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An Application of the Trial-Based Functional Analysis to Assess Problem Behavior Evoked by Ritual Interruption

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by

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DEDICATION

I dedicate this manuscript to my grandpa, James Calderone. Thank you for supporting my academic goals and always attending every holiday dinner with cannolis in hand.

I would also like to dedicate this manuscript to my parents, Mark and Debbie Weyman. My parents have been my role models and greatest supporters since day one. I would not have been able to reach this goal without your unconditional love and endless support!

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ABSTRACT

Higher-order restricted and repetitive behavior includes a rigid adherence to routines and schedules or insistence on sameness or completeness. Some individuals with autism spectrum disorder engage in problem behavior when these higher-order rituals are interrupted. Modifying the trial-based functional analysis to assess problem behavior evoked by the interruption of higher-order rituals might allow therapists and teachers with limited resources to assess this function of problem behavior. In addition, it may mitigate some of the risks associated with the traditional functional analysis. Thus, the first purpose of the current study was to evaluate the use of the trial-based functional analysis to assess problem behavior associated with ritual interruption. After identifying the function of problem behavior, one empirically-validated treatment is functional communication training. However, it is important to thin the schedule of reinforcement for functional communication responses following functional communication training because it is impractical and sometimes impossible to reinforce every functional communication response. Thus, the second purpose of the current study was to evaluate if a multiple schedule is an effective way to decrease the schedule of reinforcement rapidly while maintaining low levels of problem behavior. We found that the trial-based FA correctly identified the presence or absence of a rituals function of problem behavior in all five subjects. In addition, the multiple schedule was effective with all four of our subjects that had a rituals function.

CHAPTER ONE:

AUTISM SPECTRUM DISORDER

Diagnosis

An estimated 1 in 59 children in the United States of America are diagnosed with an autism spectrum disorder (ASD; Baio et al., 2018). ASD is a neurodevelopmental disorder characterized by deficits in social skills and communication as well as restricted and repetitive behavior (RRB; American Psychiatric Association, 2013). Social skill and communication deficits include having difficulties initiating and maintaining social interactions, nonverbal communication, and adapting to various social situations (American Psychiatric Association). RRB include stereotypy, rigid adherence to routines or schedules, highly restricted interests, and abnormal reactions to sensory stimulating environments (American Psychiatric Association).

RRB can be organized into two categories: lower order and higher order (Boyd, McDonough, & Bodfish, 2012; Szatmari et al., 2006; Turner, 1999). Lower-order RRB are simple forms of ritualistic behavior such as vocal and motor stereotypy, whereas higher-order RRB are more complex ritualistic behavior such as a rigid adherence to routines or schedules and insistence on sameness (Boyd et al.; Turner).

Functional Behavior Assessments

Individuals with ASD are more likely to engage in problem behavior than those who are not diagnosed with ASD (McClintock, Hall, & Oliver, 2003). It is estimated that 27.7% and 25% of individuals with ASD engage in self-injurious behavior and aggression, respectively (Hill et al., 2014; Soke et al., 2016).

Functional behavior assessments are used to identify the function of an individual's problem behavior. Previous research has shown that function-based treatments are more effective than treatments that do not match the function of problem behavior (e.g., Richman, Wacker, Asmus, & Casey, 1998). Thus, it is important to identify the function of problem behavior via a functional behavior assessment before treatment development.

There are three approaches to functional behavior assessments: indirect assessments, descriptive analyses, and functional analyses (Iwata & Dozier, 2009). Indirect assessments involve gathering information about the problem behavior via verbal report from the child's caregivers and teachers. Some examples of indirect assessments include the Functional Assessment Interview (O'Neill et al., 1997), the Functional Analysis Screening Tool (Iwata, DeLeon, & Roscoe, 2013), and Questions About Behavioral Function (Paclawskyj, Matson, Rush, Smalls, & Vollmer, 2000). Unfortunately, previous research suggests that at least some indirect assessments have poor reliability and validity (e.g., Iwata et al.; Zarcone et al.). Nonetheless, indirect assessments can be used to collect information about the individual before conducting descriptive and functional analyses.

Descriptive analyses involve observing and collecting data on the individual in the natural environment (Bijou, Peterson, & Ault, 1968). For example, an experimenter may collect data on antecedents to and consequences for problem behavior in the natural environment and

calculate conditional probabilities of problem behavior given specific antecedents and consequences. However, it is important to note that the original purpose of the descriptive analysis was not to identify the function of problem behavior (Bijou et al.). In addition, research suggests that there is poor correspondence between descriptive analyses and functional analyses (e.g., Camp, Iwata, Hammond, & Bloom, 2009). Thus, descriptive analyses alone are not a recommended method of identifying the function of problem behavior.

Functional analyses involve systematically setting up different environmental conditions by manipulating antecedents and consequences for problem behavior and measuring the rate of problem behavior during each condition (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982/1994). The functional analysis is an effective method of identifying the environmental variables that maintain an individual's problem behavior. The typical conditions are play, attention, alone or ignore, escape, and tangible. The play condition serves as the control condition. During the play condition, the subject has access to highly-preferred toys, the experimenter provides attention, and no demands are placed on the subject. There are no programmed consequences for problem behavior. During the attention condition, the subject has access to a moderately-preferred toy and the experimenter ignores the subject while pretending to be busy reading. Contingent on problem behavior, the experimenter provides a statement of concern (e.g., "Don't do that, you'll hurt yourself!"). The purpose of the attention condition is to determine if problem behavior is maintained by social positive reinforcement in the form of attention. During the alone condition, the subject does not have access to any materials and the experimenter is not present. The ignore condition is identical to the alone condition, except, an experimenter is present, and all problem behavior is ignored. A behavior analyst may choose to use an ignore condition instead of an alone condition if they do not have access to a room with a

one-way window. The purpose of the alone or ignore condition is to determine if problem behavior is maintained by automatic reinforcement. During the escape condition, the experimenter provides demands continuously and contingent on problem behavior, the subject is given a 30-s break and all task materials are removed. The purpose of the escape condition is to determine if problem behavior is maintained by social negative reinforcement in the form of escape from demands. Prior to the initiation of a tangible condition, a subject is given 2-min access to a highly-preferred toy. During the tangible condition, the experimenter removes the toy and contingent on problem behavior, the subject is given access to the toy for 30 s. The purpose of the tangible condition is to determine if problem behavior is maintained by social positive reinforcement in the form of access to tangible items.

In order to identify the behavioral function, we compare the rate of problem behavior during each test condition (i.e., attention, alone, escape, tangible) to the control condition (Thompson & Iwata, 2005). That is, if an individual engages in a higher rate of problem behavior during one of the test conditions relative to the control condition, this suggests the behavioral function. For example, an attention function is identified if an individual engages in a high rate of problem behavior during the attention condition and little or no problem behavior during the play condition. After identifying an attention function, we can now decrease problem behavior by weakening the relationship between problem behavior and attention or teaching the individual to engage in an alternative response to gain access to attention.

Prior to the development of the functional analysis, behavior analysts often relied on default technologies, such as arbitrary punishment-based contingencies, to decrease problem behavior (Mace, 1994). With the development of the functional analysis, we now have the ability to make informed treatment decisions based on the variables that reinforce problem behavior.

Restricted and Repetitive Behavior

RRB can severely interfere with the daily lives of children with an ASD and their families. They are correlated with caregiver stress (Gabriels, Cuccaro, Hill, Ivers, & Goldson, 2005), may hinder skill acquisition (e.g., Koegel & Covert, 1972), and may evoke severe problem behavior when RRB are interrupted (e.g., Hausman, Kahng, Farrell, & Mongeon, 2009; Kuhn, Hardesty, & Sweeney, 2009).

Previous researchers have assessed the function of lower-order RRB (e.g., Ahearn, Clark, McDonald, & In Chung, 2007; Kennedy, Meyer, Knowles, & Shukla, 2000; Love, Miguel, Fernand, & LaBrie, 2012; Sprague, Holland, & Thomas, 1997). In addition, several treatments, such as noncontingent reinforcement (e.g., Britton, Carr, Heidi, Landaburu, & Kimberlee, 2002; Love et al.; Sprague et al.), response interruption and redirection (e.g., Ahearn et al.; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Cassella, Sidener, Sidener, & Progar, 2011; Love et al., 2012; Saini, Gregory, Uran, & Fantetti, 2015), and functional communication training (e.g., Kennedy et al.) have been effective for lower-order RRB. Although there is extensive research on the assessment and treatment of lower-order RRB, there is limited research on higher-order RRB (Boyd et al., 2012).

Conclusion

Although there is extensive research on lower-order RRB, due to the complexity of higher-order RRB, we may have to develop different assessment and treatment approaches to treat this behavior. Thus, behavior analysts should evaluate different ways to conduct functional analyses of higher-order RRB in order to develop successful, less intrusive treatments.

CHAPTER TWO:

RITUALS

Functional Analysis of Rituals

Some researchers have assessed the functions of higher-order RRB. For example, Rodriguez, Thompson, Schlichenmeyer, and Stocco (2012) conducted functional analyses (FAs) of rituals with three individuals with developmental disabilities. The ritual for each participant was arranging and ordering (e.g., placing objects in the same location repeatedly, placing items in a particular pattern, placing furniture in a particular layout). The conditions were similar to those described by Iwata et al. (1982/1994). However, the objects or furniture used to complete the rituals were moved to different locations prior to each session during each condition. The conditions included were attention, escape, no interaction, and control. During the attention condition, the experimenter pretended to be busy reading a magazine and contingent on the ritualistic behavior, the experimenter provided a statement related to the ritual (e.g., "Leave it"). During the escape condition, the experimenter used three-step prompting to guide the subject to complete several tasks and contingent on the ritualistic behavior, the experimenter removed the tasks and provided a 30-s break. During the no interaction condition, the experimenter did not interact with the subject and there were no programmed consequences for ritualistic behavior. During the control condition, the experimenter allowed access to preferred items, delivered attention, and did not present demands. In addition, there were no programmed consequences for

ritualistic behavior. The experimenters observed a high rate of problem behavior across all conditions for two participants, suggesting their ritualistic behavior was maintained by automatic reinforcement. In addition, the experimenters observed a high rate of problem behavior during the ignore and escape conditions and a low rate of problem behavior during the play and attention conditions for one participant, suggesting that the ritualistic behavior was maintained by automatic reinforcement and escape from demands.

Although the FA for the second participant suggested an escape function, the experimenters conducted an additional escape analysis to confirm the escape function. During the escape analysis, two conditions were compared: response blocking and response blocking plus escape. During the response blocking condition, the experimenter physically blocked the participant from engaging in the ritual. During the response blocking plus escape condition, the experimenter continually provided demands and blocked the participant from engaging in the ritual and contingent on an attempt to complete the ritual, the experimenter provided a 30-s break. The experimenters observed low rates of the target behavior in both conditions suggesting that the ritualistic behavior was maintained by automatic reinforcement alone because responding did not maintain when escape was provided.

