RESPONSE PATTERNS IN FUNCTIONAL ANALYSES: A PRELIMINARY ANALYSIS

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Functional assessment procedures have proven effective in identifying the operant contingencies that maintain problem behavior. Typically, the evaluation of responding during functional analyses is conducted at the condition level. However, some variables affecting occurrences of behavior cannot be evaluated solely through the use of a cross-session analysis. Evaluating within-session patterns of responding may provide information about variables such as extinction bursts, discriminative stimuli, and motivating operations such as deprivation and satiation. The current study was designed to identify some typical response patterns that are generated when data are displayed across and within sessions of functional analyses, discuss some variables that may cause these trends, and evaluate the utility of within-session analyses. Results revealed that several specific patterns of responding were identified for both across- and within-session analyses, which may be useful in clarifying the function of behavior.
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INTRODUCTION

Over the last 30 years, a substantial body of research has demonstrated the effects of operant contingencies in maintaining a wide range of problem behaviors (Mace, 1994; Roane et al., 1999; Dolezal & Kurtz, 2010.). Knowledge of the environmental conditions that motivate, set the occasion for, and reinforce problem behaviors is useful in the development of positive and effective interventions (Ayllon & Michael, 1959; Iwata et al., 1982/1994; Laraway et al., 2003). Several methodologies have been used to identify the specific contingencies associated with problem behaviors, including functional (experimental) analysis, descriptive assessment, and anecdotal assessment. However, the functional analysis methodology described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) has emerged as the most extensively researched approach. Functional analysis procedures involve comparing the outcomes of conditions designed to represent the environmental antecedents and consequences suspected to be functionally related to the behavior. A typical functional analysis consists of one control condition and three to four test conditions in which contingencies of social positive reinforcement (e.g., attention, access to tangible items), social negative reinforcement (e.g., escape from task trials), and no programmed social consequences (e.g., alone) are presented. After several sessions in each condition, overall levels of responding across conditions are compared to determine the primary function of the targeted response. Test conditions that generate high mean or absolute values of problem behavior, relative to the outcomes of the control condition, are implicated in the maintenance of the problem behavior.

Most research and clinical applications of functional analysis methodology have summarized measures at the session or condition levels when evaluating the outcomes of functional analyses. Only a few studies have evaluated within-session trends during functional
analysis. In fact, a review of the Journal of Applied Behavior Analysis (JABA) from 1996 until 2006 revealed that only 8% of articles evaluated responding at the within-session level (Fahmie & Hanley, 2008). There may be several advantages to using detailed, moment-to-moment depictions of problem behavior when interpreting functional analysis outcomes. When conducting within-session analyses, researchers typically plot the number of responses observed during successive temporal intervals (e.g., 1-min). Data can then be evaluated to determine the “flow” of behavior within sessions, potentially revealing evidence of extinction bursting, sequence effects, or other relevant influences on the target behavior (Vollmer et al., 1993).

For example, differentiated response patterns that are not seen when results are summarized at the session level may become apparent using within-session displays. For example, an overall rate of 5 responses per minute across a 10-min session can be generated by a range of different within-session response patterns. Responses may be equally distributed across the session, with minute-by-minute responding roughly representative of the 10-min average. This type of pattern would be expected if problem behavior was maintained by the contingency in effect during this condition. Alternatively, 50 responses may occur in the first 2 minutes and 0 responses in the following 8 minutes. This type of patterning is similar to what may be observed during an extinction burst, in which responding does not produce its maintaining reinforcer and ceases following a temporary increase. Although both of these patterns could result in similar values when summarized at the level of the session, it is unlikely that they would be generated by the same contingency of reinforcement. In such cases, incorrect interpretations might result from inspection of typical functional analysis displays. Alternatively, displaying results in a within-session format may reveal differences in reinforcement sensitivities that are not apparent at the session or condition levels. Thus, inspection of within-session response patterns may be useful in
increasing the efficiency and accuracy with which clinicians and researchers can identify the operant functions of behavior (Roane et al., 1999).

Only recently have researchers begun to investigate the potential utility and significance of within-session analyses. Vollmer, Iwata, Zarcone, Smith and Mazaleski (1993) examined within-session trends across functional analyses of self-injurious behavior (SIB) and compared results to across-session data. They evaluated responding both within and across conditions using a minute by minute analysis for the first six sessions of the full length functional analyses. The within-session analysis clarified results of one undifferentiated functional analysis and allowed verification of behavioral function for all four participants. For the individual whose results were clarified through within-session analysis, high rates of responding occurred during the attention condition and were followed by bursts in responding at the beginning of sessions that followed attention. These patterns were obscured when mean rates of responding were evaluated across sessions; however, the within-session analysis revealed that the behavior was maintained by contingent attention. These results show that within-session analysis can be useful in identifying sequence effects and clarifying behavioral sensitivity to specific contingencies.

Vollmer and colleagues (1995) developed a four-tiered sequence of assessments to rapidly evaluate maintaining variables for problem behavior. The goal of this assessment was to arrange the most efficient sequence of experimental analyses, progressing from within-session through extended analyses. Within the first tier of this method, Vollmer et al. analyzed within-session responding on a minute-by-minute analysis during the first ten sessions of a functional analysis. If clear patterns of responding were evident, treatment sessions were developed and implemented. If within-session data revealed undifferentiated results then the participant was exposed to experimental conditions in an extended multielement design (Phase 2). If
experimental control was not achieved following Phase 2, then the participant moved to Phase 3. During this phase, the participant was exposed to an extended no interaction, or alone, condition. This phase was conducted to determine if undifferentiated results in Phase 2 could be attributed to behavior that is not maintained by social consequences. If the target behavior persisted in Phase 3 then an intervention was evaluated for behavior maintained by automatic reinforcement. If the behavior extinguished during Phase 3, then one more phase was conducted. The purpose of Phase 4 was to help minimize carryover effects due to rapid alternation of conditions. During this phase, each social test condition for social reinforcement condition was presented in a reversal format.

Of the 20 participants within the study, 6 revealed differentiation within the first Phase, 4 revealed differentiation during the second phase, 5 in the third phase, and only 2 of the remaining 5 revealed differentiation between conditions in Phase 4. Results indicate that a brief assessment evaluated at the within-session level may be a useful for “initial indication of behavioral function” (p. 570). However, further assessment may be necessary to clarify ambiguous outcomes of the initial brief assessment.

Roane, Lerman, Kelley, and Van Camp (1999) extended this line of research, evaluating within-session changes in responding associated with relevant establishing operations and using within-session data to clarify undifferentiated functional analysis results. These researchers examined how momentary changes in establishing operations affected responding during a functional analysis. Session data were reviewed to determine when establishing operations were present, and responding was examined during the presence and absence of these establishing operations. For participants with differentiated functional analyses, within-session data corresponded with functional analysis results. For both participants with undifferentiated
functional analysis results, within-session analyses helped to clarify the function of the target behavior.

