"USING STEREOTYPY AS REINFORCEMENT" FOR ALTERNATIVE BEHAVIORS IN A CHAINED SCHEDULE

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by

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

"USING STEREOTYPY AS REINFORCEMENT" FOR ALTERNATIVE BEHAVIORS IN A CHAINED SCHEDULE

presented by Katherine Johnson,

a candidate for the degree of master of science in applied behavior analysis,

and hereby certify that, in their opinion, it is worthy of acceptance.

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LIST OF ABBREVIATIONS

ASD	Autism spectrum disorder
RIRD	Response interruption and redirection
DR	Differential reinforcement
SGD	Speech-generating device
S-	Stereotypy blocked component
S+	Stereotypy allowed component
IOA	Interobserver agreement
FR	Fixed ratio
RPM	Responses per minute

Abstract

Some individuals with autism spectrum disorder (ASD) engage in stereotypy, or repetitive behavior typically maintained by automatic reinforcement. Chronic stereotypy, especially at high frequencies, can interfere with learning and cause social stigmatization. Response blocking and response interruption and redirection (RIRD) have been found to be effective for reducing motor and vocal stereotypy. Previous literature has evaluated stereotypy as reinforcement for alternative behaviors, such as functional play or work tasks. The current study sought to replicate and extend previous studies by evaluating the effectiveness of a chained schedule on gaining stimulus control over stereotypy and increasing the complexity of alternative behaviors. Preliminary results indicate that chained schedules are effective at reducing stereotypy during the s-delta and increasing the complexity of alternative behaviors. These results emphasize the importance of providing contingent access to stereotypy when attempting to gain stimulus control over stereotypy.

"Using Stereotypy as Reinforcement" For Alternative Behaviors in a Chained Schedule

Some individuals diagnosed with autism spectrum disorder (ASD) or other developmental disabilities engage in stereotypy, or a behavior that usually a) can be insensitive to social stimuli, b) receives large amounts of time allocation, c) persists over time, d) consists of varying vocal and/or motor response forms which are usually repetitive, and e) is highly salient to others in the immediate environment (e.g., Rapp & Vollmer, 2005; Sackett, 1978; Tierney, McGuire, & Walton, 1978; Berkson & Andriacchi, 2000; Berkson, Rafaeli-Mor, & Tarnovsky, 1999; Smith & Van Houten, 1996). Stereotypy is typically maintained by automatic reinforcement, or reinforcement that is produced directly from engaging in the behavior itself and does not require social mediation (Lovaas, Newsom, & Hickman, 1987; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp, 2006; Rincover, Cook, Peoples, & Packard, 1979; Rapp, Miltenberger, Galensky, Ellingson, & Long, 1999; Vollmer, Marcus, & LeBlanc, 1994). Other studies have shown the possibility for multiply controlled stereotypy including automatic reinforcement in addition to the sensitivity to social reinforcers (e.g., Mace, Browder, & Lin, 1987; Durand & Carr, 1987; Kennedy, Meyer, Knowles, & Shukla, 2000).

Engaging in stereotypy, especially at high rates, can interfere with social activities and skill acquisition, and also cause performer to be socially stigmatized (Cunningham & Schreibman, 2008; Dunlap, Dyer, & Koegel, 1983; Lanovaz, Robertson, Socrono, & Watkins, 2013; Lovaas, Litrownik, & Mann, 1971; Koegel & Covert, 1972; Koegel, Firestone, Kramme & Dunlap, 1974; Risley, 1968). Since automatically maintained behaviors do not depend on social mediation for reinforcement, targeting stereotypy in a behavior change program can be difficult. Some common interventions from past studies

have included antecedent manipulations such as environmental enrichment with matched or unmatched stimuli (e.g., Vollmer, Marcus, & LeBlanc, 1994; Piazza et al., 2000), or consequence manipulations such as response blocking (e.g., Sprague, Holland, & Thomas, 1997; Fellner, Laroche, & Sulzer-Azaroff, 1984; Hanley, Iwata, Thompson, & Lindberg, 2000; Lerman, Kelley, Vorndran, & Van Camp, 2003; Rapp, Vollmer, St. Peter, Dozier, & Cotnoir, 2004;), variations of differential reinforcement including contingent access to stereotypy (e.g., Charlop, Kurtz, & Casey, 1990; Hanley et al., 2000; Wolery, Kirk, & Gast, 1985; Potter et al., 2013; Slaton & Hanley, 2016), and response interruption and redirection (e.g., Ahearn, Clark, MacDonald, and Chung, 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Schumacher & Rapp, 2011).

Vocal stereotypy requires special treatment modifications due to the inability to physically block vocal responses. Response interruption and redirection (RIRD) focuses on interrupting the stereotypic response and redirecting the behavior toward some other appropriate response. There is some evidence that RIRD functions as a punisher and the type of RIRD task (i.e., vocal demand vs. motor demand) may be irrelevant in its effectiveness in reducing stereotypy (Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Martinez & Betz, 2013). While RIRD has been shown to be effective by many studies (e.g., Ahearn et al. 2007; Ahrens et al., 2011; Schumacher & Rapp, 2011), other studies have shown that certain data collection methods (i.e., scoring stereotypy throughout the whole session vs. scoring stereotypy just outside RIRD implementation time) can lead to overestimating the true efficacy of RIRD (Carroll & Kodak, 2014; Wunderlich & Vollmer, 2015; DeRosa, Novak, Morley, & Roane, in review).

It is also important to consider the goal of stereotypy treatments since most stereotypy is not considered dangerous behavior (Slaton & Hanley, 2016) and to ensure that individuals have a therapeutic environment in which they have "freedom of individual movement and access to preferred activities" (Van Houten, Axelrod, Bailey, Favell, Foxx, Iwata, & Lovaas, 1988). Providing signaled access periods to stereotypy, especially contingent on some other alternative functional behavior, is in line with this goal.

Many studies have examined an inverse relationship between motor stereotypy and object manipulation and have focused on increasing object manipulation in attempt to decrease rates of motor stereotypy (Berkson & Mason, 1964; Davenport & Berkson, 1963; Horner, 1980; Singh & Milichamp, 1987). Alternative behaviors like object manipulation can be increased by using a person's own automatically-reinforced stereotypy as reinforcement for engaging in these more desirable behaviors (Charlop et al., 1990; Hanley et al. 2000; Potter et al. 2013; Slaton & Hanley, 2016). In order to use stereotypy as reinforcement for engagement in an alternative behavior, restricting access or blocking stereotypy through a gentle hands-down procedure is necessary. Hanley et al. (2000) observed that for two out of three participants, merely blocking stereotypy produced increases in appropriate item engagement. The third participant, however, needed a differential reinforcement (DR) component, or contingent access to stereotypy, to achieve similar results.