Rodriguez et al. (2012) also conducted an analysis to identify the specific automatic reinforcers maintaining one of their participant's rituals. Specifically, the experimenters were evaluating if the reinforcer was physically moving the furniture or having the furniture in her preferred location. During this evaluation, two conditions were compared: original arrangement and preferred item placement. During the original arrangement condition, the furniture was moved to different locations. During the preferred item placement condition, the furniture was placed in the participant's preferred layout. Consequences were not provided for ritualistic

behavior (i.e., arranging furniture) during either condition. The experimenters observed low rates of the ritual during the preferred product placement condition relative to the original arrangement condition, suggesting that the rituals were maintained by the final placement of the furniture rather than by the physical movement of the furniture.

Chok and Koesler (2014) conducted an FA of ritualistic behavior with a 14-year-old male diagnosed with ASD and an intellectual disability. The participant's ritual was cleaning and ordering. Cleaning and ordering was defined as placing items in a specific arrangement, wiping down surfaces, and placing items in containers. The FA procedures were similar to those described by Iwata et al. (1982/1994). However, salt was sprinkled on a table in the session room prior to each session during each condition. The conditions included were attention, escape, alone, and play (i.e., control). The participant engaged in high levels of the ritualistic behavior across all conditions, suggesting that the ritualistic behavior was maintained by automatic reinforcement. After the standard FA, the experimenters conducted a series of alone sessions. Cleaning and ordering maintained at a high level, further suggesting that ritualistic behavior was maintained by automatic reinforcement.

Treatment of Rituals

Previous researchers have used sensory extinction (e.g., Rincover, Newson, & Carr, 1979), competing items (e.g., Rodriguez, Thompson, Schlichenmeyer, & Stocco, 2012; Sigafoos, Green, Payne, O'Reilly, & Lancioni, 2009), and exposure plus response prevention (e.g., Boyd, Woodard, & Bodfish, 2011; Chok & Koesler, 2014; Lehmkul, Storch, Bodfish, & Geffken, 2008; Reaven & Hepburn, 2003) to reduce the rate of higher-order RRB in individuals with ASD.

Sensory Extinction

Sensory extinction involves eliminating the sensory consequences of a behavior (Rincover, 1978). Sensory extinction is an effective treatment for behavior maintained by automatic reinforcement (Rincover). Some research suggests that it is effective in decreasing ritualistic behavior. For example, Rincover, Newsom, and Carr (1979) evaluated the effects of sensory extinction on ritualistic light switching in two children with developmental disabilities. During the evaluation, two or three conditions were compared for each participant. The conditions included were baseline, visual sensory extinction, and auditory sensory extinction. During baseline, the participants had the opportunity to engage in light switching and the switch produced both visual (i.e., the light turned on and off) and auditory (i.e., clicking sound) stimulation. During the visual sensory extinction condition, light switching did not result in visual simulation (i.e., the switch was rewired so it did not produce light). During the auditory extinction condition, the light switch was padded so it could not produce an auditory stimulation. The experimenters observed a higher rate of light switching in baseline relative to the visual sensory extinction condition for one participant, and a higher rate of light switching during baseline and the visual sensory condition relative to the auditory sensory extinction condition for the second participant. These results suggest that sensory extinction is an effective treatment for ritualistic behavior.

Competing Stimuli

Competing stimulus assessments (CSAs) are used to identify items associated with a high level of engagement and a low level of problem behavior (Piazza, Adelinis, Hanley, Goh, & Delia, 2000). Competing stimuli are one treatment for automatically maintained problem

behavior (Jennet, Jann, & Hagopian, 2011). Some research suggests that competing stimuli combined with other treatment components can be used to decrease ritualistic behavior. For example, Rodriguez et al. (2012; described above), evaluated the effects of competing items on the ritualistic behavior maintained by automatic reinforcement for each of the three participants. Prior to this evaluation, three items associated with a high level of engagement and a low level of problem behavior were identified via a CSA for each participant. During the treatment evaluation, initially two conditions were compared: baseline and matched items. During the baseline condition, procedures were similar to those described in the no interaction condition of the FA. During the matched items condition, the subjects were allowed access to the three items identified in the CSA. The experimenters found that providing competing stimuli alone was not effective for any of the subjects. Therefore, the experimenters evaluated the effects of competing stimuli combined with additional procedures (e.g., prompts, response blocking) to decrease ritualistic behavior. Competing stimuli combined with other treatment components decreased ritualistic behavior to near zero rates for each subject. Thus, the results suggest that prompting individuals to engage in an alternative behavior and response blocking are effective treatments for automatically maintained ritualistic behavior.

Sigafoos, Green, Payne, O'Reilly, and Lancioni (2009) evaluated the effects of competing items on ritualistic behavior. The participant was a 15-year-old male with ASD and an intellectual disability who arranged and ordered objects on his desk. The evaluation consisted of three conditions: baseline, choice, and choice plus social interaction. During all conditions, objects the participant typically arranged (e.g., pencil, paper) were placed on his desk. During baseline, no treatment contingencies were provided. During the choice condition, the experimenter provided the participant with a choice between two preferred items. These items

were different than those the participant typically arranged. During the choice plus social interaction condition, the experimenter provided the participant with a choice between two preferred items and engaged with the participant throughout the session (i.e., provided comments and made gestures related to the preferred items). The experimenters initially observed a high and variable rate of responding during the choice condition; however, near zero rates of arranging and ordering were observed toward the end of the condition. The data suggest that the choice condition may have been effective; however, a replication would have been necessary to confirm that choice alone was effective. In addition, it is unclear if access to preferred items or the opportunity to make a choice was the cause of the behavior change. The experimenters then observed near zero rates of arranging and ordering during the choice plus social interaction condition. These results suggest that access to preferred items and attention decreased ritualistic behavior. Together, these studies suggest that competing items combined with other treatment components (e.g., prompts, response blocking) are an effective treatment for higher-order RRB.

Exposure and Response Prevention

Exposure and response prevention (ERP) is a treatment for symptoms of obsessive-compulsive disorder such as ritualistic behavior (Foa, Stekette, Grayson, Turner, & Latimer, 1984). This treatment typically involves exposing an individual to stimuli that evoke anxiety and preventing the individual from engaging in ritualistic behavior related to the anxiety (Abramowitz, 1996). Anxiety can be defined as emotional effects that occur when a period of time elapses before the presentation of an aversive stimulus (Skinner, 1953). Although ERP is commonly used to treat symptoms of obsessive-compulsive disorder, previous research has also shown that it can be used to decrease rituals in children with ASD. For example, Chok and

Koeler (2014) included a treatment evaluation in which they assessed the effects of ERP on the automatically-maintained table wiping. Specifically, the experimenters compared two conditions: baseline and ERP. Prior to each session of this evaluation, salt was sprinkled on the table. During baseline, there were no programmed consequences for wiping. During the ERP condition, the subject was blocked from wiping and the subject was prompted to attend to the stimulus that typically evoked wiping (i.e., salt sprinkled on the table). The experimenters observed a decrease in ritualistic behavior during the ERP condition relative to baseline. However, the experimenters observed a high rate of out of seat behavior during the ERP condition. Therefore, the experimenters placed Plexiglass over the salt sprinkled on the table and contingent on out of seat behavior, the experimenter placed a sheet of paper, that permanently had salt attached to it, in front of the subject. Specifically, the sheet of paper was covered in salt and then laminated. The subject continued to engage in a low rate of ritualistic behavior and the Plexiglass was later removed. This study suggests that ERP is an effective treatment for children with ASD who engage in ritualistic behavior.

Conclusion

Previous research on higher-order RRB suggests that they are automatically maintained. Some potential treatments for reducing RRB include sensory extinction and ERP. Sometimes the RRB itself is not problematic but other problem behavior (e.g., aggression, self-injury, tantrums) occur when rituals are interrupted. Thus, behavior analysts should evaluate different ways of adapting the FA to identify this function of problem behavior. Identifying that an individual engages in problem behavior when rituals are interrupted will help them develop effective, function-based treatments.

CHAPTER THREE:

PROBLEM BEHAVIOR ASSOCIATED WITH RITUALS

Functional Analysis of Problem Behavior Associated with Rituals

Some individuals engage in problem behavior when their ritual is interrupted. Previous researchers have conducted FAs of problem behavior associated with ritual interruption (e.g., Hausman et al., 2009, Kuhn et al., 2009; Leon, Lazarchick, Rooker, & DeLeon, 2013; Murphy, MacDonald, Hall, & Oliver, 2000; Ollington, Green, O'Reilly, Lancioni, & Didden, 2012; Phillips, Weyman, & Kim, 2016; Rispoli, Camargo, Machalicek, Lang, & Sigafoos, 2014). Murphy, MacDonald, Hall, and Oliver (2000) conducted an FA of aggression associated with a specific ritual (i.e., flushing paper down the toilet) in a 38-year-old woman with ASD and an intellectual disability. Four conditions were evaluated: flushable paper not stopped, flushable paper stopped, unflushable polystyrene not stopped, and unflushable polystyrene stopped. At the start of each condition, the participant was given a piece of paper or polystyrene. During the flushable paper not stopped condition, the participant was allowed to flush the paper down the toilet. During the flushable paper stopped condition, the participant was blocked from flushing the paper down the toilet and was prompted to place the paper in a bin. During the unflushable polystyrene not stopped condition, the participant was allowed to flush the polystyrene; however, polystyrene is difficult to flush down the toilet. During the unflushable polystyrene stopped condition, the participant was blocked from flushing the paper down the toilet and was prompted to place the paper in a bin. The experimenters observed a higher rate of aggression (i.e., hitting)

in the flushable paper stopped condition relative to the other conditions, suggesting that aggression may be maintained by access to rituals.

Kuhn, Hardesty, and Sweeney (2009) conducted an FA of problem behavior (i.e., aggression and destruction) associated with a ritual (i.e., placing items in a trash can) in a 16-year-old with ASD and an intellectual disability. Two conditions were evaluated: contingent access to straightening and noncontingent access to straightening. Throughout all conditions, ten items (i.e., trash and nontrash items) were placed in the session room. During the contingent access to straightening condition, the experimenter blocked the participant from placing items in the trashcan. Contingent on problem behavior, the participant was allowed to throw away one item. During the noncontingent access to straightening condition, the participant was allowed to place items in the trash. The experimenters observed a higher rate of problem behavior during the contingent access to straightening condition relative to the noncontingent access to straightening condition, suggesting that problem behavior was maintained by access to placing items in the trash.

Hausman, Kahng, Farrell, and Mongeon (2009) also conducted an FA of problem behavior (i.e., self-injurious behavior, aggression, and property destruction) associated with ritualistic behavior (i.e., opening and closing doors) in a 9-year-old with ASD and an intellectual disability. Two conditions were evaluated: test and control. All sessions were 10 min. Before each condition, the participant had 2-min pre-session access to her ritual. During the test condition, the experimenter repositioned the door every 30 s. Contingent on problem behavior, the experimenter allowed the participant to engage in her ritual for 30 s. During the control condition, the experimenter did not reposition the door. The experimenters observed a higher rate

of problem behavior during the test condition relative to the control condition, suggesting that problem behavior was maintained by access to rituals.

