DISTINGUISHING BETWEEN AUTOMATIC POSITIVE AND NEGATIVE HIGHER-ORDER RESTRICTED AND REPETITIVE BEHAVIOR

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The undersigned, approved by the dean of the Graduate School, have examined the thesis entitled

DISTINGUISHING BETWEEN AUTOMATIC POSITIVE AND NEGATIVE HIGHER-ORDER RESTRICTED AND REPETITIVE BEHAVIOR

presented by Lauren Powell,

A candidate for the degree of Master of Science, and hereby certify that, in their opinion, it is worthy of acceptance.

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TABLE OF CONTENTS

LIST OF FIGURES

APPENDIX

Abstract

One of the main diagnostic features of autism spectrum disorder is the presence of restricted and repetitive behaviors (RRBs). These behaviors can include repetitive motions, repetitive speech, and engaging in rituals. These behaviors can often present a variety of challenges for the child and those around them. The purpose of the present study is to evaluate if higher-order RRBs are maintained by automatic positive or automatic negative reinforcement. Results demonstrated that Truman's ritual was maintained by automatic positive reinforcement, and Jaspers ritual was maintained by automatic negative reinforcement. The function of the participants' behavior will influence which treatment packages will be most effective in treating problem behavior associated with the interruption of their rituals.

Key words: arranging and ordering, automatic positive reinforcement, automatic negative reinforcement, restricted and repetitive behavior

Introduction

Autism and Restricted and Repetitive Behavior

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by challenges with communication and interaction with other people, and restricted and repetitive behaviors (RRBs; American Psychiatric Association, 2013). Restricted and repetitive behaviors (RRBs) include hand-flapping, playing with toys in an uncommon way such as lining up cars, following specific routines, or speaking in a unique way such as using odd patterns or sounds (American Psychiatric Association, 2013.)

Lower Order and Higher Order RRBs

Restricted and repetitive behaviors are a core feature of ASD. These behaviors provide a major barrier to learning and acquiring skills. RRBs are classified into both higher and lower order categories (Ventola et al., 2016). Higher-order RRBs have been described to include complex behaviors such as specific interests, routines, and arranging and ordering. Lower-order RRBs were described to be less complex RRBs including repetitive motions and vocalizations. Previous researchers have stated that the function of higher-order RRBs may be the "need for sameness." It is also said that RRBs can be divided into repetitive sensory-motor (RSM) and insistence on sameness (IS) behaviors (Bishop et al., 2013). RSM behaviors typically include repetitive motions and behaviors that provide sensory stimuli. IS behaviors include rituals, compulsions, and instances of sameness.

The type of RRB a person engages in may be correlated with the age and functioning level of the individual with ASD. For instance, in younger children with ASD, you are more likely to observe stereotypic movements, whereas compulsions and rituals are observed later in development (Ventola et al., 2016). Individuals who engage

in stereotypic movements are correlated with having a lower IQ (Ventola et al., 2016). In addition, individuals who demonstrate fewer language skills typically exhibit more RRBs overall (Subramanian & Weismer, 2012).

Challenges Associated with RRBs

The presence of repetitive behaviors can negatively impact the quality of life in individuals with ASD, as they may interfere with the day-to-day functioning of the individual and their family (Ventola et al., 2016). One way in which this could be seen is when problem behavior evoked by ritual interruption occurs. For example, let's consider a child that engages in a ritual where he insists on wearing the same shirt every Wednesday. Eventually, the child will outgrow the shirt and it will not fit anymore or maybe his mom forgot to wash the shirt one week. When this ritual is interrupted or it is not possible to engage in the ritual, problem behavior could arise causing a disturbance to the parents and within the house. RRBs may also impact the learning of individuals with ASD (Koegel & Covert, 1972). Specifically, RRBs can interfere with skill acquisition both in and out of the classroom. This can include deficits in learning and can have a negative impact on social skills development (Kogel & Covert, 1972). For example, if a child engages in a ritual where blocks must be aligned in a certain color or shape order, and problem behavior occurs when that ritual is interrupted, then this may impact the child's ability to learn matching and sorting skills. Another example to consider is that if a child only responds to questions from his teacher and no one else if that teacher is sick or absent one day then that may impact the child's learning that day. Due to the challenges associated with RRBs, it is necessary to develop treatments that reduce these behaviors. However, there is a vast body of literature on the assessment and treatment of

lower-order RRBs and limited research on higher-order RRBs (Boyd et al., 2013). Thus, more research on the assessment and treatment of higher-order RRBs is warranted.

Assessment and Treatment of Higher-Order RRBs

One effective approach to reducing problem behavior associated with RRBs is to develop treatments based on the results of a functional analysis (FA; Iwata et al., 1994). FAs have become the standard method to assess and treat problem behavior in children with ASD (Iwata & Dosier, 2008). This analysis allows for the manipulation of conditions to test what contingencies maintain a behavior. The conditions within an FA typically include an attention, escape, tangible, control (i.e., play), and an ignore condition. During the attention condition, the experimenter removes all attention from the participant. Contingent on the target problem behavior, the experimenter provides attention in the form of statements of concern. During the escape condition, the experimenter provides demands to the participant and contingent on problem behavior, provides a break for 30 s. During the tangible condition, the experimenter removes the highly preferred item, and contingent on problem behavior, they provide the participant access to the tangible item for 30 s. During the control condition, the participant has free access to their highly preferred toys, no demands are delivered, and the experimenter provides attention at least every 30 s. During the ignore condition, the experimenter stands on the opposite side of the room as the participant and ignores all attempts to engage with the participant and all problem behavior. After conducting these sessions, we then compare the rate of problem behavior during each test condition (i.e., attention, escape, tangible, ignore) to the rate of problem behavior during the play condition to determine the function of problem behavior.

Based on the results of the FA, experimenters can develop a function-based treatment. The goal of the treatment is to teach individuals appropriate behaviors to gain access to their reinforcers. For example, if the behavior is maintained by access to tangibles, the participant could be taught a functional communication response (e.g., "Toys, please") to ask for their toys.