Latency to the first response is another dimension of responding that can be evaluated using within-session analysis. By tracking the time that elapses from the presentation of a relevant stimulus to the first occurrence of target behavior it may be possible to expedite the functional analysis process (Harding et al., 2001; Thomason-Sassi et al., 2011). For example, Thomason-Sassi, Iwata, Neidert, and Roscoe (2011) suggested that latency measures may be helpful in assessing behaviors that are particularly harmful to the participant or others, when response opportunities are limited within a session, or when the behavior is physiologically constrained (e.g., vomiting, inappropriate toileting behavior). Thomason-Sassi and colleagues compared rate and latency measures across sets of functional analysis data, and showed that latency measures revealed the same function as rate measures for 33 of the 38 data sets. For the remaining 5 data sets, different maintaining variables were identified.

The aggregated results of studies on within-session analysis support the notion that immediate and/or extended experience with the contingencies programmed during functional analyses can generate different patterns, or trends, in responding. Furthermore, important trends may not be detected when data are summarized at the session level or when only response levels are compared for interpretation. Some patterns that have been reported in within-session analyses include accelerating or decelerating trends, as well as highly variable or stable patterns. Identification of these trends may assist in the efficient and accurate interpretation of operant functions of behavior, as well as in the development of appropriate intervention programs.

Whereas researchers and clinicians routinely compare levels of responding when interpreting functional analysis outcomes, response patterns across sessions are less frequently
emphasized. With within-session analysis, evaluation of patterning, as well as level, may be useful in interpreting the outcomes of successive exposures to contingencies. And, as with within-session analysis, patterns of responding that may be expected to be observed, depending on behavioral sensitivities, include accelerating or decelerating trends, as well as either stable or variable patterns.

A few studies have explicitly incorporated a consideration of condition-level trends in functional analyses. For example, in a pairwise analysis (Iwata et al., 1994), test conditions are presented sequentially, similar to a reversal design. Test sessions are alternated with a control condition within a multielement design, but test conditions are presented sequentially (i.e., conditions are presented one at a time). Therefore, the pairwise design limits interaction effects and discrimination difficulties that can be associated with multielement designs (Iwata et al., 1994; Roane et al., 1999).

Iwata, Duncan, Zarcone, Lerman, and Shore (1994) tested the use of pairwise analyses with five adults with development disabilities who engaged in self-injurious behavior (SIB). Each participant was exposed to the same conditions in two different design formats. First, functional analyses were conducted in a typical multielement design. Following the first assessment, subjects were exposed to a functional analysis using a pairwise design. Results of the multielement assessment revealed a function of negative reinforcement for two participants, and undifferentiated results for three participants. Results of the pairwise analyses revealed a negative reinforcement function for the first two participants, corresponding to the outcomes of the functional analyses. For the third and fourth participants, the pairwise analyses clarified the results of the multielement analyses, revealing an escape function for both participants. For the final participant, neither the multielement or pairwise assessment clearly revealed the operant
function of SIB. Results of Iwata et al. (1994) suggest that a pairwise analysis may be useful when typical multielement designs yield ambiguous results. Overall, results showing that pairwise analysis can alter the outcomes of functional analyses indicate that experimental contingencies may generate different response patterning across sessions as a function of experience with experimental contingencies. Furthermore, an analysis of across-session trends may be instructive in interpreting functional analysis outcomes.

Previous research evaluating within-session trends during functional analyses has shown that these analytic procedures can help to clarify the function of behavior when results summarized at the session or condition levels are ambiguous and may expedite the assessment process by revealing evidence of effects such as within-session extinction. However, the extent to which different patterns and trends in responding are represented in within- and across-session analyses has not been investigated. Such an analysis might contribute to the current literature by providing information about how often within- and across-session analyses 1) show evidence of orderly patterning, 2) enable more rapid interpretations, 3) clarify interpretations that are ambiguous when interpreted at the session/condition summary levels, and 4) lead to effective and efficient intervention. In the current study, representative data from functional analyses conducted by the current research team as well as those published in JABA over the past six years were examined to provide a preliminary evaluation of response patterning during functional analyses.
METHODS

Functional analysis data sets were examined for evidence of within- and across-session patterning. Data sets were selected from functional analyses reported in the Journal of Applied Behavior Analysis (JABA) as well as from clinical and research data collected by the current research team.

Article Inclusion Criteria

This study examined functional analysis data reported in JABA between 2006 and 2012. JABA was the only journal included in this search because JABA publishes the vast majority of research on functional analysis (Hanley et al., 2003). Appropriate articles were identified through a search of the JABA table of contents. Each volume published in the past six years was individually searched and articles were evaluated for inclusion of functional analysis data. Articles were selected if (a) the study included human participants; (b) a functional analysis of problem behavior was conducted; (c) results were represented in graphic form; (d) manipulation of antecedent and consequent events occurred during the functional analysis; (e) the functional analysis included comparisons between at least two test conditions for contingencies including social positive reinforcement, social negative reinforcement, and/or automatic reinforcement; and (f) a control condition was conducted. The first author identified 23 articles that included a functional analysis of problem behavior. From that set, the author and the doctoral-level behavior analyst who supervised this research determined that 21 articles met inclusion criteria. In addition, two panels of reviewers were assembled to evaluate the original set of 23 studies. Each panel reviewed a subset of the studies as a team and obtained consensus on the extent to which each study met criteria for inclusion in the current analysis. Three graduate research assistants with extensive training in behavior analysis and functional analysis of behavior disorders, and
two board certified behavior analysts (BCBAs) reviewed 11 studies (43.4%). The remaining 12 studies (56.6%) were reviewed by a Doctoral-level BCBA and two graduate research assistants from the first panel. Both panels achieved consensus and both agreed with the original determinations of the author and research supervisor. Therefore, a total of 21 articles were included in this review.

After articles were identified for inclusion, figures within the articles were selected for evaluation. Individual data sets within the articles were included if (a) sessions were conducted using a multi-element design; (b) at least three sessions were conducted in each condition; and (c) the functional analysis revealed differentiation between conditions. If a study included a functional analysis in a multielement design across environments, then the first phase in each environment was evaluated. Each graph was evaluated by the author to determine the experimental design as well as the number of sessions conducted in each condition. A set of 75 data sets were identified for further analysis. Each of these data sets was provided to all reviewers from the original review panels. Reviewers were asked to review each graph, determine if a multi-element design was utilized, and to determine if at least three sessions were conducted in each condition. The reviewers agreed that a total of 75 data sets met the first two criteria.

Following assessment for the first two criteria, the data sets were evaluated for differentiation between conditions. Differentiation was determined through discussion between the author of this report and the research supervisor. In addition, results sections of each article were reviewed to evaluate corroboration with the reviewers’ interpretations. A total of 62 data sets met the differentiation criteria and were included in this analysis.
Clinical Data Analysis

Results of functional analyses conducted in a behavior analysis clinic for assessment and treatment of behavior disorders were also evaluated in this study. Data sets from the clinic were evaluated using the criteria described above with some exceptions. As with data sets from JABA, the author evaluated each graph via discussion with the research supervisor.