Similarly, Leon, Lazarchick, Rooker, and DeLeon (2013) conducted an FA with a 9-year-old with ASD who was reported to engage in problem behavior (i.e., self-injurious behavior, aggression, and disruptions) when her ritual (i.e., arranging items in a row) was interrupted. During the FA, two conditions were evaluated: control and test. All sessions were 10 min. Before each condition, the participant had 2-min pre-session access to her ritual. During the control condition, the experimenter lifted an item and placed it back in the same location every 60 s and the participant was allowed to reposition the items. During the test condition, the experimenter lifted an item and placed it in a different location every 60 s and blocked the participant from repositioning the item. Contingent on problem behavior, the experimenter allowed the participant to engage in her ritual for 30 s. The experimenters observed a higher rate of problem behavior in the test condition relative to the control condition, suggesting that problem behavior was maintained by access to rituals.

Finally, Rispoli, Camargo, Machalicek, Lang, and Sigafoos (2014) conducted an FA for three children with developmental disabilities. For participant 1, the FA consisted of five conditions: attention, play, tangible, escape, and access to rituals. For participants 2 and 3, only two conditions were evaluated: play and access to rituals. The attention, play, and escape conditions were similar to those described by Iwata et al. (1982/1994). All sessions were 5 min. Prior to the access to rituals condition, the participants were allowed access to their ritual. The rituals included were engaging in restricted activities (participants 1 and 2), placing items in a specific arrangement (participants 2 and 3), and following a specific schedule (participant 3). At the start of the access to rituals condition, the experimenter interrupted the ritual. Contingent on

problem behavior (e.g., crying, screaming), the experimenter restored the ritual for 10 s. All participants engaged in a higher rate of problem behavior in the access to rituals condition relative to the play condition, suggesting that problem behavior was maintained by access to rituals.

Although previous researchers have modified the FA to evaluate problem behavior associated with rituals, most of the FAs involved measuring the rate of problem behavior within each condition. One notable exception used the latency to problem behavior as the dependent variable. Phillips, Weyman, and Kim (2016) conducted a modification of a latency FA to assess problem behavior associated with rituals that involved adhering to a specific schedule with one individual with ASD and intellectual disabilities. A latency FA was used because the time-based rituals occurred at one specific time each day, therefore, the rituals could only be interrupted once per day. Initially, four rituals were created (e.g., snack was provided at a specific time, an iPad was provided at a specific time). During the control condition, the subject was allowed to engage in his ritual as scheduled. During the test condition, the subject was told that he could not engage in his ritual (e.g., "We are not going to have snack time right now"). Contingent on problem behavior, the subject was allowed to engage in his ritual for the remainder of the session. Problem behavior occurred in most of the test conditions and did not occur during the control conditions. These results suggest that problem behavior was maintained by the interruption of rituals involved with adhering to a specific schedule.

Together, these studies suggest that that different types of FAs can be adapted to target problem behavior maintained by access to rituals. Another FA format that may be beneficial in assessing problem behavior evoked by ritual interruption is the trial-based FA (Bloom, Iwata, Fritz, Roscoe, & Carreau, 2011). The trial-based FA allows an experimenter to embed trials

within the subject's natural environment. There are typically four trials: attention, escape, ignore, and tangible. A trial is divided into two 2-min segments: control and test. The exception is the ignore trial that includes two 2-min test segments. During the control segment of the attention trial, the subject has access to a moderately-preferred toy and the experimenter delivers attention to the subject. After 2 min or the first instance of the target behavior, the test segment begins. At the start of the test segment, the experimenter states, "I'm going to be busy" and removes their attention. Contingent on an instance of problem behavior, the experimenter provides a statement of concern and the trial ends. If the subject does not engage in problem behavior, the test segment ends after 2 min. During the control segment of the escape trial, the subject does not have access to toys and the experimenter remains close to the subject but does not deliver demands. After 2 min or the first instance of problem behavior, the test segment begins. During the test segment, the experimenter continuously provides demands and contingent on problem behavior, the experimenter stops providing demands and removes the task materials. If the subject does not engage in problem behavior, the test segment ends after 2 min. During both test segments of the ignore trial, the experimenter remains in the room with the subject but does not provide attention. The ignore trial ends after 4 min (two 2-min segments). During the control segment of the tangible trial, the subject has access to a high-preferred item. After 2 min or the first instance of problem behavior, the test segment begins. At the start of the test segment, the experimenter removes the toy from the subject. Contingent on problem behavior, the experimenter provides access to the toy. If the subject does not engage in problem behavior, the test segment will end after 2 min.

There may be several benefits of using the trial-based FA to assess problem behavior associated with rituals. First, behavior analysts do not always have the resources (i.e., controlled

setting, time availability) to conduct traditional FAs. Thus, the trial-based FA may be a more practical option because it does not require the experimenter to allocate private space and time outside of the typical environment. In addition, some rituals may only occur in specific environments. For example, an individual may engage in a ritual in which they follow the same hallways to and from certain locations. Attempting to evaluate problem behavior associated with this ritual is not possible in the context of a traditional FA. Thus, embedding trials within the subject's natural environment would allow behavior analysts to evaluate this function of problem behavior. Third, the trial-based FA would be beneficial for rituals that only occur once per day. For example, an individual may expect to follow a certain schedule at specific times (e.g., playground at 10 am, math at 11 am, and art at 12 pm). If this individual is reported to engage in problem behavior when their schedule is not adhered to, it would be difficult to implement the contingencies repeatedly throughout a 10-min session. In this case, the expectation or ritual associated with the playground only occurs once per day. Thus, we can only interrupt the ritual once per day. The trial-based FA would allow us to evaluate problem behavior associated with these types of rituals because the trials can be conducted in the subject's natural environment when the ritual typically occurs. Finally, the trial-based FA mitigates some risks associated with conducting the traditional FA because a segment during the trial-based FA is terminated after one instance of problem behavior. This FA variation reduces the opportunity for the individual to engage in problem behavior.

Treatment of Problem Behavior Evoked by Ritual Interruption

Previous researchers have used functional communication training (FCT) (e.g., Hausman et al., 2009; Leon et al., 2013; Kuhn et al., 2009; Rispoli et al., 2014) and visual schedules (e.g., Phillips et al., 2016) to decrease problem behavior evoked by ritual interruption.

Functional Communication Training

FCT (Carr & Durand, 1985) is the most common treatment for socially mediated problem behavior (Hagopian, Boelter, & Jarmolowicz, 2011). This procedure typically involves teaching an individual a functional communicative response (FCR) to gain access to their functional reinforcer, while placing problem behavior on extinction (Tiger, Hanley, & Bruzek, 2008). Some researchers have used FCT to reduce problem behavior maintained by access to rituals. For example, Kuhn et al. (2009) used FCT to decrease problem behavior evoked by ritual interruption (i.e., preventing the subject from placing items in a trash can). The experimenters taught the subject to state, "Is this trash?" to identify if he was allowed to place the item in the trash or not. During this treatment evaluation, if the experimenter stated, "yes," the participant was allowed to throw away the item. If the experimenter stated, "no," the participant was not allowed to throw away the item, the experimenter blocked any attempts at placing the item in the trash, and problem behavior was placed on extinction. The ratio of trash to nontrash items was slowly increased across sessions. The experimenters observed a decrease in problem behavior during FCT relative to baseline.

Hausman et al. (2009) also used FCT to decrease problem behavior maintained by access to rituals. Specifically, the experimenters taught the participant to state, "My way please" to gain access to her ritual while placing problem behavior on extinction. During FCT, the

experimenters observed low rates of problem behavior and a high rate of FCRs. Similarly, Leon et al. (2013) taught their participant to state, "Laura's way" to gain access to her ritual while placing problem behavior on extinction. During FCT, there was a decrease in problem behavior and an increase in FCRs. Together these studies suggest that FCT is an effective treatment for problem behavior maintained by access to rituals.

Although FCT has been shown to reduce problem behavior evoked by ritual interruption, it may result in the participant engaging in a high rate of the communicative response. Reinforcing appropriate communication on a continuous schedule may be impractical or impossible for caregivers to implement. Therefore, Rispoli et al. (2014) extended previous research on problem behavior evoked by ritual interruption by implementing FCT and then thinning the schedule of reinforcement with the three participants who engaged in problem behavior evoked by ritual interruption. First, the experimenters taught each participant to engage in an FCR to stop the experimenter from interrupting their ritual while implementing extinction for problem behavior. The experimenters observed a decrease in problem behavior and an increase in FCRs during FCT plus extinction relative to baseline. The experimenters then thinned the schedule of reinforcement using a timer and "no" sign. During this condition, the experimenter informed the participant that they could engage in the FCR after the timer sounded. The experimenter then set the timer to the specified time, placed a card that signaled "no" near the participant, and continued to interrupt the ritual until the timer sounded. After the timer sounded, the experimenter prompted the participant to engage in the FCR. Contingent on an FCR, the ritual was restored for 30 s. The duration of time the participant was required to wait was increased gradually across sessions. The experimenters observed low rates of problem behavior during FCT plus extinction plus schedule thinning for all participants. The participants

were effectively taught to tolerate a 1-min (Participant 1 and 2) or a 2-min delay (Participant 3) for each of their rituals. However, it is important to note that all subjects had access to toys throughout FCT plus extinction and the scheduling thinning phase. Given that playing with toys may compete with problem behavior, it is unknown which treatment component (i.e., toys or the timer plus a "no" sign) was responsible for the reduction in problem behavior.

Together, these studies suggest that FCT can be used to decrease problem behavior evoked by ritual interruption. However, only one study attempted to thin the schedule of reinforcement for FCRs following FCT. Specifically, Rispoli et al. (2014) used a timer and a "no" sign to teach their participants to tolerate a delay of 1- or 2-min to their ritual. Another potential way to thin the schedule of reinforcement is to use a multiple schedule with two stimuli, one signaling reinforcement and the other signaling extinction. For example, Hanley, Iwata, and Thompson (2001) evaluated the effects of using a multiple schedule to decrease the rate of FCRs following FCT in three individuals with developmental disabilities. During the multiple schedule condition, the experimenters alternated between two stimuli throughout each session, one stimulus associated with reinforcement and the other stimulus associated with extinction. In addition, the experimenters slowly increased the amount of time the stimulus associated with extinction was present across sessions. The experimenters found that using two separate discriminative stimuli was effective in thinning the schedule of reinforcement to 4 min of extinction and 1 min of reinforcement.