Rodriguez et al. (2012) was the first study to use FA methodology to analyze higher-order RRBs. More specifically, Rodriguez et al. (2012) extended the FA model to the assessment and treatment of arranging and ordering and other compulsive behavior for three individuals with ASD. Arranging and ordering were defined as moving objects to different locations, aligning objects against another surface, moving around objects when doing so was not the intended purpose of those objects. During the FA, the following conditions were evaluated: attention, escape, no interaction (i.e., ignore), and a control. Procedures were similar to those described by Iwata et al. (1994) with the exception that before and throughout each session, the items that each participant arranged were intentionally unarranged to set up opportunities to engage in arranging and ordering (e.g., toys were placed outside of their bins).

An additional analysis was then conducted for one participant to clarify whether arranging and ordering were maintained by both automatic reinforcement and escape from demands or by automatic reinforcement alone. The experimenters compared two conditions: response blocking and blocking plus escape conditions. During the response blocking condition, the experimenter blocked attempts to engage in the ritual target behavior. The response blocking plus escape condition was similar to the escape condition of the FA except that when the behavior was observed, it was either interrupted

or blocked and they were also provided escape from demands. If the behavior served an escape function, then it would be observed in the response blocking plus escape condition because the participants were given escape contingent on the target behavior. The results of this assessment demonstrated that when the automatic reinforcer was eliminated, levels of arranging and ordering decreased across all conditions. However, responding did not maintain when escape was provided suggesting that arranging and ordering was not maintained by escape but only maintained by automatic reinforcement for this participant.

The experimenters then hypothesized that arranging furniture may have been maintained by the final placement of the stimuli rather than the opportunity to arrange and order the furniture. Thus, they conducted a process versus product analysis to identify the specific variable maintaining arranging and ordering of furniture. The experimenters compared two conditions: original arrangement and preferred product placement. During the original arrangement, which served as the control condition, the furniture was arranged identically to that of the FA (i.e., the trash can being angled away from the wall, the desk being placed 3 in away from the wall, and toys were placed outside of their bins). During the preferred product placement condition, which served as the test condition, the furniture was arranged according to each participant's ideal arrangement. The results of this analysis demonstrated that levels of arranging and ordering were high during the original arrangement condition relative to the preferred product placement. This suggests that the final placement of the furniture served as the reinforcer rather than the process of arranging and ordering.

After identifying that arranging and ordering were maintained by automatic reinforcement, the experimenters then evaluated the effects of matched items, matched items plus prompts, matched items plus prompts plus product extinction, and matched items plus prompts plus product extinction plus reinforcement for engagement. Matched items were included to identify whether providing the participants with appropriate materials to arrange and order would decrease inappropriate behavior. The participants did not engage with the matched items, so the experimenters added prompts to promote appropriate engagement. Lastly, product extinction (i.e., immediately replacing the objects to their original arrangements) and additional reinforcers were added if the other treatments were not successful. This was done because even though levels or arranging and ordering were lower than baseline, item engagement was still low as well. The experimenters found that levels of arranging and ordering decreased and were maintained at low levels in the matched items plus prompts plus product extinction condition for one participant. For the second participant, matched items plus intermittent response blocking were found to be the most effective. And lastly, for participant three, matched items, plus prompts, plus product extinction, plus reinforcement contingent on item engagement was most effective. These results suggest that matched items alone were not an effective treatment but when combined with additional components (e.g., prompting, reinforcement), the treatment was successful.

Similarly, Chok and Koesler (2014) assessed and treated RRBs. More specifically, they attempted to distinguish between obsessive-compulsive disorder (OCD) and stereotypic behavior by analyzing the participants' heart rate when they were blocked from engaging in their ritualistic/stereotypic behavior. Then they evaluated the effects of

different treatments based on the assessment results. First, they conducted an FA for two individuals. One participant engaged in behavior more in line with OCD (e.g., cleaning surfaces and arranging items), and the other participant engaged in stereotypy (i.e., spinning a string). The OCD behavior is similar to the description of higher-order RRBs; however, they were not described as higher-order RRBs. The results suggested that the behaviors were maintained by automatic reinforcement. Following the FA, they conducted additional experiments. In Experiment 1, the experimenters attempted to identify the feelings and experiences that are described as unpleasant occurrences associated with OCD. This included measuring heart rate while also tracking repetitive behaviors. A maximum heart rate spike was calculated by identifying the largest increase in heart rate for a period of time. A maximum decline in heart rate was also calculated and these were compared. Results of Experiment 1 demonstrated that participant one demonstrated a topography of behavior which is commonly observed in individuals with OCD. The participant experience inclines in heart rate during the second period when the materials were present and access to engage in the ritual was blocked. His data represented the "building urge" which is typically described by individuals with OCD, and his peak of negative affect was observed when access to his repetitive behavior was restricted. These results suggest that when engaging in the target behavior was blocked, the participant experienced distress. The other participant experienced similar heart rate levels throughout the periods as well.

In Experiment 2, the experimenters evaluated the use of multiple schedules treatment to reduce the behaviors. The multiple schedule included two components (i.e., SD and S-delta). In the presence of the SD, no consequences were provided for the

participants' behavior. In the presence of the S-delta, the experimenters blocked access to the materials (i.e., response blocking), and if the ritualistic behavior persisted then the experimenter physically prompted the participants to remove their hands. Results demonstrate that both participants engaged in less repetitive behavior during the S-Delta component than during the SD phase. However, for the participant who engaged in behaviors similar to OCD, there were still high levels of responding across both the SD and S-delta suggesting that the treatment alone was not effective.

In Experiment 3, the experimenters evaluated exposure and response prevention (ERP). This was conducted because the multiple schedules treatment was not effective in treating the behavior of the participant who engaged in OCD-like behavior. During ERP, salt was placed on the table and the participant was blocked from engaging in their ritual (i.e., cleaning surfaces). If the participant exited his seat, he was guided back to the chair and prompted to look at the salt. Following this condition, ERP with laminated cards was introduced. During ERP with laminated cards, a black piece of construction paper was laminated with salt on top of the card. If the participant engaged in out-of-seat behavior then the experimenter could easily present the card to the participant. The results of the study demonstrate the ERP may be successful in decreasing ritualistic behavior for those individuals who exhibit characteristics of OCD behavior.