Because the data were generated by the current research team, it was not possible to corroborate the assessment of differentiation with another research team (as it was with JABA articles). However, a set of structured criteria for visual inspection of functional analyses, similar to those described by Hagopian et al. (1997), were used to further evaluate differentiation in these data sets. In the Hagopian et al. study, ten sessions from each test and control condition were evaluated. Two criterion lines were drawn between the second and third highest and lowest data points, respectively, from control conditions. Then, reviewers counted the number of points in each condition above and below the lines in order to determine differentiation between test and control conditions as well as the primary function of the behavior. If the number of points above the upper criterion line minus the number of points below the lower criterion was equal to or greater than five, then data from that condition were said to be differentiated. For data sets from the behavior analysis clinic, slight modifications were made to accommodate data sets with more or fewer than ten sessions per condition. In the current procedures, the number of data points below the lower criterion line was subtracted from the number of points above the upper criterion line, and a determination of differentiation was made if the difference was equal to or greater than half the total number sessions within that condition. If more than one condition was identified as differentiated then procedures outlined by Hagopian et al., were utilized to test for
automatic reinforcement or multiply maintained behavior. If the alone condition showed
differentiation from other conditions, data points were evaluated to determine if the alone
condition was associated with the highest rates of responding. If responding was highest in alone,
then the behavior was classified as automatically reinforced. If responding during the alone
condition was not higher than other differentiated conditions, then the behavior was considered
to be multiply controlled. Also, if more than two conditions were differentiated and alone was
not one of the differentiated conditions, then the behavior was considered to be multiply
controlled. Only data sets that revealed a single maintaining variable were included in this study,
and multiply maintained behaviors were excluded. A total of nine functional analyses from the
clinic met inclusion criteria.

Clinic Assessment Procedures

Setting and Participants. The clinic was located at a large, state-operated residential
facility for individuals with intellectual disabilities, and participants ranged in age from 18 to 58.
Each functional analysis conducted in the clinic during the calendar years 2006-2012 (to date)
was evaluated for inclusion. Functional analyses were conducted in a 3.7 m by 3.7 m room
which contained one table, two chairs, and stimuli relevant to each functional analysis condition.
The room contained one door leading to the main clinic space and was equipped with a one way
observation mirror. The room contained equipment and supplies as appropriate for each
experimental condition. For one participant, Matt, a can of his favored soft drink was available
throughout sessions in all conditions except the tangible condition. For this participant, the soft
drink was used as the tangible item in tangible assessment sessions. Also, sessions for this
participant were 15 min in duration in order to permit a more extensive analysis of within-
session variability in his aggressive behavior.
Data Collection. For data collected at the clinic, observers were stationed outside the one-way mirror and recorded data using hand held computers onto which data collection software had been installed. The software included keys for each target behavior across participants and both frequency and duration measures were available.

Interobserver agreement (IOA) data were collected simultaneously but independently during at least 37.9% of each experimental analysis. IOA was calculated by dividing sessions into 1-s bins, summing the number of bins in which both observers agreed on the occurrence or non-occurrence of the targeted behaviors, then dividing the results by the total number of bins in the session, and multiplying the result by 100. Figure 1 presents information about each participant as well as IOA results for each participant.

Clinic Functional Analysis Procedures

*Automatic reinforcement (Alone/No Interaction).* The participant was in the observation room alone and no leisure activities were available. No social consequences were delivered following target behaviors. If the behavior targeted for reduction was aggression towards others, then a No Interaction session was conducted instead of an Alone condition. Procedures were the same as the Alone condition except that a therapist was present in the room with the individual. This purpose of the condition was to test whether problem behavior persisted in the absence of social consequences; if so, results were interpreted as suggesting that the behavior was maintained by automatic reinforcement.

*Positive reinforcement (Attention).* The participant was in the room with the therapist. Leisure and recreation materials such as magazines, books, puzzles, and cards were freely available to the participant. Prior to the beginning of the session, the therapist provided positive attention to the participant for 5 to 10 s and then told the participant she/he had work to do and
sat in a chair. The therapist did not interact with the participant unless the target behavior occurred. Contingent on the target response, the therapist delivered attention to the participant for approximately 5 s, in the form of a reprimand or statement of concern (e.g. “What’s wrong,” “Don’t hit me,” “Stop it,” etc.). If the participant continued to engage in the target response, the interaction continued. All other behaviors were ignored. The purpose of this condition was to test for behavioral sensitivity to social positive reinforcement in the form of attention from others.

*Positive reinforcement (tangible).* The participant was in the room with the therapist and no leisure activities were available. Prior to the session, the participant was given brief (5-10 s) access to the tangible item. If the tangible item was an edible, a small portion was provided prior to the session. Following brief access, the tangible was removed and kept in sight of the participant. The therapist told the participant she/he had work to do and then began to look at a book or magazine. Contingent on the targeted response, the participant was allowed to access the preferred item for 20 - 30 s. If the participant engaged in the targeted response at the end of the access period, the therapist allowed the participant to keep the item for an addition 20 - 30 s. The purpose of this condition was to test for behavioral sensitivity to social positive reinforcement in the form of access to tangible items.

*Negative reinforcement (Demand).* The therapist was in the room with the participant. The room was equipped with academic or self-care materials suited to the participant’s level of functioning. The therapist began the session by stating a demand to the participant. If the participant did not comply within 5 s then a least-to-most intrusive prompting sequence was implemented. The instruction immediately terminated contingent on each occurrence of the targeted response, and the therapist did not engage with the participant until the next scheduled trial. If problem behavior occurred at the scheduled time of the demand, the demand was
postponed until at least 5 s had elapsed without the targeted response. The purpose of this condition was to test for behavioral sensitivity to social negative reinforcement in the form of escape from instructions.

*Play.* The room contained leisure and recreation materials. The participant was in the room with the therapist and was allowed free access to the materials. The therapist delivered brief attention in the form of positive conversation or encouragement to engage with the materials at 30-s intervals. No social consequences were delivered for the target response and if the response occurred at the end of a 30-s interval the interaction was delayed briefly. The purpose of this condition is to serve as a control against which data from the tests conditions were compared.

**Response-Pattern Analysis**

After data sets were identified for inclusion, each graph was evaluated for trends and patterns within the primary maintaining variable. Following a review of trends within responding during the primary condition, responding in all other conditions was evaluated. The author and the research supervisor discussed each data set and came to consensus regarding different response patterns observed. For data collected by the current research team, response patterns were evaluated both across and within sessions. For data sets collected from JABA articles, only across-session analyses were conducted.

*Across-session analysis.* Data from each functional analysis were inspected to identify the presence of trends (increasing, decreasing, variable, or stable) within conditions. An increasing trend was identified if responding in the primary condition was higher during the second half of the functional analysis than the first half. If responding was lower during the second half of the functional analysis then a decreasing trend was identified. A variable pattern was identified if
rates rose and fell throughout the functional analysis without any clear trends. A stable pattern was identified if responding during the second half of the functional analysis was relatively similar to responding during the first half without any clear increasing or decreasing trends. Finally, the latency to differentiation was evaluated by measuring how many cycles of conditions were conducted before responding in a single condition occurred at consistently higher rates relative to other conditions. A complete cycle of conditions included one session in each test and control condition.