Potter et al. (2013) found that for all participants blocking motor stereotypy and prompting appropriate engagement alone did not reduce stereotypy. When blocking was in place without a DR component (i.e., contingent access to stereotypy), they observed an

increase in stereotypy and hypothesized that response blocking had an evocative effect and increased motivation to obtain the automatic reinforcement produced by the participant's stereotypy. One limitation is that they did not use overt discriminative stimuli to signal when stereotypy was and was not available. Using overt discriminative stimuli could enhance the potential for differential responding by making the differences between conditions more salient.

In addition to using stereotypy as reinforcement contingent on functional alternative behaviors, establishing stimulus control over stereotypy could prove to be beneficial for potentially generalizing treatment to more natural settings. Slaton and Hanley (2016) evaluated rates of automatically maintained motor stereotypy and item engagement using a multiple and chained schedule (i.e., the response requirement of two or more basic schedules must be met before reinforcement) in a multielement design. Contingent on stereotypy during the S- (i.e., stereotypy not allowed), a response cost was in place in which the participants lost all their tokens and had to redo their work. Slaton and Hanley reported less stereotypy and more consistent item engagement during chained-schedule sessions and had established stimulus control over stereotypy in the chained schedule. Unlike Potter et al. (2013), Slaton and Hanley did not prompt item engagement and chose tasks that participants had already masterered. Their results demonstrate the importance of contingent access to stereotypy when attempting to establish stimulus control and increase functional item engagement. One notable limitation to the study is the lack of an evaluation on whether a total response cost (i.e., participants losing all their tokens on S- contingent on stereotypy) was necessary for the chained schedule to be effective at decreasing stereotypy. One could argue that response

blocking in addition to a total response cost might make work time aversive for individuals and could make the treatment less effective in the long-term. Another limitation is that both Potter et al. and Slaton and Hanley only evaluated their treatments for motor stereotypy, not vocal stereotypy.

The current study aims to add to the stereotypy literature and address previous studies' limitations by evaluating similar procedures used in Hanley et al. (2000), Potter et al. (2013), and Slaton and Hanley (2016) by using a chained schedule to attempt to gain stimulus control over motor and vocal stereotypy and increase novel alternative behaviors. Contrasting to Slaton and Hanley, the current study will not implement a total response cost contingent on stereotypy, will include an evaluation of both motor and vocal stereotypy, and will teach novel alternative behaviors instead of mastered tasks in order to more closely examine the effectiveness of chained schedules on decreasing stereotypy.

Methods

Participants and Setting

Three participants from the age range of 8- to 10-years-old were recruited from a university-based clinic. All participants had a neurodevelopmental disability diagnosis (e.g., autism spectrum disorder or ASD). Treatment sessions were conducted in an analogue setting at first and gradually faded to regular clinical classrooms depending on the participants' progression in the treatment evaluation. To include participants for the study, the following criteria were used: a) reducing stereotypy and increasing an alternative behaviors were a goal in the participant's behavior plan; and b) a functional analysis revealed that the participant's stereotypy was automatically maintained, and c) informed consent and interest shown to participant in study by caregivers and/or providers. A criterion was in place that excluded individuals who engaged in high rates of potentially dangerous problem behavior (e.g., self-injury, aggression, property destruction).

Frank was a 6-year-old male diagnosed with ASD who could vocally speak a few words and sounds and also used a speech-generating device (SGD). According to Frank's VB-MAPP assessment, he has strengths in visual perception and matching-to-sample, listener, imitation, and some play skills (i.e., level 1 and some of level 2). He has deficits in mands, tacting, and social skills. Frank's caregivers and teachers reported that his motor stereotypy interfered with areas of skill acquisition, social interactions, transitions between environments, and it consumed a lot of his time.

Louie was a 11-year-old male diagnosed with ASD who could vocally emit some words and phrases and also had a SGD. According to his VB-MAPP assessment, he has

strengths in reading and writing but deficits in listener and intraverbal skills. A lot of his vocalizations consisted of delayed echolalia and was not contextually appropriate for most social settings. His caregivers and teachers reported that his vocal stereotypy interfered with areas such as skill acquisition, social skills, and it consumed much of his time.

Jon was a 9-year-old male diagnosed with ASD who could vocally emit to 3- to 4-word utterances or phrases but would often engage in immediate or delayed echolalia that was not contextually appropriate most of his social environments. According to his VB-MAPP, he has strengths in math, reading and writing, and listener skills with deficits in tacts, mands, and intraverbals. His caregivers and teachers reported that his vocal stereotypy interfered with skill acquisition, social interactions, and took up a lot of his time. Providers had also been targeting vocal stereotypy for over a year using RIRD procedures throughout his entire treatment sessions and had been unsuccessful at reducing his stereotypy to clinically significant levels.

Dependent Variables and Response Measurement

Functional engagement, prompts, appropriate vocal statements, blocking and interruption procedures were scored as a frequency (later reported as responses per minute) during both S- (stereotypy not allowed) and S+ (stereotypy allowed) components. *Functional engagement* was generally defined as completing one discrete work or functional play task (e.g., completing one problem on work sheet; completing on part of image of drawing such as the trunk of an elephant). *Prompted functional engagement* was defined as the participant completing a discrete work task within 3s of the therapist providing a prompt (usually gestural or vocal) for the correct answer.

Appropriate vocal responses were defined as contextually appropriate vocalizations like mands for items, therapist attention, breaks, information, or contextually appropriate statements (i.e., tacts). *Blocks* were defined as a therapist gently placing hands on participant's hands and guiding them down on the table or to participant's side for 2-3s; therapist removing participant's body from furniture (for arm pressing) contingent on motor stereotypy during the s-delta. To interrupt Louie and Jon's vocal stereotypy, RIRD (e.g., Ahearn et al., 2007) was implemented contingent on vocal stereotypy during the S- component. *RIRD* was defined as the therapist presenting vocal or motor demands contingent on vocal stereotypy during the S- component with a 3s onset/offset criterion.

