AN EVALUATION OF INTERRESPONSE TIME AS A MEASURE OF PROBLEM BEHAVIOR DURING FUNCTIONAL ANALYSIS

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by

Erin Theresa Orchid

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Abstract

of

AN EVALUATION OF INTERRESPONSE TIME AS A MEASURE OF PROBLEM BEHAVIOR DURING FUNCTIONAL ANALYSIS

by

Erin Theresa Orchid

Different variations of the experimental functional analysis (FA) methodology have been evaluated as an attempt to reduce the amount of time and resources required for its implementation. One of these variations includes the use of latency as an index of problem behavior. When measuring latency from the start of the session to the first response, the participant may be required to respond multiple times until clear differentiation is determined. The purpose of this study was to assess whether latency and interresponse time (IRT) measures would correlate with results obtained in a standard FA. Four children (ages 4-6) diagnosed with autism were exposed to an IRT functional analysis and then to a standard FA. Results showed that for three out of the four participants all variations of FA pointed out to the same function replicating previous studies supporting the effectiveness of different variations of the standard FA methodology.

____________________, Committee Chair
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____________________

Date
DEDICATION

I would like to dedicate this thesis to my parents. Without your love and unwavering support throughout the years, this would not have been possible. Your constant belief in my passion for my work and drive for education made this project a reality. To my Father, Ron, your strength and courage to battle your Cancer gives me strength everyday to continue my work with individuals with developmental disabilities. I would also like to thank my late Uncle Bobby for his love and for encouraging me to follow my dreams. I would like to express my gratitude to my family and friends for giving me the encouragement and strength allowing me to make this vision a reality.
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I would like to acknowledge all the families, children, regional centers, and support group members whose participation in this study has allowed me to utilize my passion for working with children with developmental disabilities and gave me the opportunity to shed light on a topic that is limitedly researched and personally fulfilling.

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Chapter 1

INTRODUCTION

Behavior is a function of three possible consequences: Negative reinforcement in the form of escaping from demands, positive reinforcement in the form of access to attention or a tangible, and/or automatic reinforcement. By identifying these environmental determinants of behavior, prior to initiating an intervention, clinicians are able to develop intervention plans that address the function of behavior rather than trying different treatment interventions, one after the other, in a trial and error fashion (Cooper, Heron, and Heward, 2007). Some authors (Carr, 1977; Johnson & Baumeister, 1978), have suggested that treatment failures and inconsistencies reported throughout the literature may have been due to a lack of understanding regarding the variables that either produce or maintain aberrant behaviors.

Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) described an operant methodology used to assess the functional relationships between problem behavior self-and specific environmental events. In their study, problem behaviors consisted of self-biting, head banging or hitting, eye gouging, ear pulling, face slapping, hand mouthing, self-choking, and hair pulling (i.e., self-injury). Eight of the nine participants were exposed to each of four different assessment conditions in a multielement experimental design (one participant, who served as the pilot participant, was exposed to three of the four conditions). The four conditions described by Iwata et al. (1982/1994) included, social disapproval or attention, designed to test for a social positive reinforcement
function; in this condition, attention is withheld and is only delivered contingent on the occurrence of the target behavior. The next condition was the academic demand or escape condition, which was designed to test for a social negative reinforcement function in which escape is provided contingent on the occurrence of the target behavior. An unstructured play condition was also included, during which attention was delivered on a fixed time (FT) schedule with continuous access to preferred items, no demands were presented, and the target behavior was ignored; this condition served as a control condition by which to compare results of the previous test conditions. Finally, an alone condition was included to test for an automatic reinforcement function; during this condition the participant was alone with no access to any stimuli. Results indicated that the occurrence of self-injury varied both between and within individuals. However, more importantly, for 6 of the 9 participants, higher levels of self-injury were consistently associated with a specific condition. These results suggested that it may be possible to empirically identify variables that affect problem behavior (i.e., self-injury) prior to implementing treatment conditions.

Although the study by Iwata et al. (1982/1994) identified the maintaining functions of aberrant behaviors, this methodology has been questioned (e.g., Northup, Wacker, Sasso, Steege, Cigrand, Cook, & DeRaad, 1991; O’Reilly, Lancioni, King, Lally, & Dhomhnaill, 2000; Wallace & Knights, 2003) in that allowing repeated occurrences of target behaviors, such as self-injury, could potentially lead to permanent harm to the client (e.g., severe instances of eye gouging could potentially lead to blindness) and/or to the persons conducting the FA, in the case of aggression. FA
methodology has also been criticized due to the time required to conduct the analysis (310 minutes for a standard FA) as well as the amount of resources required (e.g., staff to conduct the FA) which could be costly (Northup et al.; Wallace & Knights).

Most recently, briefer versions of the FA methodology have been evaluated. A brief FA may be preferred in that it may require less time to conduct as well as fewer resources. Brief FA’s have been conducted in applied settings, such as schools, vocational settings, and outpatient therapy (e.g., early intensive behavioral therapy). Wallace and Knights (2003) stated that despite the empirically demonstrated utility of standard FA procedures, they may be infrequently used in clinical settings due to time constraints or untrained care providers. The infrequent use of standard FA methodologies in clinical settings may lead to treatment teams implementing various behavior reduction procedures without assessing the environmental determinants of behavior prior to treatment. Implementing multiple treatments or modifying behavior intervention plans several times could potentially lead to accidental or intermittent reinforcement of aberrant behavior (Wallace & Knights).