*Within-session analysis.* For functional analyses conducted within the behavior analysis clinic, within-session patterns of responding were evaluated. Cumulative records depicting responding during consecutive 10-s intervals were constructed and results were displayed across consecutive sessions within conditions. This method of display allowed for the identification of trends and patterns within test conditions. In addition, variability in responding at the beginning of sessions was inspected for evidence of carryover effects from prior conditions. For problem behavior maintained by social negative reinforcement, the percentage of demands escaped during each session was also evaluated. Each set of the cumulative records was inspected to identify patterns of responding during the condition identified as the primary maintaining contingency, as well as the presence of relationships between primary maintaining contingencies and patterns in other test and control conditions.
RESULTS AND DISCUSSION

Results of the data analysis revealed several response trends and patterns both across and within sessions during multiple functional analyses. Results of functional analyses conducted in the clinic revealed differentiation between conditions. Of the ten behaviors evaluated in the clinic, two functional analyses revealed positive reinforcement by attention, two revealed positive reinforcement by access to tangible items, four revealed negative reinforcement, and two revealed automatic reinforcement as the primary maintaining variable for the targeted response. For data sets reviewed from JABA, interpretation of session-summary graphs indicated 15 cases of positive reinforcement by attention, 13 cases of positive reinforcement by tangible access, 19 cases of negative reinforcement, and 15 cases of automatic reinforcement. After agreement was obtained for interpretations graphs were grouped by maintaining variables, trends and patterns of responding across sessions were evaluated.

Across Session Analysis

Figures 2 – 8 depict a subset of functional analysis graphs collected from JABA across function (for a complete review of all JABA graphs included in this analysis, refer to Appendix A). Graphs were selected at random for inclusion in the subset. For each operant function, a total of five graphs are displayed and each panel represents data from a separate article. Results of functional analyses collected from the behavior analysis clinic are displayed in Figures 9 – 12 and, again, graphs are combined by function.

Positive Reinforcement by Attention

Figures 2, 3, and 9 display functional analysis graphs for behaviors maintained by positive reinforcement by attention. The upper panel of Figure 2 depicts a multielement functional analysis across two different environments. Only responding on the playground
revealed positive reinforcement by attention as the maintaining variable, and therefore, only playground responding was evaluated for trends and patterns in the attention condition. When functional analyses revealed social positive reinforcement by attention as the maintaining variable, response patterns usually differentiated relatively quickly. Differentiation was frequently observed during the first cycle of sessions; however, as many as 6 cycles of conditions were required to produce differentiation in some cases (see John, Figure 9).

Responding during the attention condition occurred within the first or second session and response patterns generally showed relatively stable or increasing trends. Responding was also observed in other conditions, but at lower rates than the attention condition. This suggests that the environmental events that evoke or maintain behaviors maintained by attention may be present in other assessment conditions. For example, during the demand condition, a therapist is present and brief attention is provided on a fixed time schedule when placing the demand. Also, contingent task removal in the demand condition may be paired with a verbal statement such as “Ok, you don’t have to,” or “never mind.” These statements may be an alternative form of attention that further reinforces the response. Similarly, a therapist is present during tangible conditions, and contingent presentation of items may be paired with statements such as “here, take this.” The observation that lowest rates of responding in cases of positive reinforcement by attention is often observed during the alone condition may provide additional support for this account. If the presence of a therapist is discriminative for the responding maintained by attention, then the lowest rates of responding would be expected during the alone condition where no therapist is present.
Positive Reinforcement by Access to Tangible Items

Figures 4 and 10 depict functional analysis results for behavior maintained by positive reinforcement by access to tangible items. For behavior maintained by access to tangible items, responding during the functional analysis differentiated relatively quickly. The latency to differentiation ranged from 1 to 3 cycles of conditions. This brief latency may be related to the direct and systematic control of antecedent stimuli within the condition. During the tangible condition, a preferred tangible item is typically present (visible) but not freely available to the participant, thus potentially increasing its reinforcing value. Furthermore, the preferred item is not usually present during other conditions, enhancing its potential discriminative properties in the tangible condition. In addition, the therapist controls the presence and absence of the motivating operation by providing the preferred item briefly at the beginning of the session and contingent on the response, and removing the item after brief access. Perhaps these obvious antecedent manipulations evoke responses maintained by access to tangible items more quickly than conditions in which antecedent events are less salient.

Across sessions of the tangible condition responding almost always occurred in the first session and either rapidly increased or remained stable across sessions. For many of the functional analysis results, responding in all other conditions was zero. If responding did occur in another test condition, it occurred at relatively low levels and remained stable across sessions. This is, again, likely due to the direct and obvious manipulation of antecedent conditions associated with tangible reinforcement.

For one participant in the behavior analysis clinic, Matt, responding during the tangible condition continued to be evaluated during an extended baseline phase. Figure 10a depicts responding during the tangible condition across all sessions. The first four data points show
response rates during the functional analysis and the remaining ten points depict responding
during the extension of the tangible condition. During the extended baseline, responding
continued to occur at relatively high rates, but gradually decreased across sessions. This decrease
may be related to a decrease in the reinforcing value of the tangible item, perhaps due to satiation
or habituation across sessions.

Negative Reinforcement

Figures 5, 6, and 11 display functional analysis graphs for behaviors maintained by
negative reinforcement. When functional analyses revealed negative reinforcement as the
maintaining variable, the latency to differentiation was typically brief and ranged from 1 to 2
cycles of conditions. Similar to the tangible condition, the rapid differentiation observed for
behavior maintained by negative reinforcement may have resulted from the direct manipulation
of antecedent events during the demand condition. Task demands, typically considered to be
motivating operations for escape, are presented immediately and frequently during demand
sessions and, therefore, escape responding is likely to occur quickly during the demand
condition.

Responding across all behaviors maintained by negative reinforcement consistently
occurred during the first session and persisted across sessions. Responding for all data sets
showed either stable or decreasing trends with the latter seen in several cases. One reason for a
stable trend may be that task demands are typically presented according to a fixed time schedule
(e.g. every 30 seconds). If the participant only responds at the presentation of the demand then
overall responding across sessions should be relatively stable. There are at least two reasonable
accounts for decreasing trends observed in several records. First, whereas responding may not be
reinforced continuously in natural environments, an FR1 schedule of escape for problem
behavior was in effect during the functional analyses. If responding during early sessions of analyses was consistent with “natural” patterns, bouts, rather than single instances of responding might be expected. However, as behavior contacted the continuous schedule of escape programmed during demand conditions, more “efficient” patterns may be expected to develop. Consequently, response patterns may reveal a decreasing trend across sessions (e.g. the participant engages in a single response to escape the demand instead of repeated responses). Alternatively, if repeated exposure to demands resulted in a generalized decrease in the aversiveness of demands (e.g., through habituation), a similar across-session decrease in responding might occur.

In order to further assess which account was most tenable for each participant, the percentage of demands escaped and compliance was calculated for each session. Figure 13 shows the percentage of demands escaped and the percent of compliance per session for each participant. The percent of demands escaped was calculated by dividing the number of demands followed immediately by the target response by the total number of demands and multiplying the result by 100. The percent of compliance was calculated by dividing the number of demands followed with a verbal or gestural prompt by the total number of demands and multiplying the result by 100. If the client completed the task following a model or a physical prompt from the therapist, compliance was not recorded.

For two of the participants, Jesse and Susan, fewer demands occasioned escape behavior as the analysis progressed. However, the percent of compliance for Jesse increased as sessions progressed and remained low to none for Susan. This suggests that Jesse became more tolerant of demands and might therefore benefit from repeated exposure to novel tasks in order to decrease challenging behavior while Susan either became more tolerant of demands or learned to
complete the task only if a model or physical prompt was provided. For Keith, as the analysis progressed, a larger percentage of demands were escaped, even though response measures decreased. He also complied with very few demands across sessions. Therefore, it appears that Keith’s responding became more efficient throughout the analysis, and that a viable approach to intervention for Keith could consist of training an alternative response to escape aversive situations as well as escape extinction for challenging behavior. Examination of within-session trends (as was conducted for the data depicted in Figure 11) might provide more evidence about the process(es) underlying these dynamics.