Motor stereotypy, vocal stereotypy, reinforcement (S+) and work time (S-) were scored as a duration (later converted to percentage of component time engaged per component), with the exception of Frank's vocal stereotypy being recorded as a frequency (later reported as responses per minute). Vocal stereotypy was scored throughout the whole session, even when RIRD was implemented. All blocked attempts of stereotypy were scored as both stereotypy and as a block. The general definition for *motor stereotypy* was defined as any instance in which a participant engages in an action more than once with any part of his body and/or an object in a non-functional manner (i.e., not the way the object was intended to be manipulated). This repetitive manipulation could be in a back and forth motion, circular motion, etc. Each specific topography of each participants' stereotypy was also defined. Specific topographies of motor stereotypy for Frank included: tapping and sliding objects, lining up objects, body rocking, body pressing, visual inspection with objects, clothing manipulation, opening/closing objects, repetitive sitting, hand waving, skin pinching, and folding materials. Although motor

stereotypy was not a target behavior for Louie and Jon, motor stereotypy topographies for Louie included: hand flapping, pacing, head shaking, body rocking, squinting, and hand-to-mouth movements and for Jon included: hand manipulation, clapping, pacing, head shaking, and tapping. For Frank, *vocal stereotypy* was defined as repeating a sound more than once. Data recorders scored a new episode/occurrence if there was a 5s gap in between sounds. Louie's vocal stereotypy was defined as any noncontextual words/phrases or repetitions of noncontextual words, phrases, or sounds. Repetitions were defined as at least two occurrences of word or sound within a 5-s interval. Examples included rhythmic breathing patterns, noncontextual laughing (i.e., laughing in the absence of a humorous event), delayed echolalia, and noncontextual repetitive blowing of air. Since Louie's vocal stereotypy occurred with high frequency and often long durations, there was a 3s onset/offset criterion. Jon's vocal stereotypy was similarly defined but included idiosyncratic examples and nonexamples. *Reinforcement time (S+)* was defined as the therapist showing the S+ card to the participant, giving a vocal instruction (i.e., "you can do your own thing"), prompting participant to leave the table/S-area, providing free access to stereotypy (i.e., not blocking or interrupting stereotypy) and staying a 3-5 ft. away from the participant, if possible. *Work time (S-)* was defined as the therapist showing the participant the S- card with tokens while giving a vocal instruction (i.e., "it's time to do some work").

Table 1. *Participants' targeted forms of motor and vocal stereotypy.*

Participant	Target Motor/Vocal Stereotypy	Response Form
Frank	Motor	Tapping/sliding objects, lining up objects, opening/closing objects, body rocking, body pressing, visual inspection with objects, clothing manipulation, repetitive sitting, hand waving, skin pinching, and folding materials
Louie	Vocal	Immediate and delayed echolalia, rhythmic breathing/blowing air patterns, noncontextual laughing
Jon	Vocal	Immediate and delayed echolalia, rhythmic breathing patterns

The percentage of component time elapsed to the first onset of stereotypy in the first trial of each component per session was used to assess the level of discrimination between the conditions between the conditions (Tiger, Wierzba, Fisher, & Benitez, 2017; Slaton & Hanley, 2016). This was calculated by taking the latency to the first onset of stereotypy divided by the component duration and multiplied by 100. If stereotypy did not occur, the elapsed time was reported as 100%. Data are presented as the percentage of component time elapsed because each S- component varies in duration.

Interobserver Agreement

Data were collected on a computer using the BDataPro data collection program (Bullock, Fisher, & Hagopian, 2017). Each session was videotaped and scored in real

time as well as at a later time to calculate interobserver agreement (e.g., partial agreement within intervals) for 31% of sessions for Frank, 32% of sessions for Louie, and 30% of sessions for Jon. Agreement was calculated by dividing session data into 10s intervals and dividing the number of agreements and disagreements per interval and multiplying by 100 to get a percentage. Agreement for stereotypy averaged at 82% for Frank (range, 68% to 94%), 83% for Louie (range, 73% to 98%), and 83% for Jon (range, 69% to 97%). The overall mean agreement across all sessions averaged at 91% for Frank (range, 88% to 96%), 92% for Louie (range, 86% to 98%), and 89% for Jon (range, 71% to 95%).

Procedural Fidelity

Procedural fidelity was assessed for 13% of all sessions for Frank (mean, 94%; range, 75% to 100%), 14% of sessions for Louie (mean, 100%), and 34% of sessions for Jon (mean, 99%; range, 85% to 100%).

Procedures

A multielement design was used during the functional analysis and an ABAB reversal design was used during treatment evaluation. At least one session was conducted on a weekly basis with the exception of holiday breaks and if participants canceled their therapy appointments for that week.

Functional Analysis. Informal interviews with staff or caregivers and brief unstructured observations were conducted prior to the functional analysis. A functional analysis of stereotypy was conducted based on the procedures described by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) and included an alone condition to test for automatic reinforcement (Vollmer, Marcus, Ringdahl, & Roane, 1995). All

sessions lasted five minutes. The attention condition included a brief reprimand as well as the therapist gently touching the participant on the arm contingent on stereotypy (e.g., "stop that" or "keep a calm body/voice"). Since Frank engaged in high rates of motor stereotypy with objects, objects that Frank had a history of engaging in stereotypy with were present in all the functional analysis conditions, including the alone condition. The objects were included in order to control for any influence they may have exerted over the rate of Frank's stereotypy. Furthermore, a tangible session was not included for Frank because he engaged in stereotypy mostly with tangibles, therefore the deprivation of tangibles was not a hypothesized function for his motor stereotypy.

Baseline. A two-sided colored card was placed on the table next to the participant, although the contingencies associated with the colored card sides were not assigned until treatment evaluation sessions. Similar to Slaton and Hanley, the therapist started baseline sessions by instructing the participant to come to the table. Once at the table, the therapist prompted the participant to point to the card and gave an instruction to do work. Every one minute, the therapist flipped the card over provided praise for whatever the participant was doing at that time (i.e. "Good job staying in your chair"). Baseline sessions lasted six minutes and there were not any consequences delivered for stereotypy at this time. The cards were laminated on construction paper (5 in. x 7 in.) with a different color on each side. Ten square tokens were attached with Velcro to one card to determine whether or not differential responding occurs in the presence of the tokens before treatment. The return to baseline followed the same procedures with the exception of exposure to the contingencies associated with each card.