The efficacies of brief FA methodologies are supported by studies conducted by Northup et al. (1991), O’Reilly et al. (2000), and Wallace and Knights (2003). Brief FA’s were used to identify maintaining variables of aberrant behavior (i.e., aggression, self-injury, and stereotypic behaviors) with individuals with developmental disabilities between 5-22 years old and were conducted during a 90-min evaluations consisting of a series of conditions lasting 10 min or less. The initial assessments focused on identifying maintaining contingencies for the target behavior. Results for all three studies showed
differentiated patterns of responding; in other words, one condition was associated with a greater frequency of aberrant behavior when compared to other conditions. Both brief FA and standard FA results were determined through visual inspection. When comparing the standard and brief FA, maintaining functions of aberrant behavior matched for each participant; in other words, the brief FA produced the same results as the standard FA in less time (an average of 90-min for brief FA’s and 310 min for the standard FA). These studies demonstrated that a brief FA can be effective in identifying maintaining variables of aberrant behavior for some individuals (Wallace & Knights, 2003).

The overall time required to conduct a FA can be reduced using brief FA methodologies described in the previous studies; however, there are still some limitations that exist even when session durations are reduced. It is still possible for the participant to emit several responses, which may not be desirable when the target behavior is potentially harmful. If the aberrant behavior is one that could be life threatening to the participant or could possibly cause permanent damage (e.g., eye gouging, head banging, face hitting), multiple instances of responding during FA conditions may not be tolerated.

As mentioned previously, problem behaviors that are potentially harmful or dangerous may not be tolerated, precluding one from being able to conduct an FA. A study conducted by Smith and Churchill (2002) sought to address this limitation by assessing environmental determinants of behavior through analysis of precursor behaviors. By assessing the precursor behaviors that occur prior to the target behavior there is little to no chance that the target behavior would occur during the FA (assuming that the precursor behavior and target behavior are part of the same response class). Four
participants between 35-35 years old with developmental disabilities were selected to participate in the study. All participants engaged in various forms of SIB or aggression. Each participant was exposed to the standard FA conditions described by Iwata et al. (1982/1994) until maintaining functions of problem behavior were determined. Participants were then exposed to the same conditions; however, experimental contingencies were placed on the precursor behaviors rather than the actual problem behavior. It was found that for all four participants the function of behavior “matched” when comparing results of the standard FA and precursor FA. This study suggested that functions of problem behavior could be determined without the actual target behavior occurring during the analysis. Although placing environmental contingencies on a precursor behavior rather than the actual problem behavior seems to address the limitation of assessing life threatening or potentially dangerous behaviors, it only allows for the evaluation of those behaviors maintained by social contingencies and not behaviors the occur independent of social contingencies. Also, when relying merely on a precursor FA, there is a possibility that the topography of the precursor behavior may vary. Smith and Churchill (2002) did not describe a methodology for identifying precursor behaviors; hence, there may have been inconsistencies among observers or even the false identification of a maintaining function of problem behavior.

In a more recent a study, Najdowski, Wallace, Ellsworth, MacAleese, and Cleveland (2008) extended Smith and Churchill’s (2002) study by conducting a precursor FA and then testing whether treatments based on results of the analysis would both eliminate precursor behavior and decrease occurrences of the target behavior to low or
near zero levels. Two children (ages five and eight diagnosed with developmental disabilities, traumatic brain injury, and emotional handicaps) and one adult (45 years old diagnosed with mental retardation) participated in the study. Target behaviors included aggression toward peers and teachers (for the 2 children) and public masturbation and attempting to grab genitalia of staff and peers (for the adult participant). An indirect assessment followed by direct observation of the behavior was conducted prior to the FA in order to identify precursors to the severe problem behaviors. Problem behavior and precursor behavior was then operationally defined. The precursor FA was conducted, following procedures similar to those described by Smith and Churchill, and clear differentiation between the conditions was apparent through visual inspection of data. The treatment phases consisted of individualized interventions all involving Functional Communication Training (FCT) and were based on the variables that were identified to maintain precursor behavior. An ABAB reversal design was used to evaluate treatment effectiveness. Results indicated that the treatments implemented based on the function of the precursor behavior, which was identified during the precursor FA, eliminated precursor behavior and possibly prevented occurrences of severe problem behavior (Najdowski et al.). Although the treatments implemented were effective in reducing instances of severe problem behavior, a standard FA was not conducted; therefore, an assessment of the ‘true’ maintaining variables was not evaluated. For this reason, the authors suggested that it may be possible that the related antecedents and consequences were not present during the precursor FA and treatment phases; hence, it may be possible
that the precursor behavior was not related to the target behaviors (Najdowski et al., 2008).

Time based evaluations such as latency and interresponse time (IRT) are considered innovative approaches for determining functions of problem behaviors (Thomason-Sassi, Iwata, Neidert, & Roscoe, 2008). The most common methods of measurement used during functional analyses have included frequency (converted to rate), duration, or the percentage of intervals during which the target behavior occurs. Latency measures have been used occasionally throughout applied research; however, most of the research has focused on the initiation of adaptive behaviors, such as compliance (Belfiore, Lee, Vargas, & Skinner, 1997; Ardorin, Martens, & Wolfe, 1999; Wehby & Hollahan, 2000). These studies indicated that response latency was a sensitive measure for evaluating treatment efficacy. However, they provide little information regarding the relationship between response latency and response rate (Thomason-Sassi et al.).