In general, the results of the study suggest that the one way to discriminate between OCD and stereotypic behavior is to examine the topography of the behavior in association with the physiological behaviors (i.e., heart rate). The experimenters found that when comparing OCD and stereotypic behavior, one treatment may be more effective than another. For the participant who engaged in repetitive behaviors, they

found that multiple schedules involving response blocking were effective in reducing behaviors. However, for the participant whose behavior contained characteristics of OCD, the multiple schedules with response blocking were less effective. Thus, they evaluated the effects of ERP and their results suggested that it was an effective treatment for OCD behaviors. Based on these results, clinicians need to identify the difference between OCD and stereotypy. By doing so it allows them to be able to develop the most effective treatment.

Based on this logic, it is possible that higher-order RRBs may have different functions for different children. For some children, interrupting higher-order RRBs may produce a negative effect or an increase in heart rate and it may not produce these changes in other children. Identifying this information would help clinicians select a more appropriate treatment for higher-order RRBs.

Rationale & Purpose

RRBs are typically maintained by automatic reinforcement (Rodriguez et al., 2012). However, it is unknown if the RRBs are maintained by an automatic positive (i.e., gain sensory stimulation) or an automatic negative reinforcement (i.e., remove/avoid aversive stimulation). One potential way to determine if an individual is engaging in RRBs to remove/avoid aversive stimulation or to gain access to sensory stimulation would be to assess preference for an uninterrupted arrangement versus an interrupted arrangement using a concurrent-chains assessment. In a concurrent-chains schedule, participants chose between two concurrently available stimuli (i.e., initial links) to obtain access to one of two reinforcers associated with the initial links (i.e., terminal links; Herrnstein, 1964). Thus, the purpose of the present study was to use a concurrent-chains

assessment to evaluate if higher-order RRBs are maintained by automatic positive or automatic negative reinforcement. In doing so, this will allow clinicians to develop more appropriate treatment packages in the future.

Methods

Participants

Three participants participated in the present study. All participants were between the ages of 5-11 and were diagnosed with ASD. All three participants attended a clinic in Central Missouri. Truman was a Caucasian 11-year-old male who had been diagnosed with ASD and spoke in English. He had a vocal verbal repertoire and could speak in complete sentences. Truman engaged in high levels of both vocal and motor stereotypy. His arranging and ordering behaviors assessed consisted of removing tape off of action figures and toys, picking stickers off of timers, throwing trash away, and separating markers and crayons. His selected ritual was taking tape off of action figures and toys. When interrupted, Truman engaged in problem behavior consisting of property destruction and noncompliance. Donald was an African American, English-speaking, 5-year-old male who was diagnosed with ASD. He engaged in non-contextual vocal sounds and his main form of communication was PECS. Donald engaged in high levels of vocal stereotypy. His arranging and ordering behaviors assessed consisted of playing with game pieces in a very specific manner, building toys in the same way, and putting toy people into a bus. His selected ritual was playing with game pieces in a specific manner. When interrupted, Donald engaged in flopping and crying. Jasper was a Caucasian, English-speaking, 8-year-old male who was diagnosed with ASD. He had a vocal verbal repertoire and could speak in complete sentences. His arranging and ordering behavior

assessed consisted of placing all stimuli cards face up on the table, aligning his tokens on his token boards, and placing items in rainbow order. His selected ritual was placing all stimuli cards face up. If interrupted, he engaged in screaming and crying, and property destruction.

Measurement

During the FA, data were collected on arranging and ordering. Truman's definition of arranging and ordering was any permanent product of tape removed from the action figures. Donald's definition of arranging and ordering was the full hamburger toy piece passing the planes of the lips of the pop-the-pig toy. Jasper's definition of arranging and ordering was flipping a stimuli card 180 degrees to be facing upwards. A frequency measure was used to record arranging and ordering. Frequency data were summarized as latency to the first response. This was done by calculating the number of seconds it took from the onset of the session for the behavior to occur. During the preference evaluation, data were collected on selection and arranging, and ordering. Selection was be defined as the participant lifting the colored box to expose one of the two terminal links. The definition of arranging and ordering was identical to the definitions during the FA.

Interobserver Agreement (IOA) was calculated across all phases of the study. This was calculated by dividing the smaller number by the larger number for each interval then averaging it across all intervals and converting it to a percentage by multiplying by 100. A second observer independently scored data during a minimum of 33% of sessions, across all phases. During the FA's Truman had an average IOA score of 97% (range, 96% to 100%), Donald had an average IOA score of 96% (range, 92% to 100%), and

Jasper had an average IOA score of 100%. During matching and preference assessments, all IOA was scored at 100% for all participants.

Treatment integrity data were collected on at least 33% of sessions across all phases (excluding pre-session exposure) by a secondary experimenter. Treatment integrity was calculated by taking the total number of correct steps divided by the total number of steps and then multiplied by 100%. Treatment integrity must have been scored above 85% average across sessions. Donald's FA had treatment integrity scored at an average of 95% (range, 80% to 100%). Truman's FA had treatment integrity scored at an average of 95% (range, 80% to 100%). And Truman's preference assessment had treatment integrity scored at an average of 95% (range, 80% to 100%). All other participants and phases had a treatment integrity score of 100%.

Preassessments

Parent Interview.

The restricted and repetitive behavior scale-revised (RBS-R) is a 43-item parent-report question are that measures both the presence and severity of RRBs (Bishop et al., 2013). It is used to measure the severity of repetitive behavior in people diagnosed with ASD. Each item is rated on a four-point Likert scale ranging from 0, meaning that the behavior does not occur, to a 3, which means that the behavior occurs and is severe. Typically, the higher scores will indicate more severe RRBs. Within the survey, there are six subscales present. They include stereotyped behavior, self-injurious behavior, compulsive behavior, ritualistic behavior, sameness behavior, and restricted behaviors. This allows for differential identification and scoring of discrete varieties of repetitive behaviors. Before conducting an FA, all parents or guardians of the participants were

asked to partake in the assessment to help us better evaluate their child's RRBs and provide insight into which rituals should be used during the FA. Truman's parent questionnaire reported that "instances of sameness" occurred and are a severe problem. Donald's parent questionnaire reported that "instances of sameness" occurred and is a severe problem and it results in difficulty with transitions and changing activity. Jasper's guardians did not respond.

Color Preference Assessment.