Treatment. The card color associated with the highest rates of stereotypy, or an increasing trend during baseline was assigned to the S- component for the chained schedule (Slaton & Hanley). Treatment sessions included a total of three trials with each trial consisting of three S- and three corresponding S+ components. For the S- component, the therapist prompted the participant to come to the work table, touch the S- card and said, "We're going on [color] now, so [play with the toys/do your work]." Response blocking or RIRD for stereotypy was in place until the participant fulfilled the response requirement and earned all the required tokens to produce the changeover to the S+ component. Response blocking for motor stereotypy was implemented for Frank, and RIRD for vocal stereotypy was implemented for Louie and Jon. Contingent on motor stereotypy for Frank, response blocking or a gentle hands-down procedure was implemented for 3-5s. Contingent on vocal stereotypy, the therapist required the participant to stand up from his chair and presented sight reading tasks (for Louie) or pictures to tact (for Jon) for the RIRD demands. The participant had to complete three consecutive RIRD demands without vocal stereotypy before returning to the S- work task. Following response blocking or RIRD for vocal stereotypy, the therapist prompted the participant to repeat the current step of the task before earning a token for that response (e.g., re-stack the building block). During the changeover procedure to S+, the therapist provided praise, prompted the participant to touch the S+ card, and said, "We're going on [S+ color] now, so you can have a break and do whatever." During the S+ component, therapist did not block or interrupt any stereotypy and tried to stay a few feet away from the participant. The S+ component lasted 60s for each trial. Similar to Slaton and Hanley, during the first three treatment sessions, the therapist modeled the

participant's stereotypy topographies and gave vocal instructions following the component changeover to S+. For example, the therapist said something like, "You're on [colored] card now. That means you can clap your hands like this [model stereotypy]" or "You can talk like this [modeled vocal stereotypy]." Each S+ component lasted one minute.

The task in the S- component differed for each participant and was determined via caregiver or provider suggestion; Frank was required to stack building blocks into a predetermined structure, Louie worked on worksheets of various academic tasks such as time telling, and tacting actions and body parts, and Jon worked on a drawing animals, writing his parents' names, tacting body parts, and intraverbal questions. Most-to-least prompting was used for new tasks and prompts were faded out within session as necessary. For Frank, the task was required to be built in the same way every time with additional steps to the structure being added as he met his criteria to advance the FR schedule. For Louie and Jon, the same tasks were presented progressively in line with the FR schedule during the first phase and were varied throughout the second phase to "train loosely" (Stokes and Baer, 1977) and try to promote generalization. New tasks were slowly faded in to take place of formerly mastered tasks were slowly faded out in order to maintain the FR schedule.

The response requirement (either academic or functional play responses) started on a FR1 for all participants. The advancement criteria for Frank to increase the FR schedule were as follows: four nonconsecutive sessions with motor stereotypy at or below 20% of S- component time (i.e., 80% reduction from highest point of baseline) or at or below 3s total duration, functional item engagement at or above 1.5 RPM, and a

maximum of one prompt per session. Louie required three consecutive sessions with vocal stereotypy at or below 15.8% of S- component time (i.e., 80% reduction from highest point of baseline), functional work engagement at or above 1.25 RPM (slightly below his average RPM for functional engagement while in acquisition) and a maximum of one prompt per session. Jon required three consecutive sessions with vocal stereotypy at or below 18.9% of S- component time (i.e., 80% reduction from highest point of baseline), functional work engagement at or above 1.25 RPM, and a maximum of one prompt per session.

Table 2. *Terminal FR schedule and functional engagement tasks for S- component per participant.*

Participant	Terminal FR Schedule	Functional Engagement Tasks
Frank	FR6	Stacking Lego structure
Louie	Reached FR7, regressed to FR5	Telling time worksheets, tacting actions and body parts, intraverbal WH-questions
Jon	FR10	Drawing picture, writing parents' names, tacting body parts, intraverbal WH-questions

Results

Functional Analysis

Frank had the high responding in the alone and play conditions compared to the other conditions suggesting a possible automatic function (see Figure 1). Louie's functional analysis results reveal undifferentiated results with more stable responding in the alone and play condition, suggesting an automatic function (see Figure 2). Jon's functional analysis results were also undifferentiated across all the conditions, suggesting a possible automatic function (see Figure 3).

Treatment

In the first baseline, stereotypy occurred generally at high percentages of component time and was variable for all participants. The different colored cards and tokens did not appear to have an effect on the participants' duration of stereotypy. Figure 4 show the results for Frank indicating that stereotypy is occurring more often in the S+ (mean, 52% of component time) than in the S- component (mean, 1% of component time). Both Louie (see Figure 5) and Jon's (see Figure 6) results also demonstrate more time allocated to stereotypy during S+ (mean, 14% of component time for Louie and 13% of component time for Jon) than in S- (mean, 33% of component time for Louie and 48% for Jon). In the return to baseline phase, there was an increase in stereotypy in each component for all participants relative to treatment.

During both baseline phases, Frank had a lower rate of independent functional engagement with toys during S- (mean, 0.3 RPM) than in treatment phases (mean, 2.56 RPM) (see Figure 7). Frank's rate of prompted functional engagement in S- during treatment phases was 1.22 RPM. Frank met his terminal goal of FR6 for building the

building block tower structure. For Louie, Figure 8 shows that during baseline phases he had a lower rate of independent functional work engagement during S- (mean, 0 RPM) compared to S- treatment phases (mean, 2.79 RPM). Louie reached and mastered tasks on a FR7, but researchers decided to regress back to a FR5 due to his increased stereotypy responding on S-. Louie's mean prompted functional work engagement during S- treatment phases was 0.43 RPM. Figure 9 displays Jon's mean functional work engagement during treatment phases in the S- was 3.18 RPM compared to 0.33 RPM in baseline phases. Jon's rate of prompted functional work engagement during S- in treatment phases was 0.22 RPM.

Figure 11 shows the latency data for Frank which demonstrates a shorter latency to stereotypy on S+, or a shorter percentage of component time elapsed (mean, 35%) than on S- (mean, 78%). Louie's mean component time elapsed for vocal stereotypy was 43% on S- and 38% on S+ (see Figure 12). Jon's mean component time elapsed during S- for vocal stereotypy was 47% compared to 18% in S+ (see Figure 13). (For summarized table of all participants, see Figure 10).

Data were also collected on each participants' non-targeted form of stereotypy throughout baseline and treatment phases. Frank's mean rate of vocal stereotypy was 0.7 RPM in S- and 1.00 RPM in S+ during treatment phases compared to 1.05 RPM and 3.17 RPM in baseline phases, respectively. For Louie, the mean percentage of component time engaged in motor stereotypy during treatment phases was 7% in S- and 19% in S+ compared to baseline phases were the mean was 56.2% in S- and 65.2% in S+. For Jon, the mean percentage of component time engaged in motor stereotypy during treatment

phases was 1.3% in S- and 7% in S+ compared to baseline phases of 19% in S- and 19% in S+.