Although Rispoli et al. (2014) demonstrated that using a timer and a "no" sign is effective in thinning the schedule of reinforcement to 1 or 2 min, using a multiple schedule may be a more effective method for thinning the schedule of reinforcement following FCT. Specifically, it may be beneficial to have a continuous stimulus signaling reinforcement is available rather than

having the sound of a timer signal that reinforcement is available. It is possible that having a continuous stimulus present may be more salient than having the timer go off once at the beginning of the reinforcement period. In addition, using a multiple schedule may allow the experimenter to thin the schedule more rapidly while maintaining low levels of problem behavior. It may also allow the experimenter to teach an individual to tolerate waiting more than 2 min to gain access to their ritual.

Visual Schedules

Visual schedules are commonly used with children who have problem behavior during transitions (Waters, Lerman, & Hovanetx, 2009). Some research suggests that using a visual schedule is an effective treatment for problem behavior maintained by access to schedule-based rituals. For example, Phillips et al. (2016) evaluated the effects of a treatment consisting of a visual schedule and a response cost on the rate of problem behavior maintained by access to rituals. Throughout this evaluation, data were collected on the latency of problem behavior. During the treatment evaluation, two conditions were evaluated: control and test. During the control condition, the subject was allowed to engage in his ritual as scheduled. During the test condition, the subject was shown a visual schedule with his typical schedule in place. However, the subject was told that there would be a schedule change. Specifically, the subject was required to complete a different activity before they could access their ritual. This schedule change was displayed on the visual schedule. If the subject did not engage in problem behavior, he was allowed access to his ritual after he completed the other activity. If he did not engage in problem behavior, the ritual was removed from the visual schedule (i.e., response cost). During some test conditions, the subject was told that his ritual was completely unavailable for that day. During

these sessions, the subject was allowed to choose to engage in other activities displayed on a choice board. During this evaluation, problem behavior remained low. The results suggested that a visual schedule, response cost, and choice board were effective in reducing problem behavior evoked by ritual interruption. Specifically, the subjects were taught to tolerate delays to their ritual and to tolerate denied access to their ritual.

Purpose

RRB may severely interfere in the lives of individuals with ASD and their families. They are correlated with caregiver stress and may hinder skill acquisition. For example, a parent may feel stressed because they have to ensure that certain items are arranged in a specific way to placate their child or a child may be so focused on the stimuli associated with their higher-order RRB that they do not attend to their teacher during school. In addition, some individuals engage in problem behavior when their ritual is interrupted. Although it is unknown how commonly individuals with ASD have a rituals function of problem behavior, it is known that an individual must engage in restricted and repetitive behavior (i.e., rituals) to be diagnosed with ASD. Thus, there is a possibility that many individuals with ASD have problem behavior maintained by access to rituals. Luckily, previous researchers have evaluated different methods to assess and treat this function of problem behavior. Several researchers have evaluated the use of different types of FAs to target problem behavior maintained by access to rituals. However, no researchers to date have adapted the trial-based FA to assess this function of behavior. There may be several benefits of using the trial-based FA relative to the traditional FAs when evaluating this function of problem behavior. The trial-based FA allows behavior analysts to conduct FAs when resources are limited, to evaluate rituals that only occur in the naturalistic settings, and to

evaluate schedule or time-based rituals that only occur once per day. In addition, it may mitigate some of the risks associated with the traditional FA. Thus, the first purpose of the current study was to evaluate the use of the trial-based FA to assess problem behavior evoked by ritual interruption.

After conducting an FA, several researchers have used FCT to decrease problem behavior evoked by ritual interruption. However, only one study thinned the schedule of reinforcement for FCRs after FCT. Rispoli et al. (2014) taught their participants to tolerate waiting 1 or 2 min to their ritual using a timer and a "no" sign. There are other scheduling thinning procedures that may be effective. One alternative could be to thin the schedule of reinforcement using a multiple schedule as described by Hanley et al. (2001). This procedure may allow us to thin the schedule more rapidly and to even thinner schedules of reinforcement while maintaining low levels of problem behavior. Therefore, the second purpose of the current study was to evaluate if a multiple schedule is an effective means of decreasing the schedule of reinforcement while maintaining low levels of problem behavior for individuals who engage in problem behavior when their rituals are interrupted.

CHAPTER FOUR:

METHOD

Subjects

Five individuals diagnosed with ASD and an intellectual disability participated in the study. The subjects ranged from 6 to 13 years of age. All subjects were reported by their caregivers to engage in problem behavior (e.g., aggression, property destruction, self-injury) when ritualistic behavior (e.g., placing items in a specific pattern or arrangement) was interrupted. All participants were given pseudonyms.

Matthew was a 6-year-old male who used short phrases to communicate. Matthew's rituals were placing numbers in order (main ritual), placing letters in order, and removing purple balls from a ball pit. Matthew engaged in tantrums defined as screaming or crying with or without tears. Matthew was not taking any medication during the study. Georgia was a 7-year-old female who used full sentences to communicate. Georgia's rituals were insisting on sitting in a specific chair in the classroom and lunchroom (main ritual) and placing her tokens in a specific order on her token board. Georgia engaged in tantrums defined as refusal statements (i.e., "No," "Never") and stomping. Georgia was not taking any medication during the study. Rosemary was a 12-year-old female who used 10 to 15 complete sentences to communicate. Rosemary's rituals were insisting on having all the pieces of the classroom calendar (e.g., numbers, months, days) be present and straight on the calendar (main ritual) and placing her tokens in a specific order on

her token board. Rosemary engaged in whining defined as a long, high-pitched crying sound. Rosemary was not taking any medication during the study. Sheldon was a 7-year-old male who did not communicate independently. When conducting the initial parent interview, Sheldon's parents asked to have their son's pseudonym be Sheldon. Sheldon's ritual was insisting that others could not lean their backs on the couch or chairs. Sheldon engaged in aggression defined as hitting, scratching, pulling, pushing, pinching, or biting another person. Sheldon was not taking any medication during the study. Jasper was a 13-year-old male who used complete sentences to communicate. Jasper's ritual was clearing the numbers on the microwave (i.e., the microwave should show the time and not show a couple seconds left on the timer). Jasper engaged in whining defined as a long, high-pitched crying sound, property destruction defined as kicking, hitting, throwing, or ripping objects, walls, or furniture, and aggression defined as kicking or hitting another person. Jasper was not taking any medication during the study.

Materials, Setting, and Measurement

Session materials included items specific to an individual's ritual, tasks, highly and moderately preferred tangible items, red and green laminated sheets of paper, picture card, an electronic data collection system, and a video camera. All sessions were conducted in the subject's school, home, or clinic. During the trial-based FA, two to ten trials were conducted each session day for a total of 10 trials per condition. During the treatment evaluation, sessions were 5 min, and two to eight sessions were conducted each session day.

Trained observers collected data using an electronic data collection system and paper and pencil. During the trial-based FA, data were collected on the frequency and latency of problem behavior. Problem behavior was defined on an individual basis for each subject. During the

treatment evaluation, data were collected on prompts, prompted FCRs, independent FCRs, discriminative stimulus (S^D; Skinner, 1938) and s-delta (Skinner) presentations, and problem behavior. Prompts were defined as the experimenter stating the vocal FCR or the experimenter hand-over-hand guiding the subject to hand over a picture card. Prompted FCRs were defined as engaging in the FCR after the delivery of the prompt. Independent FCRs were defined as engaging in the FCR without the experimenter providing a prompt. S^D presentation was scored when the S^D was present. S-delta presentation was scored when the S-delta was present. Data were also collected on procedural integrity. Specifically, trained observers collected data on experimenter behavior (e.g., did the experimenter provide attention contingent on problem behavior during the test segment of the attention trial?).

Interobserver Agreement and Procedural Integrity

A second observer collected data on subject and experimenter behavior for an average of 55.42% (range, 40%-90%) of trials during the trial-based FA and an average of 54.41% (range, 33.33%-87.50%) of sessions during the treatment evaluation. During the trial-based FA, interobserver agreement (IOA) was calculated for problem behavior on a trial-by-trial basis as well as using the latency measure. Interobserver agreement for the trial-by-trial data was calculated by dividing the total number of trials in which both observers recorded the occurrence or nonoccurrence of problem behavior within each segment by the total number of segments and multiplying by 100%. The interobserver agreement for the trial-by-trial data was 100% across all subjects. Interobserver agreement for the latency data was calculated by dividing the shorter latency by the longer latency in each segment, averaging the results, and multiplying by 100%. Interobserver agreement for the latency data was 98% (range, 78.17%-100%) for Matthew, 97%

(range, 74.22%-100%) for Georgia, 99% (range, 94%-100%) for Rosemary, 99% (range, 93%-100%) for Sheldon, and 99% (range, 93.75%-100%) for Jasper. During the treatment evaluation, interobserver agreement was calculated for problem behavior and functional communication responses by dividing the smaller number of responses by the larger number of responses within each interval, averaging the results, and multiplying by 100%. Interobserver agreement for problem behavior was 98.89% (range, 90%-100%) for Matthew, 99% (range, 93.33%-100%) for Georgia, 99.33% (range, 93.33%-100%) for Rosemary, 98.5% (range, 93.33%-100%) for Sheldon, and 100% for Jasper. Interobserver agreement for functional communication responses was 96.85% (range, 86.57%-100%) for Matthew, 97% (range, 73.33%-100%) for Georgia, 97.22% (range, 83.33%-100%) for Rosemary, 94.91% (range, 83.33%-100%) for Sheldon, and 100% for Jasper.

An independent observer collected data on experimenter behavior using a task analysis listing all of the procedures for each condition (e.g., provide access to ritualistic behavior or stimuli contingent on problem behavior) for an average of 49% (range, 46%-50%) of trials during the trial-based FA and an average of 56.52% (range, 48.48%-66.67%) of sessions during the treatment evaluation. Procedural integrity was calculated by dividing the total number of correct responses by the total number of incorrect plus incorrect responses and multiplying by 100%. During the trial-based FA, mean procedural integrity were 100% for Matthew, 98.86% (range, 85.71%-100%) for Georgia, 99.43% (range, 85.72%-100%) for Rosemary, 100% for Sheldon, and 98.91% (range, 87.5%-100%) for Jasper. During the treatment evaluation, mean procedural integrity scores were 100% for Matthew, Georgia, Rosemary, Sheldon, and Jasper.

Procedures and Experimental Design

Indirect Assessment

We used the Functional Analysis Screening Tool (Iwata et al., 2013) to collect information about the subject before implementing experimental procedures. We identified potential antecedents and consequences for problem behavior via verbal report from the caregiver, behavior therapist, or teacher. In addition, we asked the informant to describe the subject's ritualistic behavior. We used this information to construct the ritual trial for each subject during the trial-based FA.

Preference Assessment

We conducted a Multiple Stimulus Without Replacement preference assessment (DeLeon & Iwata, 1996) to determine high and moderate-preferred toys to use during the trial-based FA. A highly preferred toy was used during the tangible condition and a moderately preferred toy was used during the attention condition.