Killeen and Hall (2001), in a study conducted with pigeons, assessed overall rate (the overall frequency of the behavior), run rates (the overall time of each session), latency (the time between the start of the session and the first response), and probability (a measure of how likely it is that the behavior will occur) in an effort to evaluate their efficacy as a measure of response strength. Results showed an inverse correlation between latency to the first response in a trial and subsequent response rate. In other words, the smaller the latency measure (the less amount of time between the start of the session to the first response) the higher the response rate; thus, according to the authors,
indicating that results of the latency matched the rate results. These findings suggest that response latency might be an appropriate measure of response strength.

In a series of three studies, Thomason-Sassi et al. (2008) examined, first, the relationship between response rate throughout a session and latency to the first response under baseline, acquisition, and maintenance conditions. The baseline condition consisted of the experimenter modeling the target response once and no access to reinforcement for target responses. The purpose of this condition was to determine a measure for responding without the use of reinforcement and to determine if lower rates of responding were consistent with longer latencies. The acquisition condition was similar to the baseline condition, however, reinforcement (i.e., a small edible) was provided contingent upon the target behavior. This condition established whether high rates of responding coincide with shorter latencies. During the maintenance condition there was no experimenter modeling and reinforcement for target responses was provided. The purpose of the maintenance condition was to determine if short latencies between the start of the trial to the first response would maintain after only one response.

The second experiment was a retrospective analysis conducted in which data from functional analyses of problem behavior were compared when graphed as overall rates of responding and as latency to the first response within a session. Thirty-eight latency graphs and 38 standard FA graphs from adult participants diagnosed with developmental disabilities were presented in random order. A group of raters were then asked to discuss the graphs and agree about the function of the target behaviors.
Finally, the third experiment compared results from latency FA’s in which one exposure to programmed contingencies within conditions was evaluated with standard FA’s (repeated exposure to programmed contingencies as conducted by Iwata et al. (1982/1994). Ten individuals diagnosed with developmental disabilities participated in the third experiment. Target behaviors consisted of SIB, aggression, and property destruction. The latency FA was conducted first followed by the standard FA to control for possible experimenter bias in favor of the latency FA.

Different stimuli were associated with the conditions (i.e., the attention condition was associated with a particular treatment room, the therapist wearing a colored shirt, and stimuli only used during this condition). Between conditions the participants were given 5 min break to increase session discrimination. Each condition within the FA was conducted in a multielement design, the sequences of the conditions were as follows: alone, attention, play, and demand (Thomason-Sassi et al.). According to the authors, the latency FAs were considered complete when differential responding was observed through visual inspection of the graphs over at least three complete sets of data and/or when ten complete sets of conditions were conducted. The standard FA followed the latency FA and was conducted in the same fashion as outlined by Iwata et al.; sessions lasted 10 min in duration. Results of all three experiments showed a consistent inverse relationship between rate and latency. Therefore; these results suggest that latency may be a useful measure of responding when repeated occurrences of a behavior are clinically undesirable; for example, behaviors that may be dangerous to the client or to the therapist
(e.g., SIB or aggression); latency measures may also be useful when standard FA procedures are too costly and/or too time consuming to conduct in an applied setting.

A possible limitation of the latency FA conducted by Thomason-Sassi et al. (2008) is that when measuring latency from the start of the session to the first response (and then terminating the session), participants may need to respond multiple times before learning that a specific session is associated with a certain consequence (i.e., discrimination). Due to participants only contact the consequence once per condition during the latency FA repeated sessions may be needed in order to see differentiation between the test conditions and until clear differentiation can be determined through visual inspection of the results. Due to the participant contacting the contingency once, discrimination between conditions does not solely rely on the extraneous variables added to each condition (e.g., particular books during the attention condition or the experimenter wearing different colored shirts) but also on the programmed contingencies the participant may contact prior to IRT being measured. Thus, by measuring the IRT between the first and second response may address this limitation while still restricting the number of responses required within the FA. In this case, the consequence contingent on the emission of the first problem behavior may cue the participants on which condition is in effect.

Cooper, Heron, and Heward (2007) define IRT as “a measure of temporal locus; defined as the elapsed time between two successive responses.” (p. 698). IRT is a measure of temporal locus because it measures when a specific instance of behavior occurs with respect to another event (i.e., a previous response). IRT is functionally
related to rate of response; therefore, shorter IRTs coexist with higher rates of response, and longer IRTs are found within lower response rates. IRT used as a measure of response strength has been evaluated in basic research using pigeons during discrete trial and free operant concurrent variable-interval schedules (Cleaveland, 1999), as well as in applied settings in reinforcement/response-cost contingencies (Kawashima, 2003).

Therefore, the purpose of this study was to replicate the Thomason-Sassi et al. (2008), to extend the study to children diagnosed with Autism Spectrum Disorder, and to examine the use of an IRT measure as an index of response strength of problem behavior. Results of the IRT FA were compared to a standard FA to ensure that the maintaining variable is identified as the same across both the IRT FA and the standard FA. Also, with in the IRT FA latency between the start of the condition and the first response was measured to further evaluate the relationship between latency and IRT.
Participants, Settings, and Materials