Response blocking and RIRD data were also collected for each participant. There was a general decreasing trend for the rate of response blocking for Frank (see Figure 14) and percentage of component time engaged in RIRD for Louie and Jon (see Figure 15 and 16, respectively).

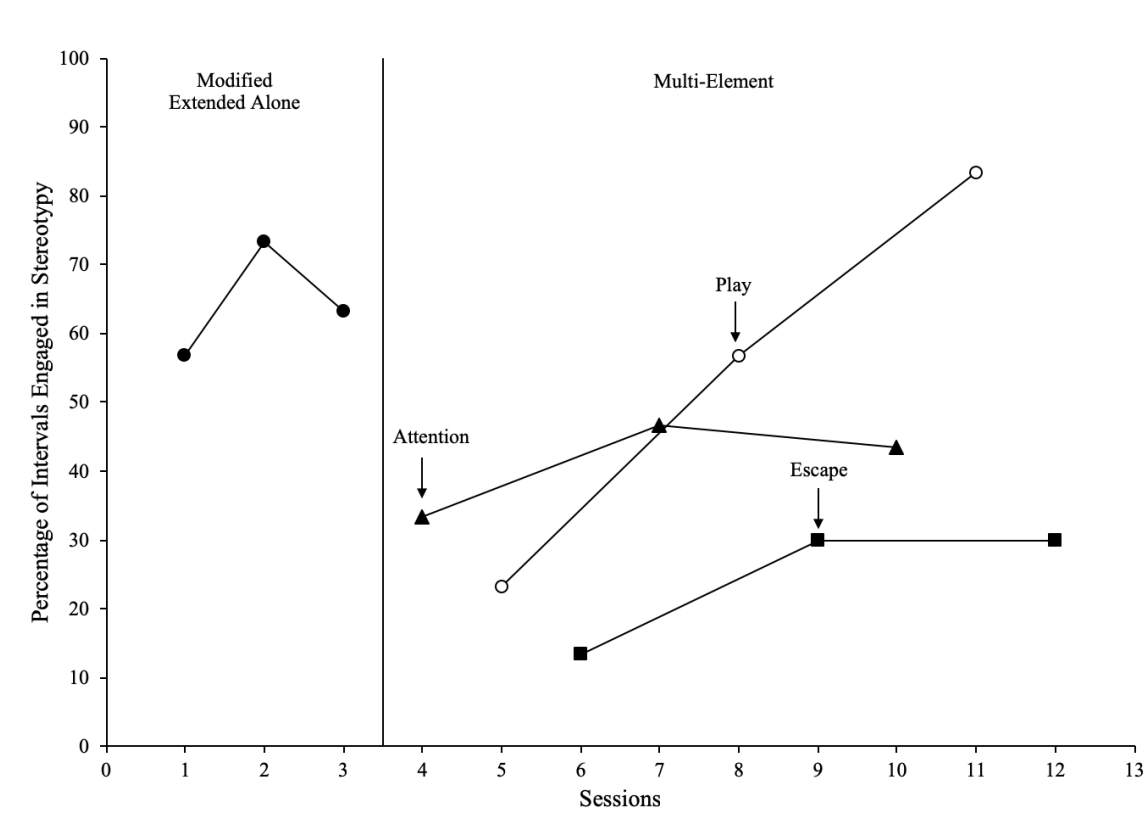

Figure 1. Results of functional analysis for Frank depicting the percentage of intervals engaged in motor stereotypy across a modified extended alone condition and the multi-element conditions.

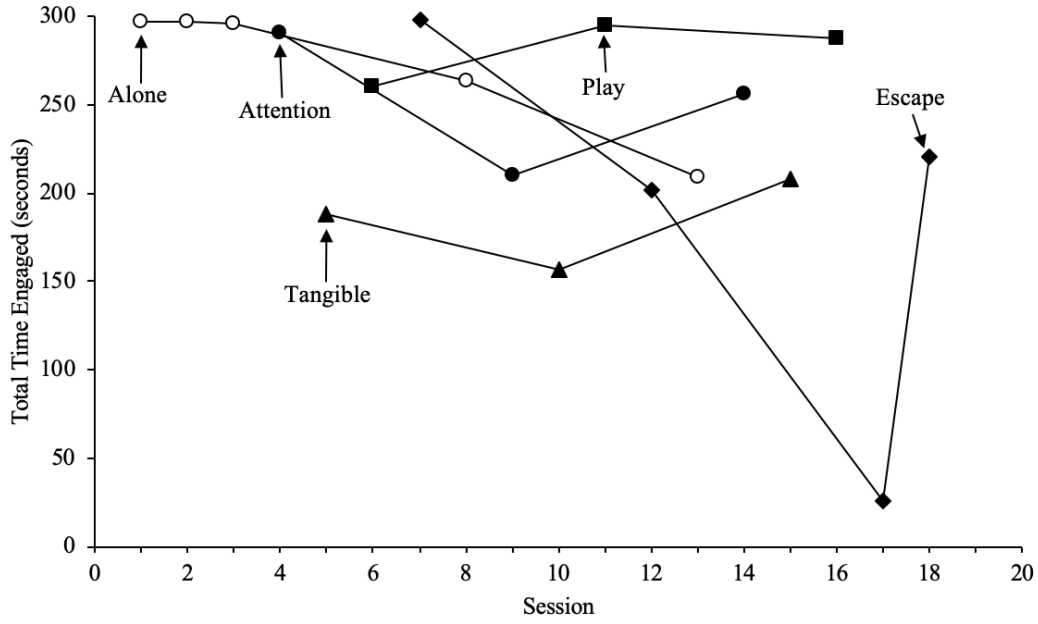

Figure 2. Results of functional analysis for Louie depicting the total time engaged in stereotypy.