For the color preference assessment, experimenters conducted a multiple stimulus without replacement (MSWO) preference assessment (DeLeon & Iwata, 1996). Before the preference assessments, a list of five possible colors was generated. The colors that were used in the MSWO are purple, yellow, orange, blue, and green. Three separate and identical preference assessments were conducted with each participant.

At the start of each session, the experimenter randomized all of the colors on a table in no specific order. The participant had 30 s to engage with all of the colored cards. That included tacting them, pointing at them, or holding them. The experimenter then rearranged the order of colors and instructed the participant to "pick your favorite." Following each choice made by the participant, the experimenter removed the chosen color cards. The experimenter then shifted all of the color cards one space to the left and the leftmost card was moved to the furthest right space. The color that was chosen was not a part of the new array. These steps were followed to reduce the possibility of selections being chosen off a side bias. This procedure was followed until there were cards left to choose from. The moderately preferred colors were the colors used as the initial link stimuli during the concurrent chains arrangements. The colors used during

Traumas sessions were red and blue, the colors used during Donald's sessions were orange and blue, and the colors used during Jaspers sessions were purple and yellow.

Tangible Preference Assessment

An MSWO for tangible items was conducted for each participant to determine items to include in the FA. Six items were evaluated to see which were the highest and least preferred. The experimenter then began by providing the participant with 30 s access to each item. Following pre-session access, the experimenter laid out all six toys in front of the participant and instructed them to "pick your favorite." That item was given to the participant for 30 s and then removed. The steps were repeated until all items had been chosen. The highest preferred items were used in the tangible condition of the FA, and the moderately preferred items were used during the attention condition of the FA. Truman's highest preferred item was the instruments, and his moderately preferred items were the magnets. Donald's highly preferred items were the Knex, and his moderately preferred items were the magnets. Jaspers's highly preferred item was the marble maze, and his moderately preferred item was the number ball.

Rituals Assessment

A rituals assessment was conducted to identify which ritual to assess during the participant's FA. This was done by assessing three to four rituals for each participant and assessing the latency to arranging and ordering for each. Sessions were conducted in session rooms (5 m by 5 m). Sessions were 2 min, and no distractor items were present. Each of the session rooms contained items associated with each participant's rituals and the ritualistic stimuli were interrupted at the beginning of each session. One ritual was assessed at a time. A session was terminated following the participant engaging in the

behavior. The ritual with the shortest average latency to arranging and ordering was selected.

Functional Analysis

A latency-based FA of arranging and ordering was conducted for all participants. Sessions were conducted in session rooms (5 m by 5 m). Each of the session rooms contained items associated with each participant's ritual. Before all sessions, items associated with the ritual were intentionally rearranged. This was done to allow opportunities to rearrange. If the participant engaged in their ritualist behavior, the session was immediately terminated. The target behavior being observed was rearranging and ordering.

The FA included four conditions: attention, escape, ignore, and play (i.e., control). During the attention condition, the experimenter counted in for session and pretend to be busy reading a book. Contingent on the target behavior, the experimenter provided attention (e.g., "It's fine you don't need to fix it," "Stop," "Leave it") and then immediately terminated session. During the escape condition, the experimenter immediately began presenting demands. Demands were selected based on interviews and previous descriptions from caregivers and were delivered using three-step guided compliance. Contingent on target behavior, the experimenter moved away from the participant and provided a "break" and immediately terminated session. During the play condition, no demands were given to the participant and the participant had access to high-preferred items. Attention was provided at least every 30 s and was provided following requests for attention. If problem behavior occurred within 3 s to the intended delivery of attention, attention was not provided for 5 s. If the behavior occurred, session

was terminated 1 min later. During the ignore condition, the experimenter was present in the room but did not interact with the participant in any way. If the behavior occurred, session was terminated 1 min later.

Pre-Session Exposure

Pre-session exposure sessions were conducted for all three participants. This occurred before treatment preference sessions. The participants were exposed to the different contingencies through prompted choice trials. These trials served to teach the participant the relations between the initial links (i.e., colored boxes) and terminal links (i.e., interrupted arrangement or uninterrupted arrangement). During all of Truman's pre-session exposures, the experimenter used the least intrusive prompt that evoked a response to guide him to lift the different colored boxes, exposing him to the terminal links. During Donald and Jasper's pre-session exposures, the least intrusive prompt was used to have them point to the card, which lead to the experimenter lifting the colored box. The order in which the boxes were lifted was determined at random. Each of the two colors had 10 trials conducted. Following the pre-session exposure, a matching assessment was conducted. The purpose of the matching assessment was to ensure that the participants had learned the relationship between the initial and terminal links. For Truman, the ritualistic stimuli were placed on the table, he was handed a colored card and instructed to match. For Donald and Jasper, only one ritualistic stimulus was placed on the table (i.e., the interrupted arrangement or the uninterrupted arrangement), they were given two colored cards, and instructed to point to the one that matches. Each session consisted of 10 trials (five for each initial link) and placement was randomized to avoid responding due to a side bias. After a participant matched the initial-link stimuli to the

correct terminal-link stimuli for 90% of trials across 3 sessions, the treatment preference evaluation began.

Concurrent-Chains Preference Assessment

Following the matching assessment, each participants' preference for the arrangements was evaluated using a concurrent-chains procedure (Hanley et al., 1997). This procedure has been used to evaluate preference for different types of schedules of reinforcement (Hanley et al., 1997) but for the purpose of the current study, was used to evaluate the preference of higher-order RRBs. During these sessions, the two separate arrangements (i.e., interrupted arrangement and uninterrupted arrangement) were positioned under two different colored boxes (i.e., initial-link stimuli). Lifting one of the colored boxes resulted in access to the arrangement associated with that colored box (i.e., terminal-link stimuli). Each initial link was associated with a specific terminal link (i.e., interrupted arrangement and uninterrupted arrangement). The colored boxes (determined for each participant based on their color preference assessment) were placed on a table in front of the participant. The corresponding terminal links were underneath each box. The purpose of the arrangements being under a box was to remove the opportunity for the participants to see the arrangement interrupted. The experimenter then placed the instruction to "choose one" in a level voice. The participant then chose a colored box and removed it from the table. Contingent upon this behavior, the participant was given access to the terminal links (i.e., the interrupted arrangement or the uninterrupted arrangement). The participant then had 15 s of access to the terminal link. If the participant chose the interrupted arrangement, then they had the opportunity to rearrange

the items. Following the 30 s of access, the participant was repositioned in front of the colored boxes and was instructed to choose a box again.