Trial-Based FA

The purpose of the trial-based functional analysis was to modify a trial to test if problem behavior was maintained by access to rituals (i.e., ritual trial). A trial-based FA similar to that described by Bloom et al. (2011) was conducted. The trials included attention, escape, ignore, tangible, ritual, and tangible ritual (Matthew only). We included trials other than the ritual trial to ensure that we identified all functions of problem behavior. In addition, a sixth type of trial was included for Matthew to test if problem behavior was maintained by access to the items he used

to engage in his ritual. Trials were conducted when naturally occurring establishing operations were presented throughout the day. All trials except the ignore trial consisted of two 2-min segments: control and test. The ignore trial consisted of two 2-min test segments.

Attention. The purpose of this trial was to determine if problem behavior was maintained by access to attention. During the control segment, the subject has access to a moderately preferred item and the experimenter provided attention continuously. After 2 min or the first instance of problem behavior, whichever occurred first, the test segment began. At the start of the test segment, the experimenter stated, "I'm going to be busy." During the test segment, the experimenter did not provide attention to the subject and contingent on an instance of problem behavior, the individual provided a statement of concern and the trial ended. If the subject did not engage in problem behavior, the test segment ended after 2 min.

Escape. The purpose of this trial was to determine if problem behavior is maintained by escape from demands. During the control segment, the subject did not have access to toys and the experimenter remained close to the subject but did not provide attention. After 2 min or the first instance of problem behavior, whichever occurred first, the test segment began. During the test segment, the experimenter continuously provided demands. Contingent on problem behavior, the experimenter stated, "Fine, you don't have to," stopped providing the demands, and removed the task materials. If the subject did not engage in problem behavior, the test segment ended after 2 min.

Ignore. The purpose of this trial was to evaluate if problem behavior was maintained by automatic reinforcement. This trial consisted of two test segments. During the test segments, the experimenter remained in the room with the subject but did not provide attention. There were no

programmed consequences for problem behavior and the occurrence of problem behavior did not terminate the segment of the trial in which it occurred. The ignore trial ended after 4 min.

Tangible. The purpose of this trial was to evaluate if problem behavior was maintained by positive reinforcement in the form of access to tangibles. During the control segment, the subject had access to their high-preferred toy. After 2 min or the first instance of problem behavior, whichever occurred first, the test segment began. At the start of the test segment, the experimenter removed the toy from the subject and stated, "No more toys." Contingent on problem behavior, the experimenter provided access to the toy. If the subject did not engage in problem behavior, the test segment ended after 2 min.

Ritual. The purpose of this trial was to determine if problem behavior was maintained by allowing the subject to engage in their ritual. Rituals were identified via parent or teacher report. For Mathew, a ritual trial began after a minimum of 10 cards were placed in the pattern. During the control segment, the subject was allowed to engage in their ritual (e.g., arrange their items in a particular pattern). After 2 min or the first instance of problem behavior, whichever occurred first, the test segment began. At the start of the test segment, the experimenter provided a statement suggesting that the ritual would be interrupted (e.g., "You can't do that anymore"), disrupted the ritual, and blocked the subject from engaging in the ritual. Contingent on problem behavior, the experimenter state, "Fine, you can do it" and the experimenter provided access to the ritual. If the subject did not engage in problem behavior, the experimenter interrupted the ritual every 30 s if possible. For example, during the test segment for Matthew, the experimenter switched two of the numbered cards every 30 s and blocked him from rearranging the cards. For Georgia, the experimenter told her that she could not sit in her preferred chair and lifted the chair, so she could not sit comfortably. We did not physically guide her away from the chair

because her teacher did not have the ability to do so in the classroom. For Rosemary, the experimenter removed or switched two of the calendar day icons on the calendar every 30 s and blocked her from fixing them. For Sheldon, the experimenter sat with their back against the couch. For Jasper, the experimenter removed something from the microwave and left a few seconds on the visual display.

Tangible Ritual (Matthew only). The purpose of this trial was to determine if the problem behavior was maintained by positive reinforcement in form of the tangible items used to engage in the ritual. This trial was identical to the tangible trial except we used the items that Matthew used to engage in his ritual.

Treatment Evaluation

A treatment consisting of FCT was used to decrease problem behavior evoked by ritual interruption and teach an FCR. A multiple schedule using two different stimuli (e.g., red and green cards) was used to thin the schedule for reinforcement for FCRs. All sessions were 5 min. We used a multiple baseline across participants design to demonstrate experimental control.

Baseline. There were two purposes of the baseline phase. First, we used the results of baseline to confirm whether the trial-based FA correctly identified if there was an access to rituals function. Second, the baseline phase was used to measure problem behavior before the treatment was implemented. During baseline, two conditions were alternated: contingent reinforcement and noncontingent reinforcement. Prior to the contingent reinforcement condition, the subject was allowed to engage in their ritual for 2 min. At the start of the contingent reinforcement condition, the experimenter provided a statement suggesting that the ritual would be interrupted (e.g., “You can’t do that anymore”), disrupted the ritual, and blocked the subject

from engaging in the ritual. Contingent on problem behavior, the experimenter stated, “Fine, you can do it” and the experimenter provided access to the ritual for 30 s. During the noncontingent reinforcement condition, the experimenter allowed the subject to engage in their ritual without any interruption. In addition, if the subject was reported to engage in more than one ritual, a baseline probe (i.e., one NCR and one CR session), in which another ritual was interrupted, was conducted to measure problem behavior before the treatment has started. If the data from this phase suggested that problem behavior was not maintained by access to rituals (i.e., if the subject did not engage in a higher rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition), the participant did not continue to the next phase of the study.

Functional communication training. The purpose of this phase was to teach the subjects to engage in an FCR (e.g., “I want to fix it”) to gain access to their ritual. Prior to each session, the experimenter provided a rule about the FCR (e.g., “If you want to fix the calendar, you can say “I want to fix it, please.”” The FCRs were chosen based on each subject’s verbal repertoire. Matthew was taught to say, “My way, please.” Georgia was taught to say, “I want to sit there, please” for her primary ritual and “I want to fix it” for her second ritual. Rosemary was taught to say, “I want to fix it.” Sheldon was taught to hand over a picture card of the couch. If the subject was taught a vocal FCR, we used a vocal prompt plus a prompt delay to teach the response. If the subject was taught to exchange a picture card as their FCR, we used a full physical prompt plus a prompt delay to teach the response. The prompt delay procedures were similar to those described by Touchette and Howard (1984). We gradually increased the delay to prompting across sessions. We began with a 0-s delay, increased the delay to 1 s, and then increased the delay by 50% (rounded to the nearest whole number) for each subsequent session.

After the subject had engaged in at least 90% independent responses across five consecutive sessions and problem behavior remained below the 75% reduction from baseline, we began schedule thinning.

Schedule thinning. The purpose of this phase was to thin the schedule of reinforcement for FCRs using a multiple schedule. Prior to each session, the experimenter provided a rule about the multiple schedule (e.g., "When it's on green and you want to fix your calendar, you can say, "I want to fix it, please," but when it's on red, you have to wait.") The schedule thinning procedures were similar to those described by Hanley et al. (2001). The multiple schedule consisted of a two-component schedule: S^D and S-delta. During the S^D component, the FCR was reinforced (e.g., if the subject stated, "I want to fix it," the experimenter allowed the subject to engage in their ritual for 30 s). During the S-delta component, the FCR was placed on extinction (e.g., if the subject stated, "I want to fix it," the experimenter did not allow the subject to engage in their ritual). We did not allow the subjects access to a moderately-preferred toy during the S-delta component to ensure that a reduction in problem behavior was a result of the multiple schedule itself rather than having access to a competing item.

Throughout this evaluation, the duration in which the S-delta was available gradually increased across sessions. The procedures were similar to those described by Hanley et al. (2001). We initially presented the S^D for 60 s and the S-delta for 15 s. This schedule repeated throughout the entire 5-min session. After the subject engaged in problem behavior at or below 25% of baseline responding, we increased the duration of the S-delta. We increased the duration of the S-delta by 50% and rounded to the nearest whole number. If the subject engaged in problem behavior for two consecutive sessions, we restarted the multiple schedule using the component durations in which we originally saw discriminated responding while problem

behavior remained low. In addition, we modified the stimuli used in the multiple schedule to make them more salient. The final component durations were 60 s for the S^D and 240s for the S-delta. This phase was terminated after the subject engaged in discriminated responding and problem behavior was below the 75% reduction line from baseline for at least five sessions at the terminal component durations.

In addition, if the subjects' caregiver or Board Certified Behavior Analyst reported that the subject engaged in problem behavior when more than one ritual was interrupted, we evaluated if the treatment was effective with the additional rituals. Specifically, we implemented the multiple schedule procedures using the component durations of 1 min of S^D and 4 min of S-delta. This phase was terminated after the subject engaged in discriminated responding and problem behavior was below the 75% reduction line from baseline for two consecutive sessions.

CHAPTER FIVE:

RESULTS

Trial-Based Functional Analysis

Figure 1 displays the percentage of trials in which problem behavior occurred across each condition for Matthew, Georgia, Rosemary, Sheldon, and Jasper. Matthew infrequently engaged in problem behavior during the attention, escape, ignore, tangible, and tangible ritual conditions. During the ritual condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was maintained by access to rituals.

Georgia infrequently engaged in problem behavior during the attention, ignore, and tangible conditions. During the ritual condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was maintained by access to rituals. In addition, Georgia engaged in problem behavior during 30% of the test segments and 0% of the control segments during the escape condition. This suggests that problem behavior was also maintained by escape from demands.

Rosemary infrequently engaged in problem behavior during the attention, escape, and tangible conditions. During the ritual condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was maintained by access to rituals.

Sheldon infrequently engaged in problem behavior during the attention, ignore, and tangible conditions. During the ritual condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was maintained by access to rituals. In addition, during the escape condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was also maintained by escape from demands.

Jasper infrequently engaged in problem behavior during the attention, ignore, tangible, and ritual conditions. During the escape condition, problem behavior occurred in a high percentage of trials during the test segment relative to the control segment. This suggests that problem behavior was maintained by escape from demands and was not maintained by access to rituals.

Treatment Evaluation

Figure 2 displays the rate of problem behavior across baseline, FCT, and scheduling thinning for Matthew, Georgia, Rosemary, and Sheldon. Matthew engaged in a high rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition. These results correspond to the results of the trial-based FA. During FCT, Matthew's problem behavior decreased to low or zero rates. During schedule thinning, his problem behavior maintained at low to zero rates. In addition, he engaged in low to zero levels of problem behavior when the treatment was used for two additional rituals (i.e., lining up numbers, removing purple balls from the ball pit).

Georgia engaged in a high rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition. In addition, she engaged in

problem behavior when a second ritual (i.e., placing her tokens in a specific order on her token board) was interrupted during the baseline probe. These results correspond to the results of the trial-based FA. During FCT, Georgia's problem behavior quickly decreased to zero rates. During schedule thinning, Georgia's problem behavior maintained at zero rates. In addition, Georgia continued to engage in zero levels of problem behavior when the treatment was evaluated with an additional ritual.