Automatic Reinforcement

Figures 7, 8, and 12 display functional analysis results for behaviors maintained by automatic reinforcement. Results of functional analyses for behavior maintained by automatic reinforcement revealed variable rates of responding across the majority of conditions. For many of the graphs, clear differentiation between conditions never occurred during the multielement format. Therefore, extended analyses were often necessary to evaluate if the target behavior was maintained by automatic reinforcement.

When differentiation between conditions did occur during multielement analyses, the latency to differentiation ranged from 1 to 4 cycles. The inconsistency in differentiation across participants and variable rates of responding are likely caused by a lack of control over consequences for the response. In both positive reinforcement and negative reinforcement conditions, the therapist has the ability to manipulate some motivating operations (e.g., the delivery of demands) as well as consequences (e.g., delivery of a tangible item or attention, or escape). However, during the automatic reinforcement condition, no social antecedents or consequences are provided for the target response.
When differentiation did occur, responding during the alone condition continued at higher rates relative to other conditions and often increased across sessions. The rapid increase in responding across sessions may be related to sensitivity to punishment. As participants engaged in target responses that did not produce aversive social consequences (e.g., reprimands, etc.), increases in response levels in alone conditions across sessions (as seen in Figure 12 for Victor and Lauren) would be reasonable to expect.

Within Session Analysis

Figures 14-33 show within-session graphs for each category of maintaining contingency across participants from the behavior analysis clinic. Graphs are grouped by operant functions and each panel represents a different participant. Each within-session graph is derived from data displayed in functional analysis graphs depicted in Figures 9 - 12. The following figures directly correspond: Figure 9 and 14; Figure 10 and 15; Figure 10a and 15a; Figure 11 and 16-17; and Figure 12 and 18.

Positive Reinforcement by Attention

Functional analyses for two behaviors evaluated in the behavior analysis clinic revealed a primary function of positive reinforcement by attention. Figure 14 shows within-session cumulative records for both participants.

In general, patterns were somewhat different between the two participants, but some distinct patterns were observed within individual records. For John, responding occurred at relatively high rates during the first half of each session and either decreased slightly towards the end of each session or persisted at high levels. John’s attention sessions were preceded by no interaction sessions; thus, deprivation of attention during the no interaction condition may have increased the reinforcing value of attention during the attention condition and produced relatively
high levels of responding during the first half of each session. As the attention was “consumed” throughout the session, habituation or satiation may have resulted in the decreases in behavior observed during some sessions. The within-session analysis of John’s behavior seems generally consistent with his across-session outcomes.

For Erin, within-session responding during the attention condition varied. During three sessions, responding occurred throughout the session with a brief latency to the first response and an accelerating pattern toward the end of this session. This pattern of responding may be indicative of a within-session reinforcement effect. Interestingly, unlike John’s response patterns which showed immediate a tendency toward gradual decreases toward the end of sessions, Erin’s responding did not show strong evidence of within-session satiation or habituation, suggesting that attention maintained its effectiveness as a reinforcer Erin’s behavior longer than for John. In addition, a tendency toward more pronounced increasing trends and higher response levels were observed as Erin’s analysis progressed, suggesting that the value of attention may have increased both within and across sessions.

Positive Reinforcement by Access to Tangibles

Functional analyses for two behaviors evaluated in the behavior analysis clinic revealed a primary function of positive reinforcement by access to tangibles. Figure 15 shows within-session cumulative records for both participants.

Within-session response patterns for both participants were similar. During the first session, for Matt, the latency to the first response was about 3 minutes; however, after the first tangible delivery, Matt consistently engaged in the targeted response almost immediately following removal of the tangible item. Responding did not occur in the first session for Anita. However, the latency to the first response in subsequent sessions was quite brief and high and
stable rates of responding were observed within sessions. Within-session analyses revealed short stair-step patterns at the beginning of initial sessions, indicating responding only occurred following removal of the tangible item. However, after a few removals, responding occurred almost continuously for both participants, effectively eliminating removal of the tangible item throughout the remainder of sessions. These patterns in responding suggest the manipulation of motivating operations increased responding for both participants within-session and possibly evoked an avoidance response to prevent future removals of the tangible item within session.

A within-session analysis of Matt’s extended baseline was also conducted (after termination of the multielement analysis) and results are depicted in Figure 15a. The first four sessions were derived from the initial functional analysis. Responding during session 5 revealed similar patterns of responding as those observed during sessions 1 through 4. However, during subsequent sessions, Matt’s behavior was more clearly characterized by “stair step” patterns with generally stable trends (with the notable exception of session 10, in which a sharp increase in responding similar to that seen in session 3 was observed). This indicates that responding consistently occurred when the tangible item was removed. Whereas Matt engaged in bouts of nearly continuous aggression sessions 2 through 7, he subsequently engaged in aggression only at the time of tangible removal (still effectively avoiding removal of the item). Within-session analysis provided an additional information to explain the decreasing trend observed in the across session analysis. The overall decrease in responding appeared not to be related to satiation to the tangible item, but instead had become more efficient in maintaining access to the tangible item within sessions.
Negative Reinforcement

Functional analyses for four behaviors evaluated in the behavior analysis clinic revealed a primary function of negative reinforcement. Figures 16 and 17 show within-session cumulative records for all four behaviors.

Response patterns for all behaviors maintained by negative reinforcement revealed variable patterns of responding both within and across participants. An interesting finding was the tendency toward decreasing levels of responding across participants across sessions. As noted previously, such trends may indicate that either the participant became tolerant of the demand context or became more efficient at responding. Each of these situations would have implications for intervention. For example, if it was discovered the demand context was no longer aversive, intervention may involve a desensitization program to include repeated presentations of demands until escape behavior is no longer is observed. If decreases in responding were due to increased efficiency, repeated exposure to the demand is not likely to eliminate challenging behavior. Therefore, intervention could consist of differential reinforcement of an alternative response to escape the demand or escape extinction procedures for challenging behavior.

Automatic Reinforcement

Functional analyses for two behaviors evaluated in the behavior analysis clinic revealed a primary function of automatic reinforcement. Figure 18 shows within-session cumulative records for both behaviors. For Victor, frequency of responding was evaluated while duration of responding was evaluated for Lauren.

For Victor, responding occurred within the first minute of the first session. Responding continued to occur throughout the session in a stair-step pattern. Due to the nature of Victor’s
behavior (PICA) the pauses between responses were likely produced by consumption of the reinforcer. During the second and third sessions responding did not begin until after five minutes had lapsed. Subsequently, shorter latencies to the first response were observed and responding returned to relatively high rates in a stair-step pattern during the final three sessions. Interestingly, the pauses between responses were shorter than observed during session 1. Victor’s response patterns showing that, as he gained experience with the experimental environment, latencies to the first response decreased and overall response rates increased are consistent with the notion that his automatically reinforced responding may have been exposed to punishment in other environments, and the absence of social consequences in the experimental context produced more immediate and rapid responding.