Results

Figure 1 displays the results of the rituals assessment for Truman, Donald, and Jasper. For Truman, the shortest latency during the rituals assessment was observed during the tape ritual and the timer ritual. The tape ritual was selected to be used during the participant's FA. For Donald, the shortest latency was observed during the pop the pig ritual and the Knex ritual. The pop the pig ritual was selected to be used during the participant's FA. For Jasper, the shortest latency to engaging in a ritual was observed during the stimuli cards ritual. The stimuli cards were selected to be used during the participant's FA.

Figure 2 displays the results of the FA for Truman, Donald, and Jasper. For Truman, arranging and ordering were observed across all conditions, in under 60 s, demonstrating that the participant's ritualistic behavior is automatically maintained. For Donald, arranging and ordering was observed in all conditions, in under 80 s, suggesting that the participant's ritualistic behavior is automatically maintained. For Jasper, arranging and ordering was observed in all condition suggesting that the participant's ritualistic behavior was automatically maintained.

Figure 3 depicts the results of the matching assessment for Truman, Donald, and Jasper. For Truman, the participant scored 100% correspondence across trials the first three trials. Donald scored 60% and below during his first three sessions. Because of this, an error correction procedure was added. This consisted of providing him an independent opportunity and if he matched incorrectly, the stimuli were removed, reset, and the

participant was prompted using a full physical prompt to match correctly. Afterward, another independent opportunity was provided. During the next four sessions responding maintained at moderate to low levels of correct matching. Jasper has scored 60% across three session thus far and additional data are being collected.

Figure 4 depicts the results of the preference assessment for Truman and Donald. Truman initially showed very clear responding for the final product of his ritual. However, between sessions four through nine, we saw very little to no differential responding. Following session 10 and on, the responding changed to show favor for the interrupted arrangement. Donald initially showed very clear responding for the final product of his ritual as well. Sessions are still being conducted to show stability.

Discussion

The results of the current study extend previous research on restricted and repetitive behavior in individuals with ASD. More specifically, the purpose of the current study was to identify the function of ritualistic behavior. First, a rituals assessment was conducted to identify which ritual to include in the FA. Then, an FA of ritualistic behavior was conducted for each participant and experimenters found that all ritualistic behavior was maintained by automatic reinforcement for all three participants. Next, experimenters used a concurrent-chains preference assessment to evaluate if higher-order RRBs are maintained by automatic positive or automatic negative reinforcement. That is, participants had the opportunity to choose between an interrupted and uninterrupted arrangement within a concurrent-chains arrangement. The experimenters found that one participant (Truman) preferred the interrupted arrangement, and thus far, the second participant (Donald) prefers the uninterrupted arrangement.

Based on the results of the concurrent-chains arrangement, we can hypothesize what subtype of automatic reinforcement is maintaining the ritualistic behavior. If a participant consistently chose the uninterrupted arrangement then this means that the function of the participants' behavior is automatic negative. That is because previous exposure to the interrupted stimuli after selecting the corresponding initial-link stimuli, during the pre-session exposure, punished responding toward that choice. In other words, the interrupted stimuli are aversive to the participant and they are trying to avoid or remove the feeling associated with those stimuli. However, if the participant consistently chose the interrupted arrangement this suggests that their behavior is maintained by automatic positive reinforcement. That is because previous exposure to the interrupted stimuli, during the pre-session exposure, reinforced responding toward that choice. That is, fixing the arrangement itself is reinforcing and add some positive sensory consequences. Based on this logic, we hypothesize that Truman's ritualistic behavior is maintained by automatic positive reinforcement and Donald's ritualistic behavior is maintained by automatic negative reinforcement. It is interesting to note that arranging and ordering serves different functions for individuals with ASD.

One aspect of the study that should be highlighted is Truman's switch in responding during the preference evaluation. During the first few sessions of his preference assessment, Truman initially allocated his choice responding toward the uninterrupted stimuli. However, by the end of the assessment, experimenters observed a clear switch to show a choice responding for the interrupted stimuli. It is hypothesized that this is due to the previous history in the clinic. Truman had previously been blocked when engaging in tape removal while attending the clinic. It is possible that after repeated

exposure to the contingencies during the current evaluation, he learned that he would not be blocked from engaging in this behavior and his preference changed. Another potential reason for this switch could be that the reinforcing value of removing the tape could have increased across repeated exposure to the interrupted arrangement. Potentially, the function of removing the tape from the action figures was originally to terminate the aversiveness of the interrupted arrangement, but after repeated exposure to the interrupted stimuli, the tape removal itself became reinforcing.

It is interesting to note that we had to switch from a traditional functional analysis to a latency-based functional analysis. Initially, experimenters conducted traditional functional analyses to assess the function of the participants' rituals for Truman and Donald. During the traditional FA, if participants arranged the interrupted ritual, the stimuli were moved back to their baited placement to allow the participant to engage in the ritual repeatedly. However, across sessions responding decreased. It is possible that consistently interrupting the ritual and resetting the opportunity for the participant to engage in their ritualistic behavior, could have led to the satiation of the ritualistic behavior altogether or a new ritual could have been created (i.e., now an interrupted arrangement is a new ritual). Following this observation, the rituals assessment was completed with Truman and Donald and then a latency-based FA was initiated. Using a latency-based FA would allow experimenters to terminate each session following one instance of arranging and ordering and this may decrease the likelihood of satiation with their ritual. Based on this information, future researchers may want to use latency-based measures when evaluating ritualistic behavior.

