reinforcement (INT) FA.* The next phase of this study included the same three conditions as the previous phase; however, consequences for occurrence of the target behavior during the attention and demand phases followed an intermittent, VR2 schedule. Aside from the change in schedule, the attention, demand, and play conditions were identical to those run during phase two. The intermittent schedule of reinforcement used during the attention and demand conditions followed an identical schedule so that the target response contacted consequences at the same times across both conditions. The INT FA phase would be complete following three cycles of the attention, play, and demand phases.
Results

Results from the preference assessment are located in Tables 1 and 2. Across both assessments, Jim engaged with only three of the seven items. Jim engaged with Legos® for 28.4% of intervals, the puzzle for 10.0% of intervals, and DVDs for 38.4% of intervals. Those three items were used during the play condition, as well as magazines and trucks which were identified by his teachers to be preferred items in which he reliably requested to use throughout the day. Across both assessments, Paul engaged with only two of the seven items presented. Paul engaged in coloring an average of 36.5% of intervals, and engaged with a Kermit doll an average of 50.0% of intervals. Both of these items were included in Paul’s play condition.

Jim’s spitting showed a decreasing trend during the extended alone phase, which ended at a near zero rate during the last session (M=0.44). During the initial CRF phase, spitting remained stable with low rates during the play condition (M=0.07). During the attention condition, spitting occurred at levels that were elevated relative to the play condition but were generally low (M=0.40). During the demand conditions, spitting occurred at variable levels, with overall averages well above those seen in the play and attention conditions (M=1.50). During the INT phase, spitting again occurred at constant, low rates during the play condition (M=0.03). During the attention condition, spitting was stable with low rates (M=0.47). Spitting was observed at much lower rates during the demand condition as compared to the previous CRF phase (M=0.33). Following the return to the CRF phase, spitting did not occur during the play condition. Spitting occurred at a constant and low rate during the attention condition (M=0.05). During the demand condition, spitting occurred at elevated rates (M=0.67).
An escape function to Jim’s spitting can be identified during the CRF phases only. Although spitting occurs variably during the initial CRF phase, mean rates were much higher than rates observed during attention and play. During the return to CRF, spitting remains at near zero rates during the attention and play conditions, and increased to high, stable rates during the demand condition. A function cannot be determined during the INT phase of Jim’s functional analysis. Compared to the play condition, rates of spitting are higher during the attention and demand conditions; however, the data are undifferentiated.

During the extended alone phase, Paul’s hands-to-pants was observed following a decreasing trend with behaviors occurring at near zero rates during the last two sessions (M=0.07). During the CRF functional analysis, hands-to-pants did not occur during the play and demand conditions. During the attention condition, hands-to-pants was observed following a decreasing trend (M=0.03). When the INT schedule of reinforcement was implemented, hands-to-pants, again, did not occur during the play condition. Hands-to-pants occurred at stable, low rates during the attention condition (M=0.03). Hands-to-pants occurred following an increasing trend (M=0.03).

A function of hands-to-pants behavior was unable to be determined during either the CRF or INT functional analysis. The condition with the highest average rate, across functional analyses, was the alone condition which would suggest an automatic function; however, the behavior seemed to be extinguishing as the phase concluded. When assessing the condition in which behavior most reliably rose above the control (play) condition, the attention condition has more points (four higher points) compared to the demand condition (two higher points).

**Discussion**
This study compared rates of target behavior observed during functional analyses in which the schedule of reinforcement for the target behavior was manipulated. A series of extended alone conditions were used to screen for behavior that may be automatically maintained. Next, three functional analysis conditions (attention, demand, play) were run in which a continuous, FR1 schedule was used to apply consequences to the target behavior. Next, consequences during the functional analysis were moved to an intermittent, VR2 schedule.

During the extended alone phase, Jim’s spitting occurred at relatively low rates with one session in which rates were significantly higher than others. This may be due, in part, to the fact that Jim could see his therapist observing from outside of the room as he would repeatedly spit and then attempt to look outside of the one-way mirror. Following this session, the lights on the outside of the analogue room were kept off to decrease visibility outside the room. An average of spitting behavior following this change decreased to 0.20 occurrences per minute, as compared to 0.44 occurrences per minute with that outlier session included.