Rosemary engaged in a high rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition during baseline. In addition, she engaged in problem behavior when a second ritual (i.e., placing her tokens in a specific order on her token board) was interrupted during the baseline probe. These results correspond to the results of the trial-based FA. During FCT, Rosemary's problem behavior quickly decreased to zero rates. During schedule thinning, her problem behavior maintained at zero rates. In addition, her problem behavior remained low when the treatment was used for an additional ritual.

Sheldon engaged in a high rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition. These results correspond to the results of the trial-based FA. During FCT, Sheldon's problem behavior decreased to low or zero rates. During schedule thinning, he engaged in a high rate of problem behavior when the duration of the S-delta was increased to 4 min. After two sessions in which Sheldon engaged in a high rate of problem behavior, we restarted the multiple schedule using the component durations of 60 s in the S^D and 53 s in the S-delta. In addition, we added a stop sign to the S-delta stimulus, a verbal statement during the stimulus change (e.g., "we are now on green"), and provided the statement, "It's on red, you have to wait" if Sheldon engaged in an FCR in the presence of the S-

delta. After restarting the multiple schedule with these changes, Sheldon's problem behavior decreased to low stable levels.

Figure 3 displays the rate of FCRs across baseline, FCT, and scheduling thinning for Matthew, Georgia, Rosemary, and Sheldon. Matthew engaged in zero FCRs during baseline. During FCT, Matthew acquired the FCR. During schedule thinning, he engaged in discriminated responding and discriminated responding maintained as the S-delta was increased to 4 min. In addition, he continued to engage in discriminated responding when the treatment was implemented for two additional rituals.

Georgia engaged in zero FCRs during baseline. During FCT, Georgia acquired the FCR. During schedule thinning, she engaged in discriminated responding and discriminated responding maintained as the S-delta was increased to 4 min. In addition, she continued to engage in discriminated responding when the treatment was implemented for an additional ritual.

Rosemary engaged in a high rate of FCRs during the contingent reinforcement condition relative to the noncontingent reinforcement condition. During FCT, Rosemary continued to engage in a high rate of FCRs with the exception of session 11 in which she was not given the opportunity to engage in an FCR independently (i.e., without a prompt) because we began with a 0-s prompt delay. During schedule thinning, Rosemary initially engaged in a high rate of FCRs during the S-delta component for three consecutive sessions. Therefore, we added the word "Wait" to the S-delta stimulus. After the change was made, Rosemary began to engage in discriminated responding and discriminated responding maintained as the S-delta was increased to 4 min. In addition, she continued to engage in discriminated responding when the treatment was implemented for an additional ritual.

Sheldon engaged in zero FCRs during baseline. During FCT, Sheldon acquired the FCR. During schedule thinning, Sheldon initially engaged in some discriminated responding; however, when we increased the duration of the S-delta to 4 min, he began to engage in a high rate of responding during the S-delta. After restarting the multiple schedule with the stimulus changes, Sheldon began to engage in discriminated responding and discriminated responding maintained as the S-delta was increased to 4 min.

Figure 4 displays the percentage of independent FCRs across baseline and FCT. During baseline, we observed zero independent FCRs across both contingent reinforcement and noncontingent reinforcement conditions for Matthew, Georgia, and Sheldon. During baseline, Rosemary engaged in a high rate of independent FCRs during the contingent reinforcement condition relative to the noncontingent reinforcement condition. During FCT, all subjects acquired the FCR independently for 90% of opportunities across five consecutive sessions.

Figure 5 displays the rate of problem behavior during baseline for Jasper. We conducted baseline (i.e., noncontingent reinforcement and contingent reinforcement conditions) in which the experimenters interrupted Jasper's ritual to ensure that the ritual trial within the trial-based FA did not produce false-negative results. Jasper engaged in no problem behavior during contingent reinforcement and noncontingent reinforcement conditions. These results suggest that Jasper did not engage in problem behavior maintained by access to rituals. These results confirm that the trial-based FA did not produce a false negative result.

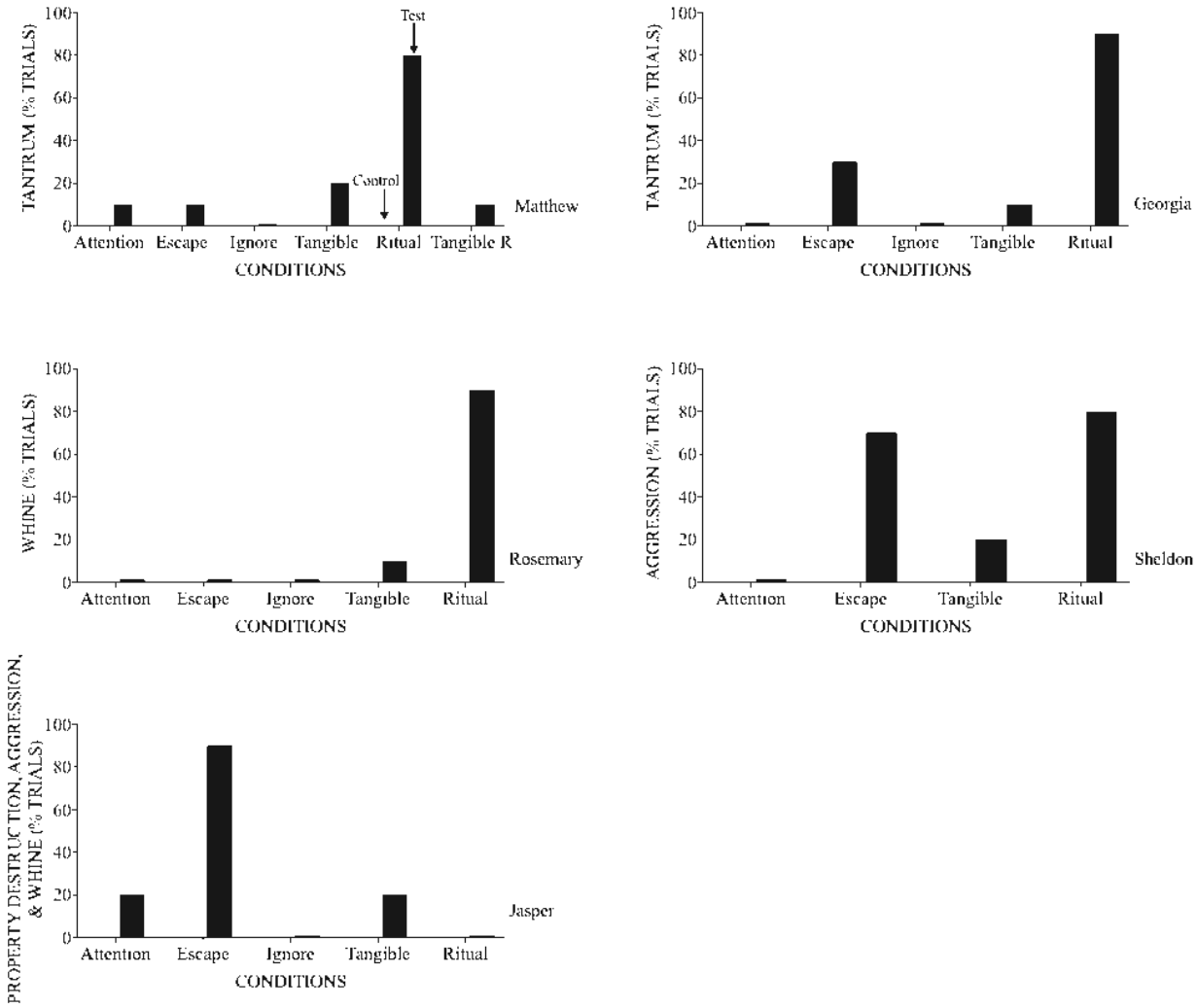

Figure 1. The percentage of trials in which problem behavior occurred during the control and test segments of each condition during the trial-based functional analysis for Matthew, Georgia, Rosemary, Sheldon, and Jasper. The conditions evaluated were attention, escape, ignore, tangible, ritual, and tangible ritual. Black bars represent the control segments and gray bars represent the test segments.

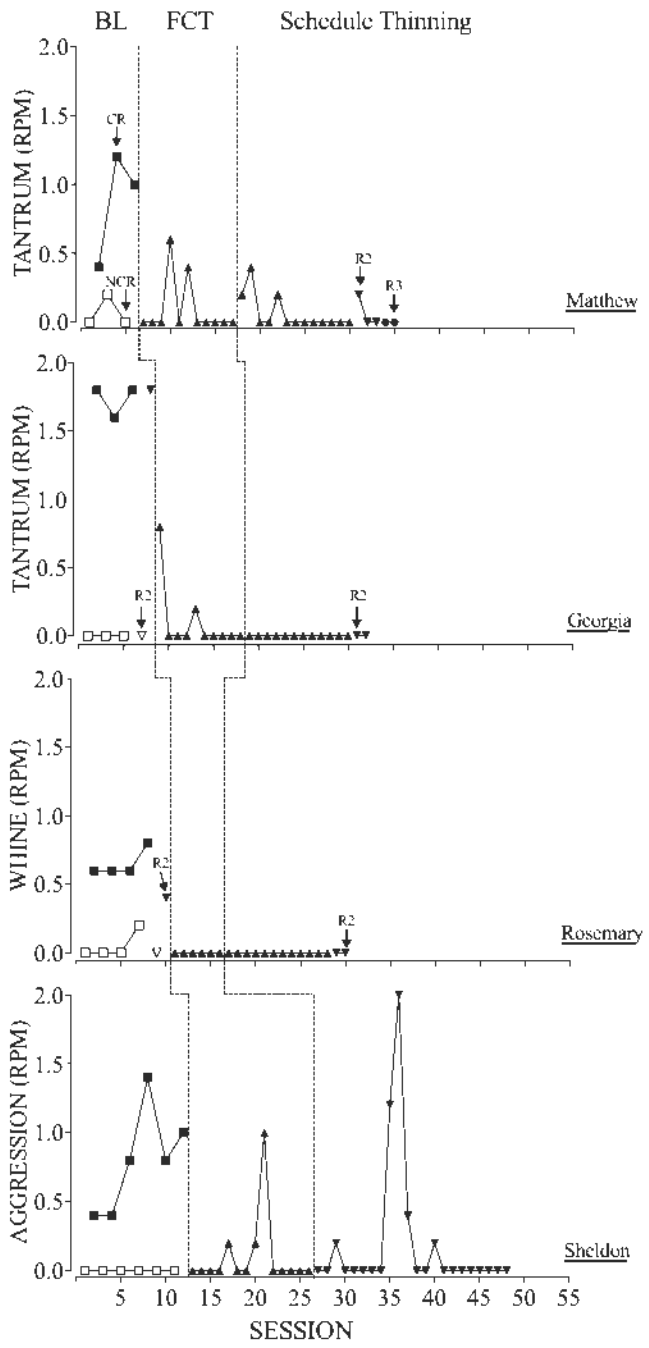

Figure 2. The rate of problem behavior during baseline, functional communication training, and schedule thinning for Matthew, Georgia, Rosemary, and Sheldon. Black squares represent the contingent reinforcement condition, open squares represent the noncontingent reinforcement condition, black triangles represent the functional communication training phase, and the schedule thinning phase. In addition, the upside-down triangles indicate sessions in which a second ritual was interrupted and hexagons indicate sessions in which a third ritual was interrupted.