There are several limitations of the current study. One limitation is the results of the matching assessment. In the current study, experimenters evaluated if the participants learned the relationship between the initial and terminal links before starting the concurrent-chains arrangement. During the matching assessment, Truman scored 100% matching during the first three sessions suggesting that he learned the contingencies. However, Donald and Jasper scored at or below 60% during their matching assessment and required a modification. This consisted of error correction for incorrect matching. Following error correction, correct matching did not increase for Donald. Due to time restraints, the preference assessment was initiated anyway and immediate preference for the uninterrupted arrangement was observed for Donald. Although we are observing clear preference during the preference assessment, it is possible that Donald never learned the contingencies via the pre-session exposures. Instead, his selection could be solely based on his favorite color. However, that is unlikely given a color preference assessment was conducted, and only moderately prefer colors were used as the initial links. It is also important to note that in previous research, matching assessments have not traditionally been conducted before concurrent-chains preference assessments. Instead, a participant is given pre-session exposure to the initial and terminal links of a concurrent-chains arrangement to learn the contingencies. After the pre-session exposure, the concurrent-chains arrangement has been initiated and preference has been evaluated

A second limitation is that the concurrent-chains preference evaluation has not been completed for Donald and Jasper. However, thus far, we are observing a clear preference for the uninterrupted arrangement for Donald. Given this information, the generality of our findings are limited.

Although there are some limitations, there are several implications of the current study. First, the results of current study suggest that a rituals assessment is effective in determining rituals to assess in FAs. That is, it may be helpful for clinicians to conduct a rituals assessment prior to a FA of ritualistic behavior to ensure that they are evaluating the most appropriate ritual.

Second, the results of the current evaluation may help inform appropriate treatment development. After determining the specific function of the behavior, multiple treatments could potentially be considered. If problem behavior is maintained by automatic positive reinforcement, then a reinforcement-based intervention may be the most appropriate. One heavily researched reinforcement-based intervention for automatically maintained behavior is competing stimuli. Effective competing stimuli may be identified by conducting a competing stimulus assessment (Piazza et al., 1998). However, if the behavior is maintained by automatic negative reinforcement then reinforcement-based interventions may not be appropriate. Instead, punishment-based or multiple component treatments may be most appropriate. For example, ERP may be a better treatment option (Boyd et al., 2013). ERP typically involves repeatedly and gradually exposing the individual to the stimulus acuminated with symptoms of anxiety. Response prevention is used during ERP to block the individual from engaging in ritualistic behavior. ERP has been proven to be an effective treatment for OCD, therefore leading us to experimenters to wonder if it could be used as a potential treatment for higher-order RRBs. Future researchers should compare treatments for each subtype of automatic reinforcement (i.e., automatic positive and automatic negative).

Moreover, the present study identified the functions that maintained high-order ritualistic behaviors. Results demonstrated that one participant's ritual was maintained by automatic positive reinforcement, and a second participant's ritual was maintained by automatic negative reinforcement. This is important because identifying the subtype of automatic reinforcement may allow clinicians to determine the most appropriate treatment. Future researchers should continue to assess and treat higher-order RRBs.

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Figures

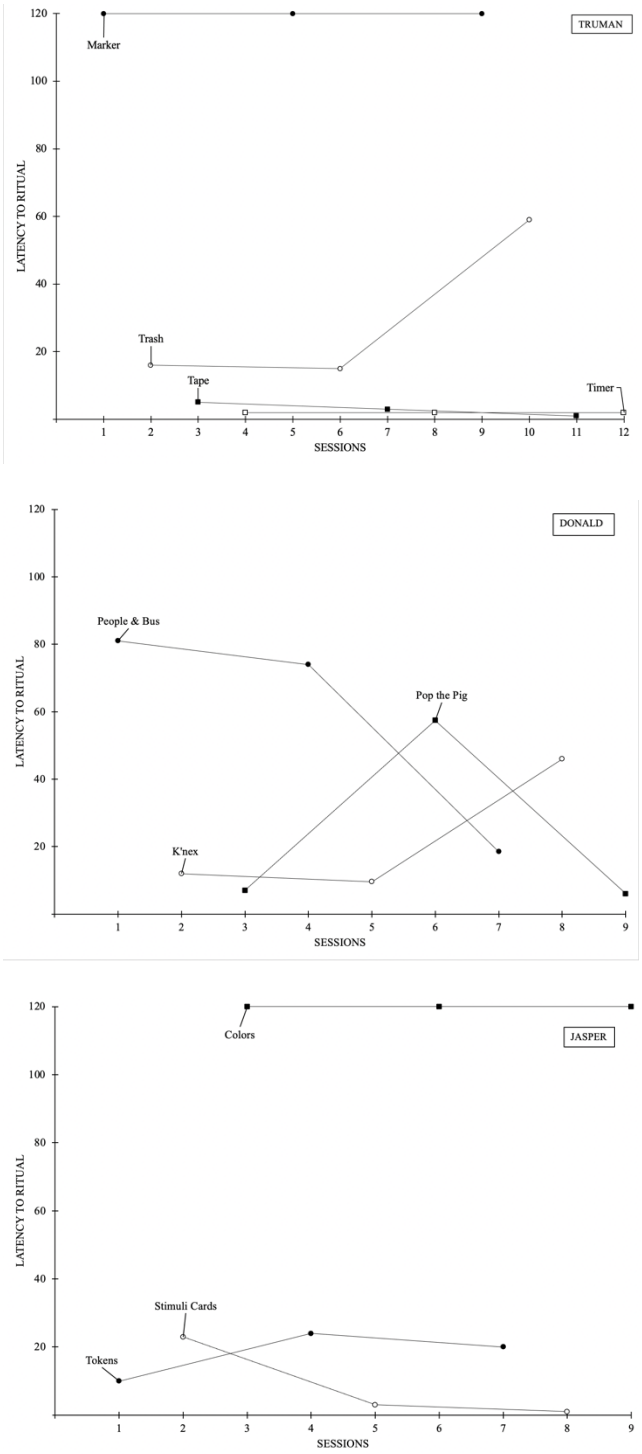


Figure 1. Latency in seconds to the ritualistic behaviorduring the rituals assessment for Truman, Donald, and Jasper