Changes in the rate of behavior across the continuous and intermittent schedules of reinforcement only occurred for one of the two participants. After moving from a continuous to intermittent schedule of reinforcement, there were some noticeable changes in the rates of behavior observed with Jim. During the CRF functional analysis, spitting occurred at an average of 1.50 occurrences per minute across demand conditions. During the INT functional analysis, when the VR2 schedule was applied to spitting, an average of 0.33 occurrences per minute of spitting was observed across the demand condition. During the return to the CRF functional analysis, spitting was observed at an average of 0.67 occurrences per minute across demand
conditions, which shows that the change in schedules did have an effect on the occurrence of spitting.

Another change in behavior occurred following the INT phase in the attention condition. During the initial CRF and INT phases, spitting remained relatively stable and elevated compared to the play condition (M=0.40 and 0.47). During the second CRF phase, spitting decreased to near zero rates (M=0.05). Having more access to reinforcement for spitting during the return to continuous reinforcement may have had a satiating effect, causing behavior to decrease.

During Paul’s functional analyses, behavior remained stable and low throughout both schedules of reinforcement. There was a small increase in hands-to-pants during the demand condition in the INT functional analysis, but this change in behavior should not be attributed to schedule manipulations because the behavior never contacted the contingency in the previous CRF functional analysis.

Manipulating the schedule of reinforcement during functional analysis sessions did have an effect on the occurrence of problem behavior observed by one participant. However, the effects were somewhat unexpected in that changing to an intermittent schedule of reinforcement produced reductions in behavior. Functional analysis results obtained while the continuous schedule of reinforcement was in effect tended to be more differentiated than those obtained while the intermittent schedule of reinforcement was in effect. These results conflict with our original hypothesis in that changing from a continuous to an intermittent schedule of reinforcement actually decreased occurrences of behavior and yielded further undifferentiated
results. One reason may be that the intermittent schedule had an extinction-like effect on the target behavior.

One limitation in this study could have been the order in which the functional analyses were introduced. For both participants, the functional analysis utilizing the continuous schedule of reinforcement was introduced first followed by the intermittent schedule. The initial decrease in responding observed during the intermittent reinforcement functional analysis could have been attributed to the extinction-like effects in the change across schedules. Future research could assess whether there is a difference when the intermittent schedule is introduced prior to the continuous schedule during a functional analysis.

This study provides only two examples of the effects that schedule manipulations have on behavior during functional analyses. Future researchers may wish to further assess these effects with more participants. Researchers may also wish to apply these procedures to behavior that occurs at high rates as opposed to low rates because of the behavior reduction observed during the intermittent phase.
References


Table 1

Jim’s Preference Assessment Results

<table>
<thead>
<tr>
<th>Item</th>
<th>Session 1 % Engagement</th>
<th>Session 2 % Engagement</th>
<th>Average % Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Magazine</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Legos®</td>
<td>56.7</td>
<td>0.0</td>
<td>28.4</td>
</tr>
<tr>
<td>Action Figure</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Elmo® Doll</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Puzzle</td>
<td>20.0</td>
<td>0.0</td>
<td>10.0</td>
</tr>
<tr>
<td>DVDs</td>
<td>0.0</td>
<td>76.7</td>
<td>38.4</td>
</tr>
</tbody>
</table>

Note. Above are the results of Jim’s free operant preference assessment from Roane et al. (1998).
Table 2

*Paul’s Preference Assessment Results*

<table>
<thead>
<tr>
<th>Item</th>
<th>Session 1 % Engagement</th>
<th>Session 2 % Engagement</th>
<th>Average % Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>iPad</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Coloring</td>
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<td>73.0</td>
<td>36.5</td>
</tr>
<tr>
<td>Legos</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Truck</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Book</td>
<td>0.0</td>
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<td>0.0</td>
</tr>
<tr>
<td>Kermit Doll</td>
<td>100.0</td>
<td>0.0</td>
<td>50.0</td>
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<tr>
<td>Action Figure</td>
<td>0.0</td>
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</tr>
</tbody>
</table>

*Note.* Above are the results of Paul’s free operant preference assessment from Roane et al. (1998).
Figure 1

>Note. Occurrence of target behavior across three phases (alone, continuous reinforcement [CRF], and intermittent reinforcement [INT]) of two functional analyses.
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