Participants were four children diagnosed with Autism Spectrum Disorder, all of whom were enrolled in Applied Behavior Analysis therapy ranging from 15-30 hours per week. Behavior problems displayed by participants included: aggression (Ricky), property destruction (Alex and Aaron), and dropping to the floor (Emily). Ricky, six years old, engaged in aggression defined as engaging in one of more of the following: hitting with right or left hand with closed fists, slapping with right or left hand with open palm, biting (teeth making contact with skin), pinching with four fingers to thumb grasp or index finger to thumb grasp, and kicking. Alex, five years old, engaged in property destruction. Property destruction was defined as engaging in on or more of the following: hitting hand held objects against hard surfaces making an audible sound, ripping paper, bending laminated stimuli, and/or swiping stimuli (i.e., pushing stimuli off the surface they were placed/presented on). Aaron was 6 years old. He engaged in property destruction as defined by engaging in one or more of the following: pushing stimuli off of tables, throwing objects (in the direction of others), climbing on chairs or tables, and ripping paper. Emily was 6 years old and her dropping behavior was defined as falling from a sitting or standing position to the floor or ground and laying on her stomach or back for more then 5 s. The functional analyses for Ricky, Alex, and Emily were conducted in a separate room at their school (approximately 10 x 12 ft. room); the
functional analyses for Aaron were conducted in therapy rooms in their homes (ranging approximately from 10 x 10 to 10 x 15 ft. rooms). Each room contained a video camera (used to record the sessions), toys and individualized stimuli (i.e., 2D picture cards, crayons and paper, building blocks, etc.) presented during specific FA conditions (i.e., the play/control condition or the demand condition). Sessions during the IRT FA were 5 min in duration for Ricky, Alex, Emily, and Aaron. All sessions during the standard FA were 10 min.

**Response Measurement and Interobserver Agreement**

For the standard FA, interobserver agreement (IOA) was calculated by dividing each session into 10-s intervals, then dividing the smaller number by the larger number for each interval, summing the responses across intervals, and dividing by the total number of intervals, then multiplying the resulting number by 100 to yield a percentage (Miltenberger, 2008). Frequency data were collected on the target behavior during each standard FA condition and a video camera was used to record all sessions. Two experimenters then independently scored each of the IRT and standard FA sessions (ranging from 45%-100% of sessions). IOA for IRT data were calculated by dividing the shorter IRT (in seconds) by the longer IRT and multiplying by 100%. Mean IOA scores across participants ranged from 95.8% to 100% for the standard FA and from 98.2% to 100% for IRT FA. Treatment integrity was assessed by scoring each step of the procedure as correct (+) or incorrect (-). These included presenting the correct antecedent (e.g., vocal statement to signify the start of the session), consequence, (e.g., programed script for target behaviors), prompting procedure (i.e., during the demand condition), and
planned ignoring (during the no interaction condition). A percentage was calculated by dividing the total number of correct steps divided by the number correct and incorrect, then multiplying the result by 100.

IOA was assessed during 50% of Ricky’s sessions across both the IRT and standard FA’s. Mean percentage of agreement for Ricky’s standard FA and IRT FA was 100% and 98.2%, respectively. Mean percentage of procedural integrity during the IRT and standard FA was 98.5% and 88.25%.

IOA was assessed during 50% of Alex’s sessions across each of the two FA’s. Mean percentage of agreement for Alex’s IRT and standard FA’s was 99.7% and 96%. Mean percentage of procedural integrity during the IRT and standard FA’s was 99% and 86.55%.

IOA was assessed during 50% of Emily’s sessions across the IRT FA and across the standard FA’s. Mean percentage of agreement for Emily’s IRT and standard FA’s was 99.7% and 97.7%. Mean percentage of procedural integrity during the IRT and standard FA’s was 99% and 89%.

IOA was assessed during 45% of Aaron’s sessions across both the IRT and standard FA’s. Mean percentage of agreement for Aaron’s IRT FA and standard FA was 100% and 95.8%. Mean percentage of procedural integrity during the IRT and standard FA’s was 98.5% and 88.7%. Additionally, latency data were collected for all four participants from both the IRT and standard FA. Reliability was not calculated for the latency scores generated from the raw data.
**Experimental Design**

In the IRT FA, conditions were similar to the study conducted by Iwata et al. (1994) in which the conditions were presented in the following order; alone/no interaction, attention, play, and demand. This sequence was repeated for four series consisting of the four conditions. Unlike the standard FA the conditions were terminated after the third response of the target behavior or after 5 min had elapsed (whichever occurred first), for Ricky, Alex, Emily, and Aaron. In the standard FA, conditions were presented in a fixed sequence as in the study conducted by Iwata et al. with conditions lasting 10 min in duration. All four participants were exposed to the IRT FA first and to the standard FA second. Fas were conducted with no more then six days between sessions.

**Functional Analysis Conditions**

Parent/caregiver interview and direct observation were used to create operational definitions of the target behaviors (described above), identify demands/instructions (to be used in the demand condition), previous intervention (i.e., behavior plans implemented for the target behaviors), and identify toys used in the attention and play conditions for each participant. In order to increase the participants ability to discriminate between conditions specific stimuli, such as toys, therapist color of t-shirt, items/activities available in the room were provided; however, some of these stimuli were not available for all participants due to environmental factors.
No interaction

During this condition participants were in the therapy room with non-preferred toys (as identified by caregivers/parents as the participant having not engaged with the item/activity within the last six months) were present in the room. The experimenters did not interact with the participant by either sitting on the floor in a corner of the room with their heads down or in a chair with their heads down.