For Lauren, response patterns revealed relative low durations of responding within the first half of sessions. Responding occurred at higher durations during the remaining half of the sessions and the latency between responses decreased drastically. The latency to the first response varied throughout sessions, but remained relatively long (e.g. 8 minutes). Lauren’s response patterns also seem consistent with an interpretation that her behavior was punished in alternative environments. Whereas Victor’s behavior conformed to the absence of punitive contingencies across sessions (latencies to the first response decreased), Lauren’s behavior appeared to show within-session effects, in which long latencies persisted but when the first response did not produce social consequences increases in within-session responding were observed.

Other Test Conditions

In addition to within-session analysis of the maintaining variable condition, each additional condition was evaluated within-session. Figures 19-32 depict cumulative graphs for all
conditions not proven to maintain behavior. Cumulative graphs are grouped by conditions across operant function (e.g. tangible conditions are grouped for each behavior maintained by positive reinforcement by attention, negative reinforcement, and automatic reinforcement). Only conditions in which responding occurred are displayed in the figures (e.g. if Matt did not engage in the targeted response during the alone condition, cumulative graphs were not generated for that condition).

Figures 19 -20 show cumulative responses during tangible sessions for participants whose target behavior was maintained by attention. For behaviors maintained by positive reinforcement by attention, only one participant (John) consistently responded during the tangible condition. During the first half of this condition, John responded relatively frequently early in sessions (except for session 5) and then showed general, but slight, tendencies toward decreases in responding later in the sessions. During the final set of sessions, responding still occurred initially, but quickly decreased as the session progressed. Also, a distinct decline in the total amount of responding is evident across the cumulative records. These types of response patterns are consistent with within- and across-session extinction. As noted previously, the presence of therapists in tangible sessions may have functioned as a discriminative stimulus during early sessions of the analysis. However, as sessions progressed a decrease in responding suggests that the absence of an attention contingency decreased the stimulus control effect. These effects are more easily identified using within-session analyses than across-session analyses. For the second participant whose behavior was maintained by positive reinforcement by attention (Erin), responding did not occur until the last session of the tangible condition. Therefore, no specific patterns could be identified.
Figures 21 - 22 show cumulative responses during demand sessions for participants whose target behavior was maintained by attention. The demand condition revealed variable patterns and generally low measures of within-session responding for behaviors maintained by positive reinforcement by attention. For John, single or short bursts of responses were separated by long interresponse intervals, with the exception of session 40 during which responding during the second half of the session was relatively continuous. For Erin (Figure 22), responding only occurred three times across two separate sessions.

Figures 23 - 24 show cumulative responses during alone/no interaction sessions for participants whose target behavior was maintained by attention. John’s results from no-interaction sessions are shown in Figure 23. For John, measures of within-session responding were variable across sessions, with several bursts in responding observed during later sessions of the analysis. These bursts may be related to the structure of the no interaction condition, in which a therapist is physically present but no social consequences are provided for behavior. The presence of a person may have been discriminative for the availability of attention because attention was often presented in other experimental conditions during the multielement assessment (e.g., attention, demand, play). The structural similarity between the no-interaction and attention conditions, in particular, paired with the absence of an attention contingency during the no-interaction condition, may have combined to produce the bursts of responding that were evident in five of the last seven sessions.

Erin’s results from alone sessions are shown in Figure 24. For Erin, there was a relatively long latency to the first response during the initial alone session followed by a short burst in responding. This type of response patterns is indicative of a small extinction burst. Since the response was maintained by positive reinforcement by attention, the absence of attention...
following the initial response may have resulted in a burst of responding. When those responses were not followed by attention, responding stopped. To further support the notion that Erin’s responses revealed signs of extinction, during the second session there was another long latency to the first response followed by a pause and one more response. Then, responding ceased to occur during any subsequent sessions.

For behaviors maintained by positive reinforcement by access to tangible items, only one participant engaged in responding during other conditions. For Matt, responding was zero for all other conditions and therefore cumulative graphs are not displayed. The lack of responding during other test conditions for Matt is likely related to the availability of a can of soda during all conditions. A can of soda was available in all conditions because Matt occasionally arrived with a soda and would refuse to release the soda prior to session. Therefore, the soda was held constant in all conditions, except the tangible condition in which it was delivered contingent on the targeted response. When preferred tangible items are freely available the motivation to engage in responses maintained by positive reinforcement by access to tangible items is low.

Anita’s results from attention, demand, and alone conditions are shown in Figures 25 - 27. During the attention condition, there was a burst in responding towards the end of session three and two responses at the beginning of session four. However, responding was not observed in other sessions. Similar results were observed during demand and alone sessions in which bursts in responding were observed during sessions three and two respectively and low or no responses were observed during other sessions. The low measures of responding within other test conditions for behaviors maintained by positive reinforcement by tangible reinforcement can be attributed to systematic control over targeted tangible items across the analysis. During the tangible condition, brief access is provided to a preferred item and then that item is removed, but
held present. The item is either present throughout other sessions (Matt) or absent throughout other sessions (Anita). The presence of the tangible item may, therefore become a discriminative stimulus for responding in the case that it is not present in other conditions (Anita) and may motivate responding when it is present but unavailable (both participants).

Figure 28 shows cumulative responses during attention sessions for participants whose target behavior was maintained by escape. Two participants engaged in responding during the attention condition. For both participants, responding occurred early in each session in which it was observed. For Jesse, bursts of responding occurred during the first few sessions of the attention condition; as sessions progressed, bursts became shorter. Often, when individuals with behavior maintained by negative reinforcement are exposed to a new environment with materials and a therapist present target responses are observed during early sessions. Materials and the presence of a therapist in a room with a table and chairs may contain similar discriminative properties to workshops or other locations in which demands are experienced. Therefore, it would be expected for responding to occur initially and as the discrimination between conditions became clearer responding would gradually decrease. For Susan, no clear response patterns were evident during the attention condition.

Figure 29 show cumulative responses during tangible sessions for participants whose target behavior was maintained by escape. For both participants responding during the tangible condition was relatively low (Jesse) or non-existent (Susan). The low measures of responding during the tangible condition for behaviors maintained by negative reinforcement can be attributed to the lack of demands and materials during the condition. Low rates of responding were also observed during the alone condition, displayed in Figure 30, for both participants, with
the exception of session 6 for Susan. These low rates can be attributed to the absence of stimuli associated with task demands (e.g., therapist and materials).

Figure 31 shows cumulative responses during attention sessions for participants whose target behavior was maintained by automatic reinforcement. For behavior maintained by automatic reinforcement, responding occurred for both participants during the attention condition. For Victor, within-session responding during the attention condition revealed relatively stable response patterns in a stair step pattern. Victor’s target response, PICA, required some time to ingest items; therefore, this pattern is likely a function of consumption patterns of the PICA item and not related to the delivery of attention. Also, because the behavior was maintained by automatic reinforcement, it would be expected to occur in the attention condition unless it was sensitive to social consequences as punishment. The relatively high measures of responding in this condition suggest that contingent attention did not effectively punish Victor’s PICA.

For Lauren, the attention condition did not reveal any clear patterns of responding, but responses were low across all additional test conditions. Figures 32 and 33 show cumulative responses during tangible and demand sessions for Lauren. Low measures of responding in all conditions in which a therapist is present may suggest that her behavior was sensitive to punishment in the form of verbal comments and reprimands. Thus, in all conditions in which a therapist was present, responding would be expected to be low, as was observed during attention, tangible, and demand conditions for Lauren.