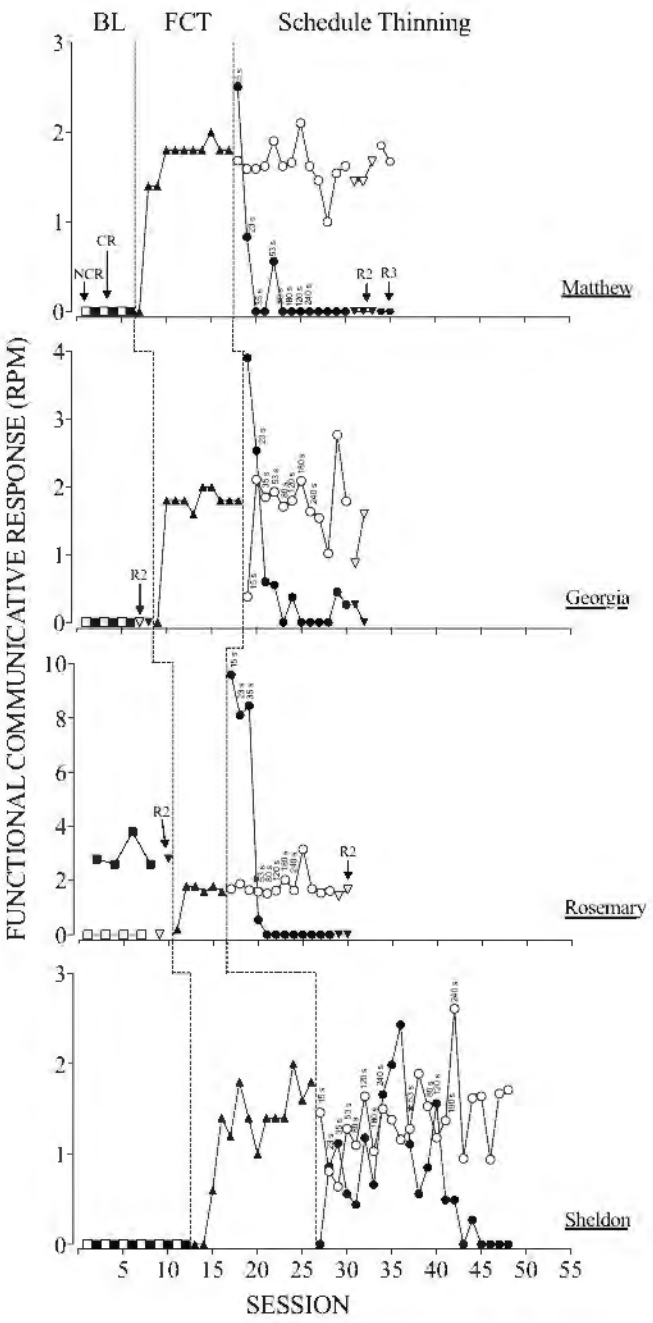

Figure 3. The rate of independent functional communicative responses during baseline, functional communication training, and schedule thinning for Matthew, Georgia, Rosemary, and Sheldon. Black squares represent the contingent reinforcement condition, open squares represent the noncontingent reinforcement condition, black triangles represent the functional communication training phase, closed circles represent the s-delta component, and open circles represent the discriminative stimulus component. In addition, the upside-down triangles indicate sessions in which a second ritual was interrupted and hexagons indicate sessions in which a third ritual was interrupted.

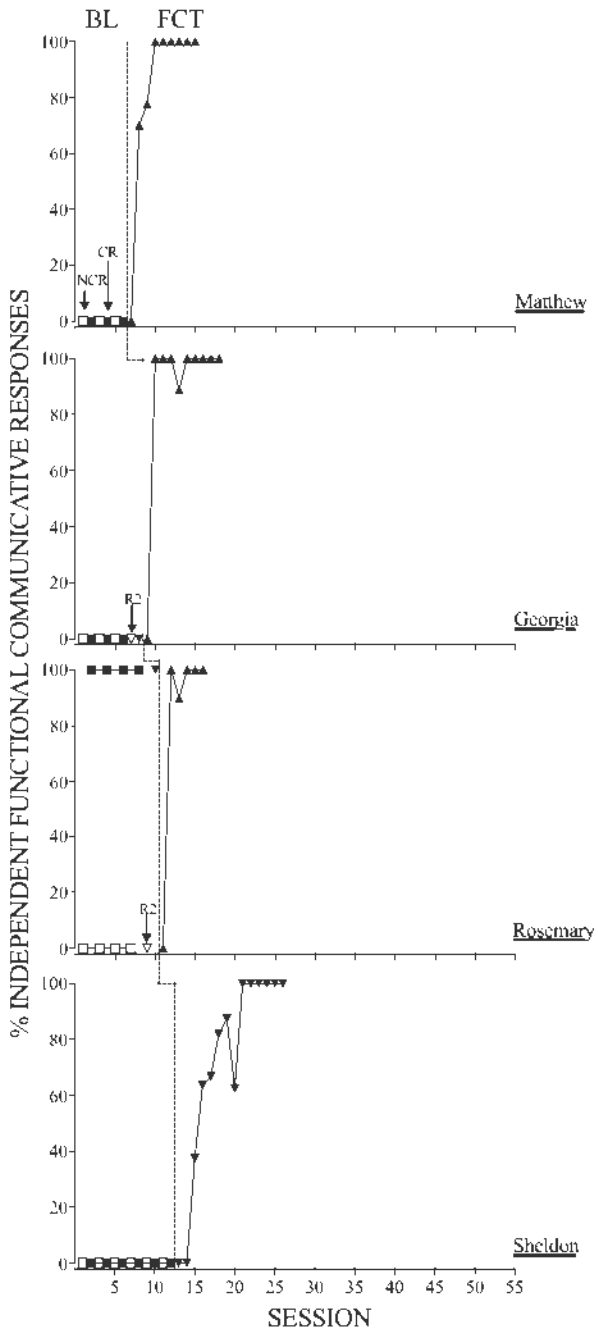

Figure 4. The percentage of independent functional communicative responses during baseline and functional communication training for Matthew, Georgia, Rosemary, and Sheldon. Black squares represent the contingent reinforcement condition, open squares represent the noncontingent reinforcement condition, and black triangles represent the functional communication training phase. In addition, the upside-down triangles indicate sessions in which a second ritual was interrupted.

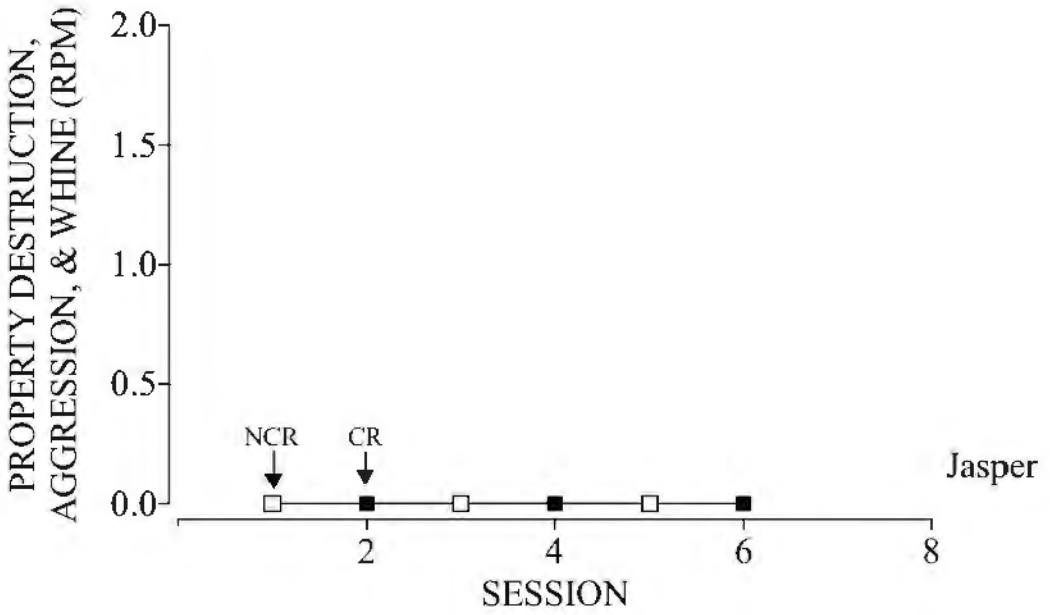

Figure 5. The rate of problem behavior during baseline for Jasper. Black squares represent the contingent reinforcement condition and open squares represent the noncontingent reinforcement condition.

CHAPTER SIX:

DISCUSSION

The results of the present study extend previous research on assessment of and treatments for problem behavior evoked by ritual interruption. In summary, the trial-based FA correctly identified the presence or absence of a rituals function for five of five subjects. That is, a rituals function was identified during the trial-based FA and the subject engaged in a higher rate of problem behavior during the contingent reinforcement condition relative to the noncontingent reinforcement condition during baseline for four subjects. In addition, the trial-based FA did not incorrectly identify a rituals function for one of the five subjects in which a rituals function was not present. That is, a rituals function was not identified during the trial-based FA and the subject engaged in no problem behavior during the CR/NCR baseline. Additionally, the treatment involving FCT and a multiple schedule decreased the schedule of reinforcement to 4 min of extinction and 1 min of reinforcement while maintaining low to zero rates of problem behavior for four of four subjects. Finally, the treatment effects successfully generalized to additional rituals for three of three subjects.

These results suggest that the trial-based FA can be modified to evaluate problem behavior evoked by ritual interruption. This will allow behavior analysts and teachers who have limited resources to assess problem behavior associated with rituals by allowing them to evaluate rituals that occur in the natural environment. In addition, using the trial-based FA to assess this function may mitigate some risks associated with the traditional FA.

The current study also demonstrates an effective treatment for problem behavior evoked by ritual interruption. Although FCT has been shown to decrease problem behavior evoked by ritual interruption, the results of the current study will help behavior analysts decrease the schedule of reinforcement to more practical levels. This is especially useful given that it is impractical and sometimes impossible to reinforce an FCR at all times. Furthermore, the treatment may be used to teach individuals with ASD to tolerate changes to their routines or schedules regardless of whether they engage in problem behavior.

It is interesting to note that Matthew engaged in problem behavior during the ritual trial but not during the tangible ritual condition. That is, Matthew did not engage in problem behavior when all of his ritualistic stimuli were removed but he did engage in problem behavior when his ritualistic stimuli were moved out of place. This suggests that the stimuli themselves are not reinforcing but the arrangement of the stimuli is reinforcing.