Attention

The attention condition was conducted in a room with moderately preferred toys available. Moderately preferred toys were defined as items/activities in the participant’s environment that they engage with at least once per week as identified by caregivers and parents. At the start of the session, the experimenter said to the participant, “I’m going to do some work, you can play.” The experimenter did not make eye contact with the child and appeared to be sorting papers and looking at a computer or phone until the child engaged in the target behavior. Attention in the form of a vocal reprimand (i.e., “No throwing, that could hurt”) and brief physical touch was delivered contingent on the target behavior.

Play/control

During the play condition continuous access to preferred activities and toys identified by parents and caregivers were available in the room. Attention in the form of praise (e.g., “Nice playing”) and brief physical contact were provided on a fixed-time 30 s schedule. If the participant engaged in the target behavior prior to social praise (i.e., at
29 s) the therapist waited 5 s then provided social praise. Target behavior was ignored during this condition.

**Demand**

In the demand condition activities from the participant’s Individualized Education Plan goals were presented (e.g., stacking cups, completing addition worksheets, scooping beans, imitating simple drawings, etc.). Novel targets and demands in which there was a low likelihood of compliance identified by parent, caregiver, and teacher/tutor report were chosen individualized to each participant. The experimenter and the participant sat at a child sized table and chairs or on the floor. A three step prompting procedure consisting of: a vocal instruction, followed by the experimenter repeating the instruction and modeling the response, was implemented if the participant did not comply within 3 s after the initial instruction was given, Mild praise (i.e., “that’s the cup”) was delivered following compliance with either a vocal instruction or modeled prompt. If the child required physical guidance to complete the task, praise was not delivered. Contingent upon the target behavior the experimenter removed lesson materials and said, “Okay, you don’t have to,” and looked away from the child for 5 s.

**IRT Functional Analysis**

All session contingencies were the same as described previously; however, each session was terminated after the second response. Attention and escape sessions were terminated immediately following the delivery of programmed consequences for the second instance of a target problem behavior. No interaction and play sessions were terminated either 1 min after the occurrence of the second target problem
behavior (to prevent inadvertent possible reinforcement in the form of session termination) or when 5 min had elapsed whichever came first. The dependent variable was the IRT from the first instance of the target behavior to the second instance of the target behavior and the total session time.

**Standard Functional Analysis**

All procedures were the same as described previously, however, sessions were not terminated after the second response and during the demand condition when a target behavior would occur, the experimenter removed the demand and looked away from the participant for 30 s (identical to Iwata et. al., 1982). Sessions were 10 min in duration. The dependent variable was the occurrence of the target behavior and was expressed as responses per minute or the percentage of 10-s intervals during which the target response occurred.

**Data Analysis**

Data were analyzed through visual inspection of graphical representations. Data paths for each condition were separately compared to the data path for the control (play) condition. When a test condition was differentiated from the control condition, the consequence associated with that condition was interpreted as the maintaining variable for the target behavior. For instance, if the data path for the attention condition showed a higher frequency than the data path for the control condition in the standard FA graph, then the target behavior was interpreted as being maintained by access to attention, or social positive reinforcement. Data were analyzed through visual inspection, following the guidelines proposed by Hagopian, Fisher, Thompson, Owen-DeSchryver, Iwata, and
Wacker (1997). An upper and lower criterion line was drawn through the highest and lowest data points of the control condition. If the majority of data points in a test condition were above the criterion line, that condition was determined as being differentiated from the control condition. If the no interaction condition was differentiated and was the highest data path, the behavior was interpreted as being maintained by automatic reinforcement. If the no interaction condition was differentiated, but another condition had a data path higher than the no interaction condition, the behavior was interpreted as having multiple maintaining variables.

Four graphs per participant were generated from results of each IRT and standard FA (IRT FA graph, standard FA graph, latency from the IRT FA graph, and latency from the standard FA graph). The graphs were then visually inspected and results were derived according to the guidelines stated above (Hagopian et. al., 1997). Latency measures were generated from the start of the IRT session to the occurrence of the first response and were then graphed as the raw score in seconds. Latency was then derived from the interval data collected during the standard FA. It was generated by scoring the latency from the start of the test condition to the first response at the end of the first 10 s interval in which the target response occurred (Thomason-Sassi et. al., 2011). To qualify as an agreement (or for the functions of behavior to ‘match’ between the FAs) the IRT and standard FA, and the latency data generated from both of those FAs, had to have higher rates of responding and shorter IRT’s and latency’s in the same condition or must both produce undifferentiated patterns of responding (Thomason-Sassi, et. al.,).
Chapter 3

RESULTS

Figure 1 depicts the IRT (first panel) and standard FA results (second down) with the latency scores derived from the IRT (third) and standard FA (forth) for Ricky. During the IRT FA the demand condition showed lower IRT ($M=44.25$ s) than the other conditions. Ricky also engaged in aggression during the attention condition and it showed lower IRT ($M=139$ s) from the control condition ($M=300$ s) however, when applying the criteria previously described, the behavior would not be interpreted as being maintained by access to attention. In the standard FA, Ricky’s aggression was differentiated in the demand condition. The demand conditions were clearly differentiated in both the IRT and standard FA’s. Latency data measured from both the IRT and standard FA showed that the demand condition was differentiated from the control condition.

In summary results from all types of functional analyses for Ricky showed the demand condition as clearly differentiated from the play (control) condition across the four graphs. In other words, across all four graphs aggression was identified as being maintained by escape/avoidance of demand. The time based FAs (latency and IRT FAs) identified the same maintaining function as the rate based (standard) FA with the time based FAs requiring less total responses per FA (one to two responses per condition versus 18 total responses during the standard FA).
Figure 1. IRT, standard, and latency from IRT and standard analyses graphs indicating correspondence between IRT and standard analyses. Both identifying maintaining function of target behavior of escape from demand.