Figure 33 shows cumulative responses during demand sessions for participants whose target behavior was maintained by automatic reinforcement. For the demand condition for Victor, within-session analyses revealed similar stair step patterns as the attention condition.
However, the latency between responses was relatively long. These longer latencies are likely related to the frequent presentation of demands which may have interfered with Victor’s engagement in the target response, perhaps through response competition. Since task completion required Victor to use his hands, PICA could not occur simultaneously, making the two responses incompatible.
GENERAL DISCUSSION

Through the use of functional analysis methodologies, researchers and clinicians have been able to identify the variables responsible for the occurrence of problem behavior. Most functional analysis results are summarized at the session or condition level. That is, graphically displayed data are inspected for evidence of differentiation across sessions between test and control conditions. This type of data analysis has both advantages and limitations. One advantage to evaluating responding across sessions is the ability to compare responding across all conditions simultaneously. By viewing graphically displayed data summarized at the session level across conditions, researchers and clinicians can quickly and directly compare response levels between conditions.

Results of the current study indicate that behaviors maintained by social positive and negative reinforcement often show fairly rapid differentiation relative to control and other test conditions. For several of the data sets inspected in the current study, only a few cycles of conditions were necessary to identify behaviors maintained by social positive or social negative reinforcement. However, for behavior maintained by automatic reinforcement, differentiation may be less evident, or may require more time to occur, possibly because the contingencies of reinforcement for these behaviors does not involve socially-mediated consequences. Thus, the level of experimental control necessary to produce rapid differentiation between test conditions for automatic reinforcement (i.e., alone or no-interaction conditions) may not be possible. To address this limitation, additional procedures such as extended exposure to the alone condition have been implemented. When extended alone sessions are conducted, response levels are evaluated to determine if responding persists in the absence of social contingences. If, after several sessions (or a few long sessions) responding continues to occur, researchers and clinicians conclude that the behavior is maintained, at least in part, by automatic reinforcement.
Despite the apparent advantages of comparing response levels between conditions, there are some limitations associated with this type of analysis. Evaluating responses at the session level minimizes the researcher’s ability to assess all aspects of responding that may be relevant for interpretation, such as latency to first responses (and changes in latencies across sessions), the presence or absence of trends within sessions, or relationships between within-session patterns of responding and other events (e.g., the presentation of task demands). During sessions, responding often fluctuates, and data summarized at the session level may not reflect dynamics in the flow of behavior within sessions.

For example, results of the current study indicated that, for behaviors maintained by negative reinforcement, decreasing trends are sometimes observed across sessions. Within-session analyses may be useful in determining the variables responsible for such across-session changes. For example, examination of within-session data for Jesse and Susan indicated that decreases in response levels across session were related to decreases in the number of demands escaped across sessions. These outcomes suggest that the MO for escape decreased across sessions (Smith et al., 1995; Roane et al., 1999). For Keith, however, decreases in response levels were not associated with corresponding decreases in the number of demands escaped, suggesting that his behavior simply became more efficient over the course of the assessment, conforming to the continuous schedule of escape for his target behavior.

Analysis of within-session trends may also be helpful in identifying dynamic changes in behavior maintained by positive reinforcement. For example, during tangible and attention conditions, access to the putative reinforcer is provided for a specified amount of time and then removal is attempted. If behavior is, in fact, maintained by these putative reinforcers, then one might expect behavior to cease briefly during “consumption” periods and then resume relatively
quickly until the next presentation occurs. Inspection of cumulative records in the current study revealed stair-step type patterning for several participants (John, Erin, and Matt), consistent with this expectation. If such patterns were immediately evident (as occurred for these participants), it may be possible to interpret functional analysis results more quickly than if only session summary data were inspected. That is, it may not be necessary to wait for clear differentiation among data summarized at session levels if stair-step patterning was observed within attention or tangible conditions. The ability to identify specific trends in responding prior to differentiation between conditions may decrease the time and resources necessary to conduct a functional analysis.

Interestingly, Anita’s cumulative records showed no such patterning, with rapid and stable responding observed across the second through the fourth tangible sessions. Anecdotally, this resulted in virtually continuous contact with Anita’s tangible item; thus, her behavior may be loosely characterized as conforming to a conjugate schedule of reinforcement, in which her behavior maintained contact with an ongoing source of stimulation (e.g., Rovee-Collier & Capatides, 1979). Analyses of these sorts of dynamics are only possible by inspecting within-session response patterns.

Another advantage to within-session analysis is the ability to identify trends related to differentiation between conditions. Trends in responding during conditions identified as those maintaining target behaviors generally revealed consistent patterns, while responding during other test conditions, not identified as maintaining the target behavior, tended to be more inconsistent. At times, the consistency in response patterns was evident during within-session analyses before clear patterns of differentiation were observed across session. Therefore, the use of within-session analyses may facilitate relatively brief functional analyses.
Despite these potential advantages to the use of within-session analyses, some limitations exist. First, for behavior maintained by automatic reinforcement, within-session data did not reveal consistent trends or patterns of responding. In such cases, an evaluation of responding within-session across all conditions may be useful. Since responding maintained by automatic reinforcement often occurs across all conditions, an evaluation of within-session responding is likely to reveal trends in other conditions that either indicate an alternative function or show evidence of extinction. If within-session analyses do not show differential response patterns indicating either multiple control or automatic reinforcement, an extended analysis of the alone condition may be necessary to determine if responding persists in the absence of social consequences.

The advantages and limitations to across and within-session analysis suggest a combination of across-session analyses of level, across-session analyses of trends, and within-session analyses may be the most useful in identifying potential maintaining variables of problem behavior. Results of the current study show the potential benefit of utilizing within-session analyses to evaluate response patterns that may lead to more efficient and effective interventions. If the use of across and within-session analyses can be used in combination to identify the function of behavior more quickly than across session analyses alone there is great potential for use in settings where time and resources may be limited for extended functional analyses.

While this study directly assessed the utility of within-session analysis in identifying specific trends and patterns across conditions, it did not directly assess the utility of these patterns in identifying effective interventions. Therefore, future research should evaluate the
effectiveness of within-session analysis in determining more effective intervention methods compared to across session analysis.
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<th>DV</th>
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*Figure 1.* Demographic information about each participant in the behavior analysis clinic as well as the dependent variable, measure for the dependent variable, and interobserver agreement (IOA). For Matt, IOA was calculated during the FA and extended baseline sessions. IOA for the FA is displayed as the upper number, and baseline IOA is displayed as the lower number.
Figure 2. Positive reinforcement by attention – JABA
Upper Panel: Retrieved from Lang et al., 2009
Lower Left Panel: Retrieved from Thompson & Iwata, 2007
Lower Right Panel: Retrieved from Thompson & Iwata, 2007
Figure 3. Positive reinforcement by attention – JABA
Upper Panel: Retrieved from Najdowski et al., 2007
Lower Panel: Retrieved from Travis & Sturmey, 2010
Figure 4. Positive reinforcement by access to tangible items – JABA
Upper Panel: Retrieved from Ingvarsson et al., 2008
Middle Left Panel: Retrieved from Rooker et al., 2011
Middle Right Panel: Retrieved from Borrero & Borrero, 2008
Lower Left Panel: Retrieved from Thompson & Iwata, 2007
Lower Right Panel: Retrieved from Thompson & Iwata, 2007
Figure 5. Negative Reinforcement – JABA
Upper Panel: Retrieved from Berg et al., 2007
Lower Panel: Retrieved from Lomas et al., 2010
Figure 6. Negative Reinforcement – JABA
Middle Panel: Retrieved from Carter, 2010
Lower Panel: Retrieved from Thomason-Sassi et al., 2011
Figure 7. Automatic reinforcement – JABA
Upper Panel: Retrieved from Ahearn et al., 2007
Lower Left Panel: Retrieved from Rooker et al., 2011
Lower Right Panel: Retrieved from Rooker et al., 2011
Figure 8. Automatic reinforcement – JABA
Upper Panel: Retrieved from Ing et al., 2011
Lower Panel: Retrieved from Morrison et al., 2011
Figure 9. Positive reinforcement by attention