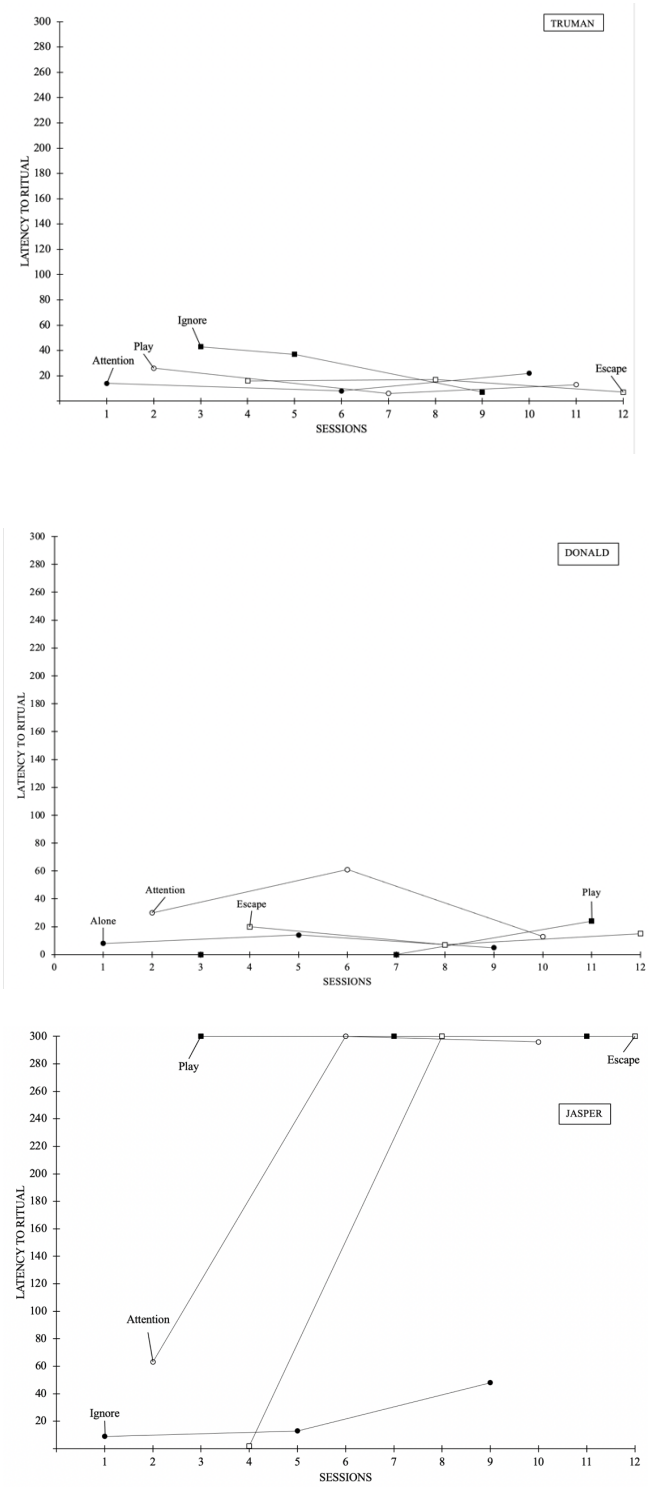
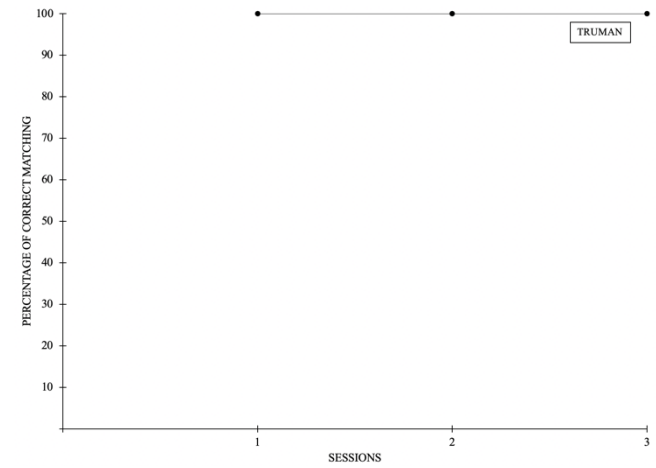
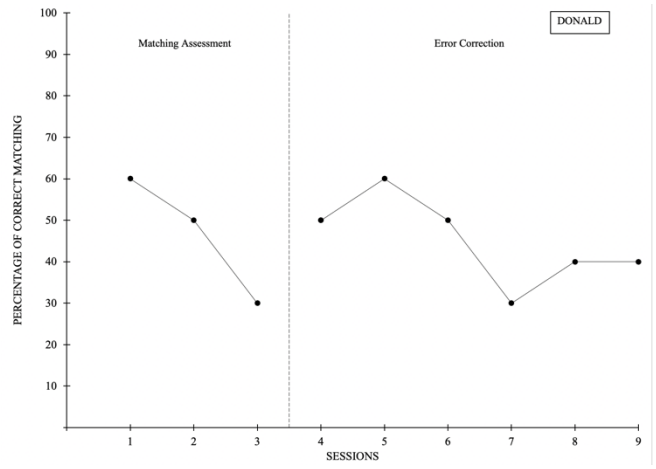


Figure 2. Latency in seconds to the ritualistic behavior during the latency-based functional analysis for Truman, Donald, and Jasper





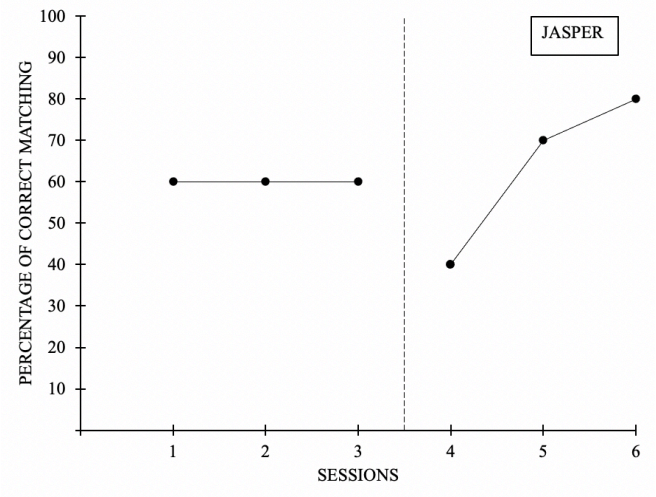


Figure 3. Percentage of correct matching during the matching assessment for Truman, Donald, and Jasper.