Figure 2 shows IRT (first panel) and standard FA results (second down) with the latency scores derived from the IRT (third) and standard FA (third) for Alex. In the IRT FA, the attention condition produced shorter IRT ($M=52.75\,\text{s}$) than the IRT from the control condition ($M=300\,\text{s}$). However, property destruction also occurred in one of the demand conditions during the IRT FA. In the standard FA, based on the above criteria for differentiation, Alex’s attention condition was differentiated from the control condition although property destruction was observed during the demand, attention, and play conditions during the standard FA. Results of the IRT FA showed lower IRT during the attention condition than the rates (frequency) during the attention condition for the standard FA. Latency data measured from both the IRT and standard FA showed that the attention condition was differentiated from the control condition.

In summary, access to attention was identified across all four graphs as the maintaining function of Alex’s property destruction. Although the graphs all correlated the IRT FA showed the clearest differentiation (shortest IRT) of the attention condition when compared with the play (control) condition with the least amount of responses required (two responses per session, eight total versus rates of responding during the standard FA ranging between 4-8 instances of property destruction per condition, totaling 26 instances).
Figure 2

Alex's IRT FA

Interresponse time between the first and second response in seconds

Sessions

Alex's Standard FA

Frequency of property destruction

Sessions
Figure 2. IRT, standard, and latency from IRT and standard analyses graphs indicating correspondence between IRT and standard analyses. Both identifying maintaining function of target behavior of access to attention.

Figure 3 shows Emily’s results for the IRT (first panel) and standard FA (second down) with the latency scores derived from the IRT (third) and standard FA (fourth). The demand condition showed lower IRT ($M=140$ s) then the IRT from the control condition ($M=300$ s) in the IRT FA. In the standard FA dropping behavior was observed in the attention, play, and no interaction condition. However, the demand condition was still clearly differentiated from the play (control) condition. Latency data measured from both the IRT and standard FA showed that the demand condition was differentiated from the control condition.

In summary, all four graphs indicated that the maintaining function of the dropping behavior exhibited by Emily was escape/avoidance of demand. The three time-based graphs depict clearer results when compared with the results generated from the standard FA. The time based FAs (latency and IRT) showed more differentiation (shorter latency and IRT) between the demand and play (control) conditions with fewer responses of dropping behavior (range of 1-2 responses per condition during the latency and IRT FAs compared to 26 responses during the demand condition in the standard FA).
Figure 3

Emily's Standard FA

Emily's Latency From IRT FA
Figure 3. IRT, standard, and latency from IRT and standard analyses graphs indicating correspondence between IRT and standard analyses. Both identifying maintaining function of target behavior of escape from demand.

Figure 4 shows IRT (first panel) and standard (second down) FA results with the latency scores derived from the IRT (third) and standard FA (fourth) for Aaron. In the IRT FA, the demand condition produced lower IRT ($M = 99$ s) from the control condition ($M = 300$ s). However, property destruction also occurred once during the attention ($M = 256.5$ s) and no interaction conditions ($M = 286$ s) during the IRT FA. For the standard FA, based on the above criteria for differentiation, there was no notable differentiation from the play (control) condition when compared with the no interaction, attention, and demand conditions; therefore, the maintaining function of property destruction would be said to be ‘multiply maintained’ (Hagopian et. al., 1997), meaning that results from the standard FA indicated that Aaron’s property destruction may be maintained by a
combination of functions of behavior (i.e., access to attention and escape from demand, automatic reinforcement and escape from demand, etc.). Latency data measured from both the IRT and standard FA showed that the demand condition was differentiated from the control condition.

In summary, escape from demand was identified across three of the four graphs as the maintaining function of Aaron’s property destruction. The two latency graphs (data pulled from the IRT and standard FA) indicated that the demand was clearly differentiated from the play (control) condition in a clearer fashion than the IRT and standard FAs. Thus indicating a clear function with a range of one to two responses required per condition versus a range of seven to fourteen responses required during the standard FA, which produced undifferentiated results.

Figure 4
Figure 4. IRT, standard, and latency from IRT and standard analyses graphs indicating non-correspondence between IRT and standard analyses. IRT identifying maintaining function of target behavior of escape from demand and the standard FA identifying that the target behavior may be maintained by multiple functions.
Chapter 4

DISCUSSION

In summary, agreement between results of the IRT, latency, and standard analyses was observed in three out of the four comparisons. Correspondence between results of the IRT and latency analyses was observed in four out of the four comparisons. Results from the IRT and latency analyses consistently indicated clearer differentiation between the identified maintaining function conditions and the control conditions (for four out of four participants) with less response requirement than the standard FA.

Table 1 (similar to data presented by Thomason et. al., 2011) depicts results of the IRT and standard FA. Agreement between results of the IRT FA and standard FA was observed for three out of the four participants. Two out of the three functional analyses that matched identified escape as the function of the target behaviors and one displayed attention maintained problem behavior. Correspondence was not observed for one participant. For this participant the IRT FA identified a possible escape function; however, results of the standard FA indicated that the target behavior might have been maintained by multiple sources of control. Table 1 also provided comparisons between the number of actual responses emitted per functional analysis (IRT and standard).