Upper panel: Responses per minute for head-up during functional analysis for John

Lower panel: Frequency of physically disruptive behavior (PDB) during functional analysis for Erin
Figure 10. Positive reinforcement by access to tangible items
Upper panel: Frequency of physical aggression during functional analysis for Matt
Lower panel: Frequency of physical aggression during functional analysis for Anita
Figure 10a. Extended baseline for Matt.
The first four sessions depict responding during the functional analysis in the tangible condition. The following ten sessions depict responding during an extended baseline of the tangible condition.
Figure 11. Negative reinforcement
Upper panel: Duration of hand biting during functional analysis for Susan
Middle panel: Frequency of aggression and disruption during functional analysis for Jesse
Lower left panel: Duration of verbally disruptive behavior (VDB) during functional analysis for Keith
Lower right panel: Duration of finger biting during functional analysis for Keith
Figure 12. Automatic reinforcement
Upper panel: Frequency of PICA during functional analysis
Lower panel: Duration of skin picking during functional analysis
Figure 13. Percent of demands escaped and percent of compliance across behaviors maintained by negative reinforcement. The left most column represents the session number within the demand condition. The following columns (from left to right) represent the percent of demands escaped for Jesse, Keith, and Susan in each session as well as the percentage of compliance. It should be noted that only one column is used to depict the number of demands escaped by Keith even though two separate behaviors were evaluated. This is because both behaviors were evaluated simultaneously during the same functional analysis.

<table>
<thead>
<tr>
<th>Session</th>
<th>Jesse</th>
<th>Keith</th>
<th>Susan</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unknown</td>
<td>Unknown</td>
<td>72.7%</td>
</tr>
<tr>
<td>2</td>
<td>83.3%</td>
<td>16.7%</td>
<td>66.7%</td>
</tr>
<tr>
<td>3</td>
<td>88.9%</td>
<td>11.1%</td>
<td>66.7%</td>
</tr>
<tr>
<td>4</td>
<td>57.9%</td>
<td>36.8%</td>
<td>76.9%</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Figure 14.** Within-session responding for positive reinforcement by attention
Upper Panel: cumulative frequency of head-up within-session for John
Lower Panel: cumulative frequency of physically disruptive behavior within-session for Erin
Figure 15. Within-session responding for positive reinforcement by tangible access
Upper Panel: cumulative frequency of aggression within-session for John
Lower Panel: cumulative frequency of aggression within-session for Anita
Figure 15a. Within-session responding during extended tangible condition
Upper Panel: cumulative frequency of aggression within-session for first 7 sessions for Matt
Lower Panel: cumulative frequency of aggression within-session for final 7 sessions for Matt
Figure 16. Within-session responding for negative reinforcement

Upper Panel: cumulative frequency of aggression and disruption within-session for Jesse

Lower Panel: cumulative duration of hand biting within-session for Susan
Figure 17. Within-session responding for negative reinforcement
Upper Panel: cumulative duration of verbally disruptive behavior within-session for Keith
Lower Panel: cumulative duration of finger biting within-session for Keith
Figure 18. Within-session responding for automatic reinforcement
Upper Panel: cumulative frequency of PICA within-session for Victor
Lower Panel: cumulative duration of skin picking within-session for Lauren
Figure 19. Tangible condition for behavior maintained by positive reinforcement by attention
Upper Panel: cumulative frequency of head up within-session for first six sessions for John
Lower Panel: cumulative frequency of head up within-session for second six sessions for John
Figure 20. Tangible condition for behavior maintained by positive reinforcement by attention
Cumulative frequency of physically disruptive behavior for Erin
Figure 21. Demand condition for behavior maintained by positive reinforcement by attention
Upper Panel: cumulative frequency of head-up within-session for first six sessions for John
Lower Panel: cumulative frequency of head-up within-session for last five sessions for John
Figure 22. Demand condition for behavior maintained by positive reinforcement by attention. Cumulative frequency of physically disruptive behavior for Erin.
Figure 23. No interaction condition for behavior maintained by positive reinforcement by attention
Upper Panel: cumulative frequency of head-up within-session for first six sessions for John
Lower Panel: cumulative frequency of head-up within-session for last six sessions for John
Figure 24. Alone condition for behaviors maintained by positive reinforcement by attention
Cumulative frequency of physically disruptive behavior within-session for Erin
Figure 25. Attention condition for behavior maintained by positive reinforcement by access to tangibles. Cumulative frequency of aggression within-session for Anita.

Figure 26. Demand condition for behavior maintained by positive reinforcement by access to tangible items. Cumulative frequency of aggression for Anita.
Figure 27. Alone condition for behavior maintained by positive reinforcement by access to tangible items. Cumulative frequency of aggression for Erin.
Figure 28. Attention condition for behaviors maintained by negative reinforcement
Upper panel: Cumulative frequency of aggression and disruption for Jesse
Lower panel: Cumulative duration of hand biting for Susan
Figure 29. Tangible condition for behavior maintained by negative reinforcement. Cumulative frequency of aggression and disruption for Jesse.

Figure 30. Alone condition for behavior maintained by negative reinforcement. Cumulative duration of hand biting for Susan.
Figure 31. Attention condition for behavior maintained by automatic reinforcement
Upper Panel: cumulative frequency of PICA within-session for Victor
Lower Panel: cumulative duration of skin picking within-session for Lauren
Figure 32. Tangible condition for behavior maintained by automatic reinforcement
Cumulative duration of skin picking within-session for Lauren
Figure 33. Demand condition for behaviors maintained by automatic reinforcement
Upper Panel: cumulative duration of skin picking within-session for Lauren
Lower Panel: cumulative frequency of PICA within-session for Victor
Appendix A

(Ahearn et al., 2007)

(Berg et al., 2007)
(Berg et al., 2007)
(Borrero and Borrero, 2008)

(Carter, 2010)
(Dwyer-Moore and Dixon, 2007)
(Ing, Roane, Veenstra, 2011)

(Ingvarsson, Kahng, and Hausman, 2008)
(Lang et al., 2008)

(Lang et al., 2009)
(Lomas, Fisher, and Kelley, 2010)

(Morrison, Roscoe, and Atwell, 2011)
(Najdowski et al., 2007)
(Najdowski et al., 2008)
(Rooker et al., 2011)
(Thomason-Sassi et al., 2011)
(Thompson and Iwata, 2007)
(Travis and Sturmey, 2010)
REFERENCES