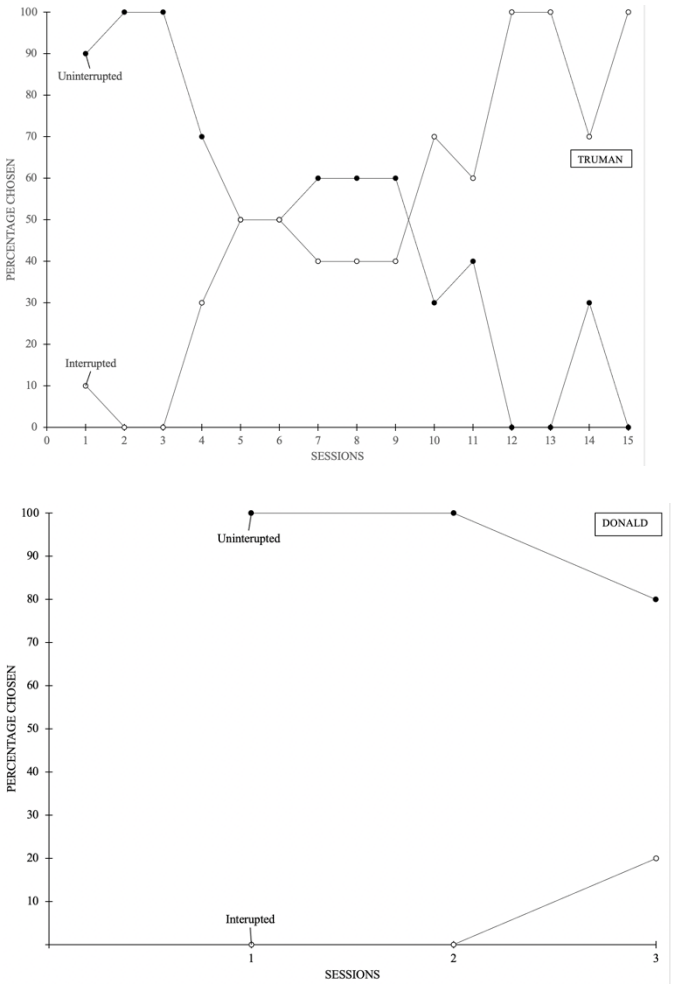


Figure 4. Percentage of times chosen during the concurrent-chains preferenceassessment for Truman and Donald.

Appendix

Client **Session** **Date** **Data collector**			
Pre Session exposure			
Target	**Yes**	**No**	**N/A**
Therapist used the least intrusive prompt possible to guide participant to lift the box			
30s access is given to the materials following exposure			
All problem behaviors are ignored			
Total Percentage=			

Appendix A. Treatment integrity data collection sheet for pre session exposure

Client **Session** **Date** **Data collector**			
Matching Assessment			
Target	**Yes**	**No**	**N/A**
The therapist does not provide any prompts to guide that participant to match the cards			
If color is matched correctly the therapist will provide a praise statement such as "good job matching the colors"			
If the color is matched incorrectly the therapist will simply remove the			

cards and represent the instruction to match			
All problem behavior is ignored			
Total Percentage=			

Appendix B. Treatment integrity data collection sheet for the matching assessment

Client **Session** **Date** **Data colelctor**			
Treatment Preference			
Target	**Yes**	**No**	**N/A**
The ritualistic stimuli are covered with the boxes			
The correct colored boxes are used			
The experimenters places the instruction “choose one” in a level voice			
Contingent on choosing a box, the participant is given 30s access to the terminal link			
All problem behavior is ignored			
Total Percentage=			

Appendix C. Treatment integrity data collection sheet for treatment prefference

Ignore	Latency FA Treatment Integrity	Yes / No / NA	# Correct
	1. Subject had no access to toys or activities.	Y N N/A	
	2. Therapist did not present demands or provided attention.	Y N N/A	
	3. If target problem behavior occurred, no programmed consequences were delivered and session was terminated after 1 minute (from PB).	Y N N/A	
Session #	4. If no problem behavior occurred, session was terminated after 5 min.	Y N N/A	____/____
_____	5. Therapist wore the correct color shirt _____	Y N N/A	_____%
Attention	1. Therapist waited at least 5 minutes in between sessions	Y N N/A	
	2. Subject was given a moderately preferred item "You can play with this toy if you want to, I will be busy over here"	Y N N/A	
	3. Contingent on target problem behavior, attention was delivered and session was terminated.	Y N N/A	
	4. If no problem behavior occurred, session was terminated after 5 min.	Y N N/A	
Session #	5. All non-targeted problem behavior was placed on extinction.	Y N N/A	____/____
_____	6. Therapist wore the correct color shirt _____	Y N N/A	_____%
Play	1. Therapist waited at least 5 minutes in between sessions	Y N N/A	
	2. Subject was given moderate and high preferred toys used in attention and tangible (if applicable)	Y N N/A	
	3. Therapist delivered attention approximately every 30 s.	Y N N/A	
	4. Therapist did not place demands on subject.	Y N N/A	
	5. If target problem behavior occurred, no programmed consequences were delivered and session was terminated after 1 minute (from PB).	Y N N/A	
Session #	6. If no problem behavior occurred, session was terminated after 5 min.	Y N N/A	____/____
_____	7. Therapist wore the correct color shirt _____	Y N N/A	_____%
Escape	1. Therapist waited at least 5 minutes in between sessions	Y N N/A	
	2. Subject had no access to toys or activities.	Y N N/A	
	3. The therapist presented demands every 30 s using a three-step prompting procedure (verbal, model, and physical prompts)	Y N N/A	
	4. Contingent on target problem behavior, therapist terminated all demands, provided subject with 30-s break, and ended the session	Y N N/A	
	5. Did not provide praise or items for compliance with demands.	Y N N/A	
Session #	6. If no problem behavior occurred, session was terminated after 5 min.	Y N N/A	____/____
_____	7. Therapist wore the correct color shirt _____	Y N N/A	_____%

Appendix D. Treatment integrity data collection sheet for the functional analysis

Session:	Date:	Participant:	Therapist:
Trial	Color	Correct matching (y/n)	PB (y/n)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Appendix E. Data collection sheet for the matching assessment

Session:	Date:	Participant:
Trial	Color Preference	PB (y/n)
1		
2		
3		
4		
5		

Appendix F. Data collection sheet for the matching assessment