Looking only at the three participants whose functions of target behavior matched; the fewest number of responses to complete the IRT FA was eight (for Emily) in comparison to the 31 responses emitted during the standard FA. The largest number of responses needed to complete the IRT FA was fourteen for Ricky, who emitted the lowest number
of responses during the standard FA (22 total). The largest discrepancy between number of responses between the two analyses was Alex. He engaged in the target behavior 10 times during the IRT FA and 37 times during the standard FA. Additionally, Aaron’s IRT FA showed short IRT between first and second responses during the demand condition, which may suggest a possible escape function; however responding during his standard FA showed high rates of responding in all conditions, which may suggest that his property destruction may be maintained by multiple functions. Aaron’s IRT and standard FA were the only analyses that did not match.

Table 1: Comparison of IRT and standard functional analyses.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Function</th>
<th>IRT No. of responses</th>
<th>Function</th>
<th>Standard No. of responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricky</td>
<td>escape</td>
<td>14</td>
<td>escape</td>
<td>22</td>
</tr>
<tr>
<td>Alex</td>
<td>attention</td>
<td>10</td>
<td>attention</td>
<td>37</td>
</tr>
<tr>
<td>Emily</td>
<td>escape</td>
<td>8</td>
<td>escape</td>
<td>31</td>
</tr>
<tr>
<td>Aaron</td>
<td>escape</td>
<td>12</td>
<td>multiply maintained</td>
<td>63</td>
</tr>
</tbody>
</table>

Results of the current study replicate the latency FA study conducted by Thomason-Sassi et. al., (2011) in which the results from nine out of 10 participants showed correspondence between the latency FA and standard FA with a reduced response requirement. Based upon the high degree of agreement between time based and rate based analyses shown in Thomason-Sassi et. al., and the replication of this study with four additional participants, in which there was correspondence between time based and rate based analyses for three out of four participants may indicate that time based
analyses may be beneficial and useful in the assessment of and treatment for problem behaviors. Especially when the problem behaviors are severe and may cause harm to the participant and/or the therapist (i.e., aggression, SIB, and property destruction). By using a time based analysis that requires a maximum of two responses per condition the need for repeated responses in no longer present and limits the potential for harm. In addition, rate based analyses may not be as effective in identifying maintaining functions as time based measures for some problem behaviors such as disrobing, elopement, and physiological responses given that these may occur at low rates limiting the number of responses per condition; therefore, making analysis difficult and time consuming.

The interresponse time functional analysis showed increased response strength (i.e., shorter durations between first and second responses) when compared to the latency FA (longer durations from the start of session to the first response) for two of the four participants. The IRT and standard FAs conducted for Ricky showed that the function of his aggression (i.e., hitting, pinching, biting, and kicking) was social negative reinforcement. Meaning, the demand condition was clearly differentiated from the control (play) condition. The IRT FA showed short IRT between the first and second response during the demand condition and the same with the standard FA resulting in the highest frequency of aggression. Ricky engaged in aggression in the attention condition; however, a social positive reinforcement function was not found in both the IRT and standard FA based on the criterion applied. This suggests that the IRT analysis may be a more sensitive measure of problem behavior when compared to standard response repetition analyses.
The functions for the IRT and standard FAs completed for Ricky demonstrated both the social negative reinforcement function, thus indicating that they correlated. They also indicated shorter IRT and increased rates of aggression during the attention (social positive reinforcement). It is interesting to note that the first attention condition preceding the no interaction condition produced lower interresponse time and higher rates of aggression compared to the subsequent conditions. In this case, the no interaction condition may have served as an establishing operation for the attention condition, thus a possible social positive function (attention) may have also been identified had the analysis been extended and may require further analysis of the attention condition. Additionally, the latency taken from the IRT FA and standard FA also matched by clearly identifying a social negative function (escape from demand).

For Alex, a social positive reinforcement function (attention) was demonstrated in the IRT and standard FAs. In the demand condition Alex demonstrated property destruction during the last session as well as during the last three demand conditions during the standard FA. Property destruction also occurred during the last three control conditions during the standard FA. However, the attention condition continued to be differentiated from the control condition. Thus, the IRT FA yielded much clearer results, which demonstrated the function of access to attention. The latency to the first response during the IRT FA and standard FA matched results of the IRT and standard FAs by identifying access to social positive reinforcement as the function.

The IRT and standard FA identified a social negative function for Emily, thus indicating the functions between the FAs matched. The IRT FA demonstrated clear
differentiation for the demand condition when compared to the no interaction, attention, and control condition. There were no other instances of the dropping behavior except during the demand condition. During the standard FA Emily engaged in dropping behavior during the no interaction, attention, and control conditions for one or more sessions. Although, through visual inspection escape from demand is apparent during the standard FA, results are much clearer when visually inspecting the IRT FA graph (See Figure 3). In addition, the latency taken from the IRT FA and standard FA also matched by clearly identifying a social negative function (escape from demand).

The functions for the IRT FA for Aaron identified a social negative function (escape from demand) and the standard FAs completed suggested that property destruction for Aaron was multiply maintained; therefore, the functions did not seem to match. The IRT FA demonstrated clear differentiation for the demand condition when compared to the no interaction, attention, and control condition. There were instances of property destruction during the attention and no interaction condition, yet the demand condition was still differentiated from the attention and no interaction condition, therefore, the escape from demand function was identified. During the standard FA Aaron engaged in property destruction during all conditions; no interaction, attention, play (control) and demand conditions for one more session. The no interaction condition was differentiated, but the attention condition has a higher data path than the no interaction condition, therefore, the maintaining function of property destruction seem to be multiply maintained. A function-based treatment would ultimately corroborate this hypothesis.
For three out of the four participants the functions identified during the IRT, standard, and latency FAs matched and for four out of four of the participants the IRT and latency analyses matched. Thus, further demonstrating the inverse relationship between rate and time based measurements. This may lend further support for the use of time based measurements to identify functions of problem behaviors to reduce time and resources used to conduct FAs in applied settings (i.e., in-home therapy, school, group living facilities, etc.). Future research in this area should continue to compare time versus rate measurements for instances of problem behavior.