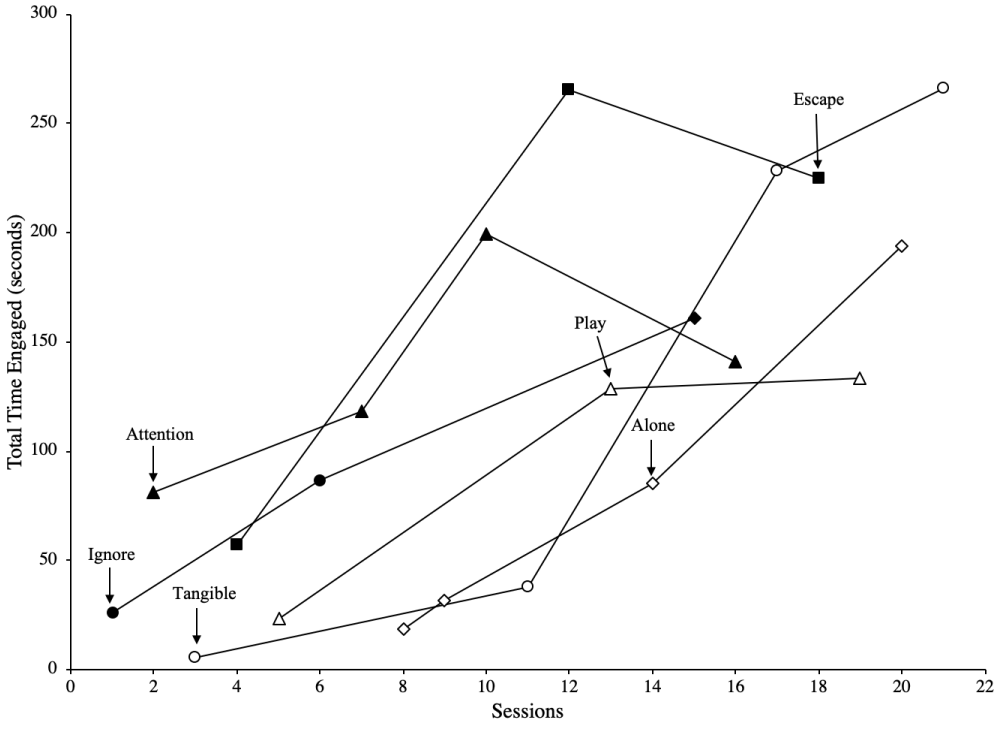

Figure 3. Results of functional analysis for Jon depicting the total time engaged in stereotypy.

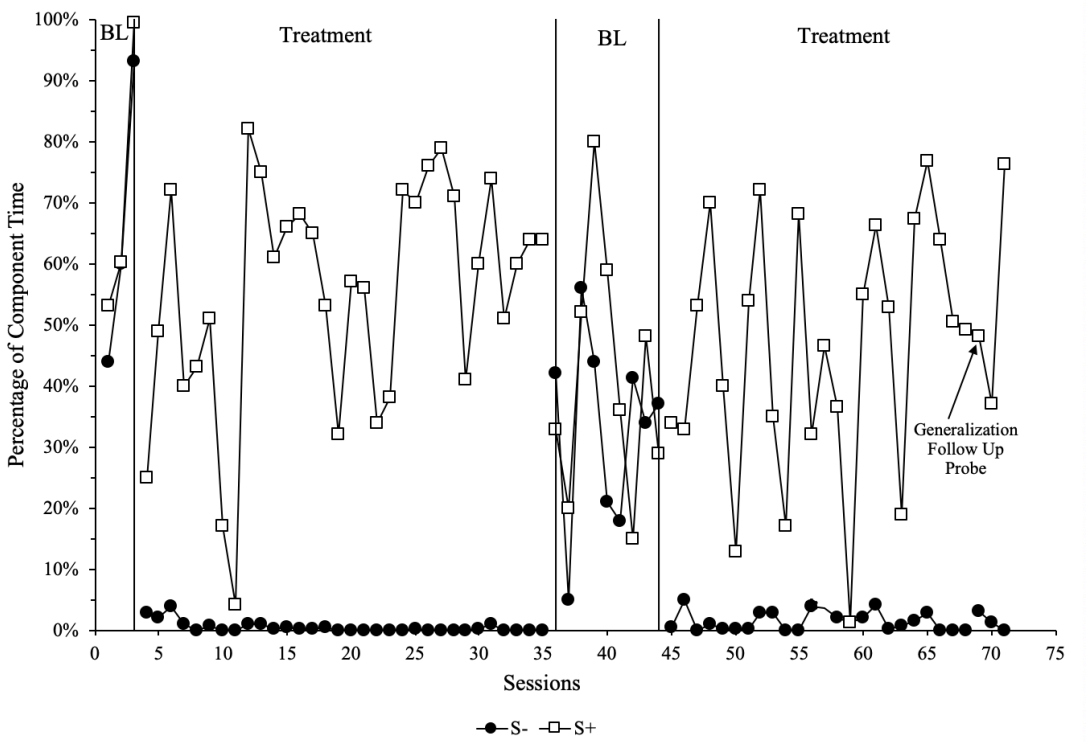

Figure 4. Successful and blocked attempts of stereotypy during the S+ and S- components for Frank.

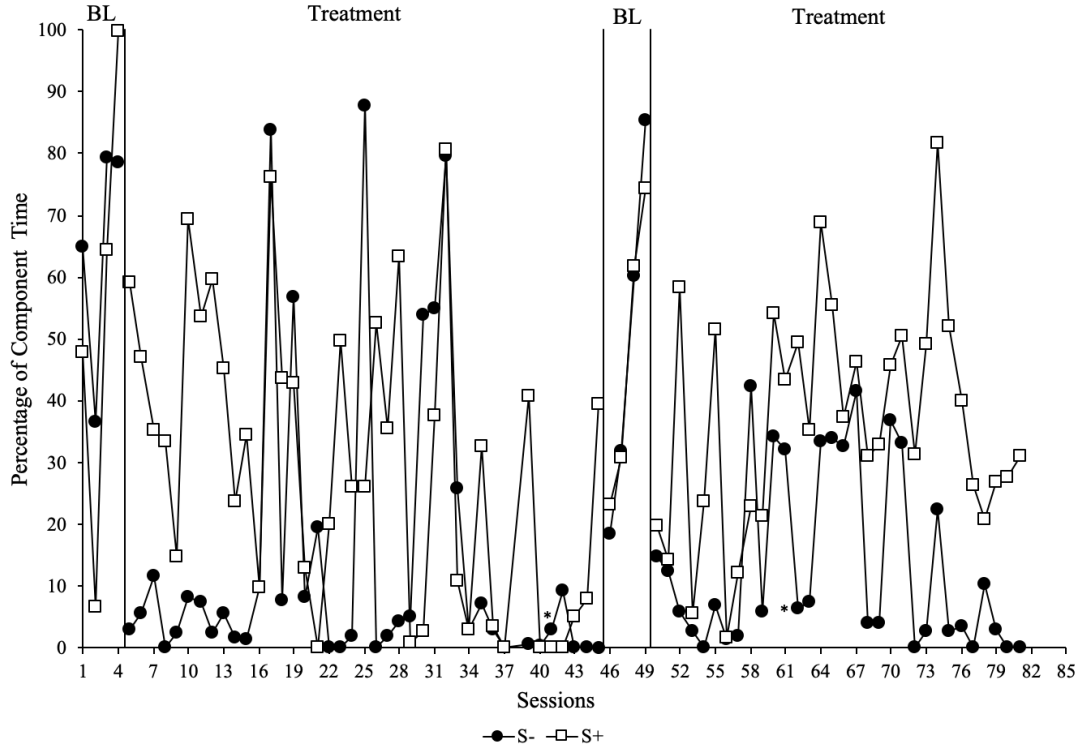

Figure 5. Percentage of component time engaged in vocal stereotypy during S+ and S- for Louie. The asterisk on session 42 indicates a change of room and the asterisk on session 61 indicates the start of new work task.