It is also interesting to note that when the ritual was interrupted, and the subject was allowed to engage in a response to gain access to their ritual (i.e., problem behavior or FCR), most of the subjects' fixed the ritualistic stimuli themselves (Georgia, Rosemary), whereas the experimenter had to fix the ritualistic stimuli for others (Matthew only). For example, during the test segment of the ritual trial, the experimenter would interrupt the ritual, Mathew would engage in his target behavior and then try to clean up all of his ritualistic stimuli while screaming, "All done," or "I want to clean up." He would try to clean up his ritualistic stimuli and continue to engage in problem behavior instead of placing them back in the correct order. Therefore, contingent on problem behavior, the experimenter would state, "Okay, I'll fix it" and quickly fix the order of the ritualistic stimuli. After the experimenter repositioned the stimuli in their correct order, he would stop engaging in problem behavior. This raises an interesting question, is it the

placement of the ritualistic stimuli or the act of placing items in the ritualistic pattern that is reinforcing? Future researchers should conduct an analysis to determine the specific automatic reinforcers maintaining different subjects' rituals using the procedures described by Rodriguez et al. (2012). Researchers could also use a concurrent-operants arrangement to determine preference for the final placement or the act of engaging in the ritualistic behavior.

There are several limitations of the current study. First, we did not conduct an assessment to determine the most appropriate ritual to interrupt for each subject. However, we did ask the subjects' caregivers and Board Certified Behavior Analysts (if applicable) to describe the ritualistic behavior in which the subject engaged. This discussion led to the identification of at least one ritual for each subject. It is possible that we did not evaluate the ritual that evoked problem behavior in Jasper. Future researchers should conduct an assessment similar to the demand assessment conducted by Call et al. (2016) to determine which rituals have the shortest latency to problem behavior when interrupted. This assessment may have helped us identify a hierarchy of ritualistic behavior, so we could have selected the most appropriate ritualistic behavior to evaluate and prevent any false-negative results.

Second, Matthew's ritualistic behavior involved arranging stimuli in a specific order or pattern. We had to wait for the ritualistic behavior to occur before conducting a ritual trial or the treatment evaluation, both of which involved disturbing the arrangement. That is, we could not conduct experimental sessions until the subject set up their ritualistic arrangement. This required the experimenters to wait from 5 min to 2 hr before conducting a trial or session. During the treatment evaluation, we briefly evaluated different ways to evoke ritualistic behavior (e.g., showing the subject a picture of their arrangement, handing the subject the items they used to engage in their ritual and asked, "Where do you want this?"). Future researchers should

systematically evaluate different ways to evoke ritualistic behavior. Another option would have been to evaluate the treatment using a trial-based format in which trials are embedded across the day. This would allow the behavior analyst or teacher to evaluate the treatment throughout their daily activities rather than wait for extended periods of time for the subject to engage in their ritual. In addition, future researchers should evaluate if problem behavior occurs if the arrangement is originally set up by the experimenter and then interrupted.

A third limitation is that the experimenters did not conduct any baseline probes for the additional rituals for Matthew. It is unknown if he engaged in problem behavior when these rituals were interrupted. However, during the generalization probe in which the second ritual (i.e., placing letters in order) was interrupted, Matthew initially engaged in problem behavior. This suggests that Matthew engaged in problem behavior when more than one ritual was interrupted.

A fourth limitation is Sheldon engaged in a high rate of inappropriate sexual behavior (i.e., rubbing his groin on chairs, couches, and benches) throughout the study. It is possible that Sheldon did not have a rituals function of problem behavior but instead engaged in problem behavior when he was blocked from engaging in inappropriate sexual behavior toward the couch. However, to isolate the maintaining variable, we did not switch from the control segment to the test segment during the ritual and escape trials of the trial-based FA if he was engaging in inappropriate sexual behavior at that time. That is, if inappropriate behavior was occurring during the switch, the trial was terminated, and a new trial was conducted. During the trial-based FA, Sheldon engaged in a high percentage of problem behavior during the test segment of the ritual trial relative to the control segment. This suggests that he engaged in problem behavior to have others sit off the couch even when he was not engaging inappropriate sexual behavior.

A fifth limitation is that we did not evaluate if the treatment generalized across the entire day and to other therapists (e.g., caregivers, Registered Behavior Technicians®). However, we did evaluate the treatment effects for multiple rituals for some subjects. Future researchers should evaluate the use of a multiple schedule in the natural environment using caregivers as experimenters.

Finally, it is unknown which of the treatment components (e.g., adding a stop sign to the S-delta stimulus, adding a verbal statement during the stimulus change and providing the statement, "It's on red, you have to wait" if Sheldon engaged in an FCR in the presence of the S-delta) were responsible for producing discriminated responding with Sheldon. Future researchers should systematically evaluate how each of these variables influence discriminated responding. In other words, it would be beneficial to identify a hierarchy of procedures to follow if a subject does not readily engage in discriminated responding when implementing a multiple schedule. Furthermore, in the current study, the duration of the S-delta was increased in the following session after the subject engaged in problem behavior at or below 25% of baseline responding. For Sheldon, it may have been beneficial to increase the duration of S-delta after there is a reduction in problem behavior and discriminated responding has been observed.

In addition to the limitations discussed, the results of the current study may guide future research. First, the results of the current study suggest that the trial-based FA can be modified to assess problem behavior evoked by ritual interruption. That is, if the rituals involve arranging items in a particular pattern, insisting on having items straight and orderly, or insisting on sameness, the trial-based FA can be used. Future research should evaluate the use of the trial-based FA to assess problem behavior associated with the interruption of time-based rituals and lower-order rituals (i.e., stereotypy). It is also possible that the trial-based FA can be modified to

evaluate other idiosyncratic functions of problem behavior such as a mands function (Bowman, Fisher, Thompson, & Piazza, 1997) or a social avoidance function (Vollmer et al., 1998). Furthermore, it is possible that the procedures to assess a rituals function within the context of a trial-based FA would be similar, if not identical, to the assessment of a mands function of problem behavior.

Most of the subjects engaged in a high percentage of problem behavior during the first few ritual trials. More specifically, Matthew engaged in problem behavior during 60% of test segments and 0% of control segments within the first five ritual trials. Georgia engaged in problem behavior during 80% of test segments and 0% of control segments within the first five ritual trials. Rosemary engaged in problem behavior during 100% of test segments and 0% of control segments within the first five ritual trials. Sheldon engaged in problem behavior during 100% of test segments and 0% of control segments within the first five ritual trials. It is possible that 10 trials are not necessary when completing a trial-based FA. Future research should evaluate the use of an on-going visual-inspection criteria to determine when a sufficient number of trials have been conducted to determine the function of problem behavior.

In the current study, we taught the subjects to tolerate waiting 4 min before gaining access to their ritual. Future researchers should increase the s-delta component to more practical durations (e.g., 20 min, 30 min). Furthermore, the treatment evaluated in the current study would not be effective for ritualistic behavior that are completely inappropriate to occur at all (e.g., if a piece of food falls on the ground, the subject insists on having all of their food on the ground). Future researchers should evaluate different methods of teaching individuals to tolerate being denied access to ritualistic behavior altogether. For example, we could evaluate the effects of a delay-discounting paradigm in which the subject has the opportunity to choose between engaging

in their ritualistic behavior in 5 min or receiving an alternative reinforcer now. It is possible that the subjects would allocate more of their choice responding toward the sooner reinforcer and thus teach them to tolerate denied access.

It is also interesting to note that during the multiple stimulus without replacement preference assessment, three of the four subjects (i.e., Mathew, Rosemary, Georgia) who had a rituals function chose the same items in the same exact order for three consecutive sessions. There may be a correlation between rigidity during preference assessments and having problem behavior evoked by ritual interruption.

Finally, there is a high comorbidity rate of ASD and anxiety disorders (Nadeau et al., 2011). It is possible that many of the individuals in the current study have an undiagnosed anxiety disorder. There are many pharmacological treatments for anxiety such as selective serotonin reuptake inhibitors. Unfortunately, there is limited research on the efficacy of these medications in the treatment of anxiety in individuals diagnosed with ASD (Nadeau et al.). Future research should evaluate the effects of selective serotonin reuptake inhibitors on restricted and repetitive behavior in individuals with ASD. For example, researchers could conduct a medication evaluation using the procedures described by Crosland et al. (2003), in which functional analysis methodology is used to determine if different functions of problem behavior maintain when subjects are on and off medication. It is possible that this class of medications reduces the reinforcing value of ritualistic behavior and thus decreases the rate of ritualistic behavior and problem behavior evoked by ritual interruption.

CHAPTER SEVEN:

CONCLUSION

RRB is one of the diagnostic criteria of ASD. RRB can be organized into lower and higher-order rituals. Lower-order RRB are associated with vocal and motor stereotypy, while higher-order RRB are associated with more complex ritualistic behavior such as a rigid adherence to routines or schedules and an insistence on sameness or completeness. Some individuals engage in problem behavior when their higher-order rituals are interrupted.

The results of the current study contribute to the literature on the assessment and treatment of problem behavior evoked by the interruption of higher-order RRB. The current study demonstrates that the trial-based FA can be modified to evaluate problem behavior evoked by ritual interruption. In addition, FCT combined with a multiple schedule is an effective way to thin the schedule of reinforcement to gain access to ritualistic behavior while maintaining low levels of problem behavior in individuals with ASD.

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APPENDIX A:

IRB APPROVAL LETTER

USF
UNIVERSITY OF
SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

10/24/2017

Jennifer Weyman,
ABA-Applied Behavior Analysis
18002 Richmond Place Drive Apt. 1823
Tampa, FL 33647

RE: **Full Board Approval for Initial Review**
IRB#: Pro00030311
Title: An Application of the Trial-Based Functional Analysis to Assess Problem Behavior Evoked By Ritual Interruption

Study Approval Period: 9/15/2017 to 9/15/2018

Dear Ms. Weyman:

On 9/15/2017, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):
Protocol Document(s):
Trial-Based FA Protocol_Version 1_10.19.17.docx

Consent/Assent Document(s)*:
Adult Consent Form_Version 1_10.19.17.docx.pdf
Child Adult Written Assent_Version 1_10.10.17.docx.pdf
LAR Consent Form_Version1_10.19.17.docx.pdf
Parental Consent_Version 1_10.29.17.docx.pdf
Child or Adult Verbal Assent_Version 1_7.14.17.docx**

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved. ****verbal assent forms are unstamped**

Research Involving Children as Subjects: 45 CFR §46.404
This research involving children as participants was approved under 45 CFR 46.404: Research not involving greater than minimal risk to children is presented.

Requirements for permission by parents or guardians: 45 CFR 46.408
Permission of one parent is sufficient.

Assent is required of children ages seven to seventeen and is not appropriate for children under the age of seven due to the age, maturity and/or psychological state of the child.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A Schinka, Ph.D.

John Schinka, Ph.D., Chairperson
USF Institutional Review Board