Results of the IRT FA, standard FA, and latency measurements taken from both analyses produced similar interpretations of the data. The time based analyses identified identical functions to the rate based analyses; which supports the notion that there is an inverse relationship between time and rate (Cooper et. al., 2007). Also, that it is possible to identify functions of behavior without requiring multiple responses of problem behavior (Thomason-Sassi et. al., 2011); thus limiting potential for harm to the participants or therapists (i.e., aggression, property destruction, and/or SIB), decreasing resources required in order to conduct FAs in applied settings, and limiting the participants exposure to programed reinforcement contingencies. However, IRT may be a more salient time-based measurement to use rather than latency because the participant contacts the contingency once prior to the IRT being measured. Thus, in theory, would suggest that the IRT FA can rely less on discriminative stimuli associated with each condition to assist in discrimination and more upon the first consequence they contact.
Moreover, further analysis of brief FAs compared to time based (IRT and latency FAs) may be beneficial to identify methods of selecting a time based or rate based FA methodology in applied settings (i.e., based on topography of target behavior, environmental constraints, reported rate of occurrence, etc.).

**Limitations**

Limitations of the current study include, first, the lack of comparison between 5 min conditions across IRT and rate based FAs (i.e., traditional brief FA methodologies, Northup et al., 1991). By not keeping the duration of the sessions consistent across functional analyses (5 min for all IRT sessions and 10 min for all standard FAs) the participant may have been more sensitive to the consequences during the conditions during the standard FA lasting 10 min due to repeated exposure to the programmed contingencies. However, the reason for conducting 10 min FAs in the current study was to ensure that the standard FA would identify the true function of behavior, especially when being compared with the other newer functional analysis methodologies. Comparison between all current functional analysis methodologies (e.g., standard, brief, IRT, latency, low-rate, precursor, etc.) would benefit future literature.

Second, the absence of additional discriminative stimuli during the attention condition (needed in order to provided maximum discriminability between conditions) may have decreased the participant’s ability to discriminate between the attention and no interaction. By adding additional stimuli to the attention condition there may be increased discrimination, which may produce more clear results more rapidly. A third limitation of the current study may be the use of a no interaction condition instead of alone condition.
This may have inadvertently provided social contingencies during the no interaction condition, which may have led to false positive identification of functions of target behaviors.

Finally, the lack of participants demonstrating target behaviors maintained by automatic reinforcement may have limited the current findings of the study only to those behaviors maintained by social contingencies (i.e., escape from demand and access to attention). Therefore, evaluating the use of time-based analyses on all possible functions of behavior could benefit future research.

In summary, to control for these limitations future research should run 5 min sessions for both time based (IRT or latency) and rate (brief FA) functional analyses. Additional discriminative stimuli should be added within the attention condition when the environment does not allow for an alone condition and may also assist in quicker discrimination between conditions for the participant and may also reduce the effects of using the fixed order functional analyses and when possible, having a true ‘alone’ condition versus a no interaction condition should be further evaluated.

**Future Research**

It is possible that for topographies of behavior that are potentially harmful to the participant or the therapist a time based analysis may limit the frequency of the target behaviors since the participant’s rate of responding can be limited to a maximum of three responses per condition. In future research, brief FAs (in which all conditions do not exceed 5 min in duration) should be compared to IRT FAs (5 min conditions) in order to further support the relationship between rate and time and support the use of FAs in
applied settings by limiting the resources (in the form of time needed to conduct the analyses) required to conduct a standard FA.

Further research in which descriptive analysis data indicates a possible automatic function of behavior should also be conducted to thoroughly assesses this function of behavior. Additionally, adding a more salient visual stimulus (i.e., different treatment room or rearrangement of furniture) to the attention condition when the environment does not allow for a ‘true’ alone condition (i.e., no access to a two way mirror or video monitoring system) would increase treatment integrity across FAs.

Additionally, further assessment and development of social validity measures for time based FAs would be beneficial to future research of time based FA methodology. Perhaps presenting clinicians with videos of IRT and latency FA sessions and having them rank the likelihood of the clinicians conducting either FA within their practice would provide further analysis of social validity of time based FA. Clinician preference could then be determined and further support the use of time based FAs in the clinical settings.

Much of the criticism of functional analysis methodology is that the analysis is too time consuming (Wallace, Kenzer, & Penrod, 2004) and requires multiple responses of potentially harmful behavior which may be dangerous to the participant and/or therapist (Thomason et. al., 2011). Therefore, time consuming and potentially dangerous (in the case of severe aggression, property destruction, or SIB) methods of conducting functional analyses could be avoided by using a systematic time based analysis, which is uncomplicated with multiple responses of target behaviors. Then practitioners in applied
settings may be more likely to use functional analysis methodology rather than looking to
time consuming methods of collecting narrative forms of data, caregiver (indirect) report,
or on results of descriptive assessments which can often be subjective in nature and often
lead to ambiguous functions of problem behavior.
References