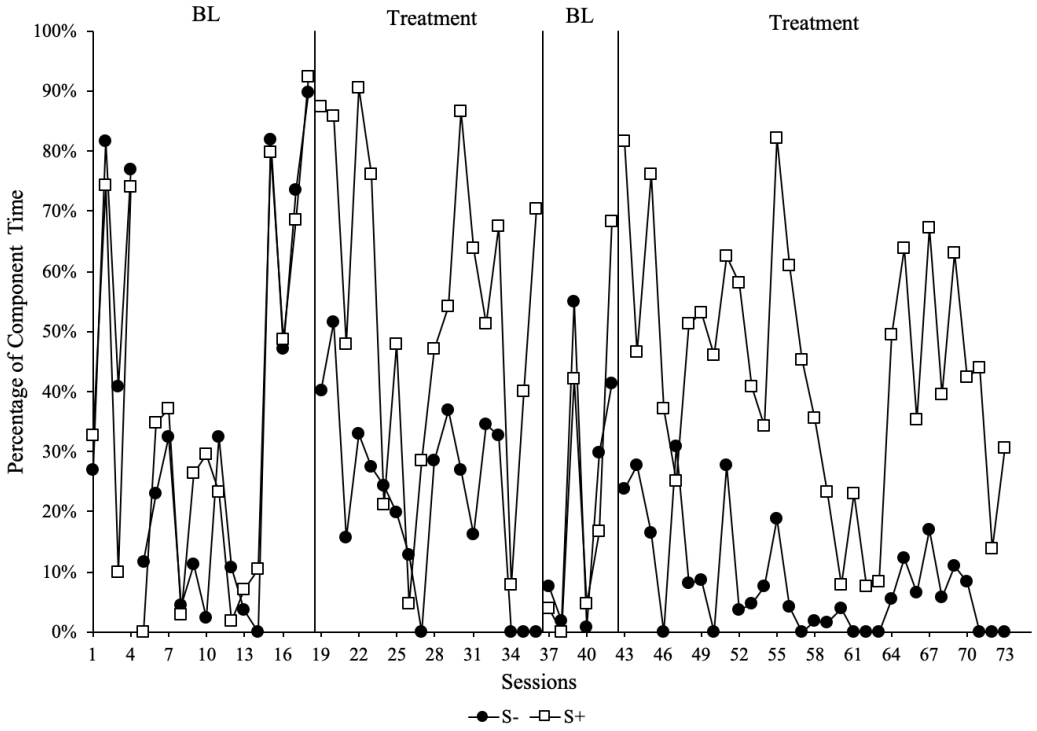

Figure 6. Percentage of component time engaged in vocal stereotypy during S+ and S- for Jon.

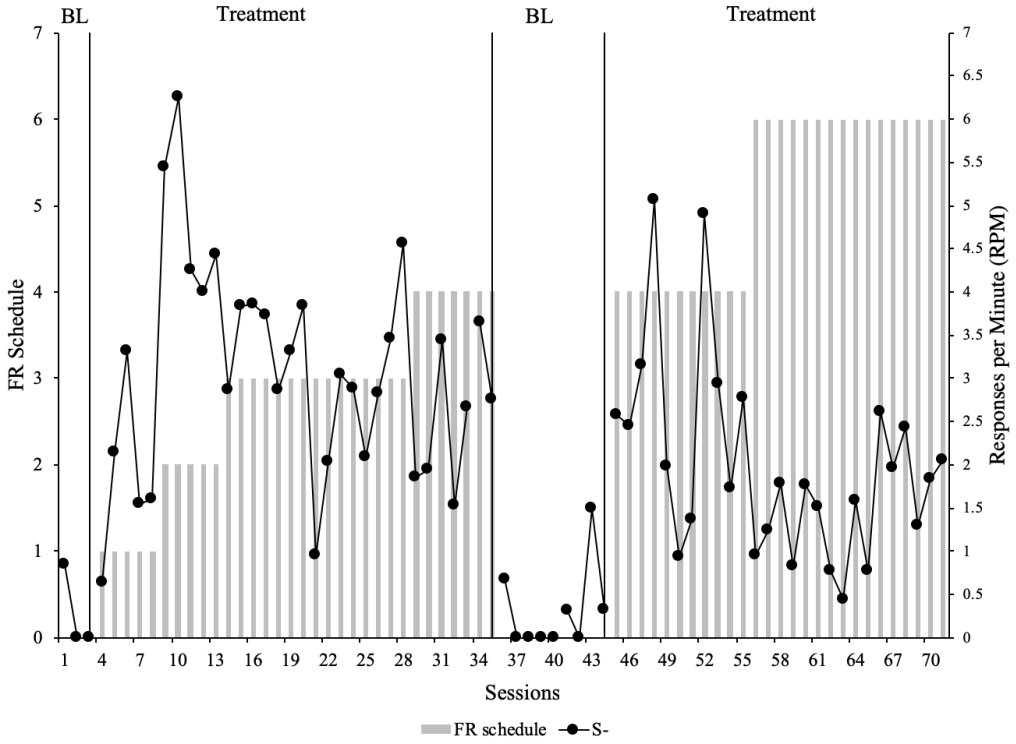

Figure 7. Rate of independent functional item engagement and FR schedule during the S- component for Frank. The primary y-axis (bar graph) depicts the FR schedule rate of and the secondary y-axis (line graph) depicts the Frank's independent functional engagement.

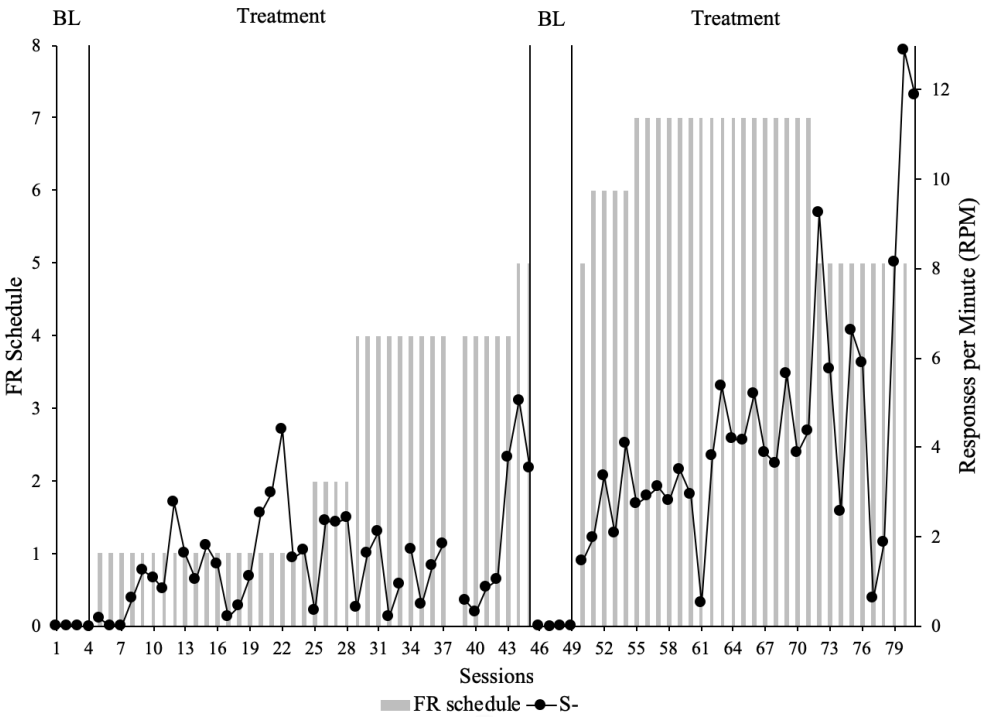

Figure 8. Rate of independent functional item engagement and FR schedule during the S- component for Louie. The primary y-axis (bar graph) depicts the FR schedule and the secondary y-axis (line graph) depicts Louie's rate of independent functional engagement.

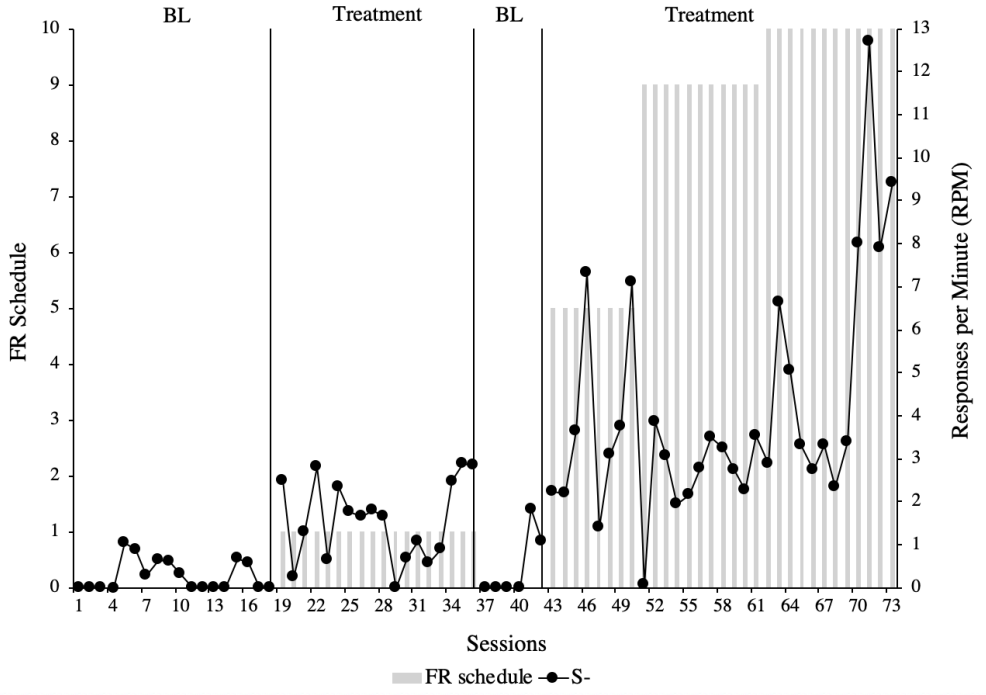

Figure 9. Rate of independent functional item engagement and FR schedule during the S- component for Jon. The primary y-axis (bar graph) depicts the FR schedule and the secondary y-axis (line graph) depicts Jon's rate of independent functional engagement.

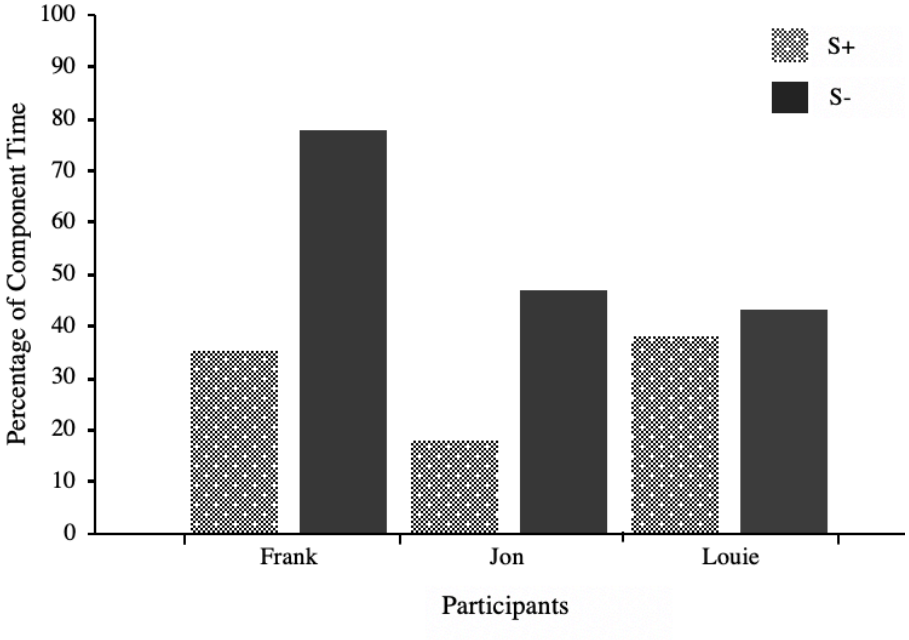

Figure 10. Mean percentage of component time elapsed to the first instance of stereotypy per session in the S+ and S- components for all participants.

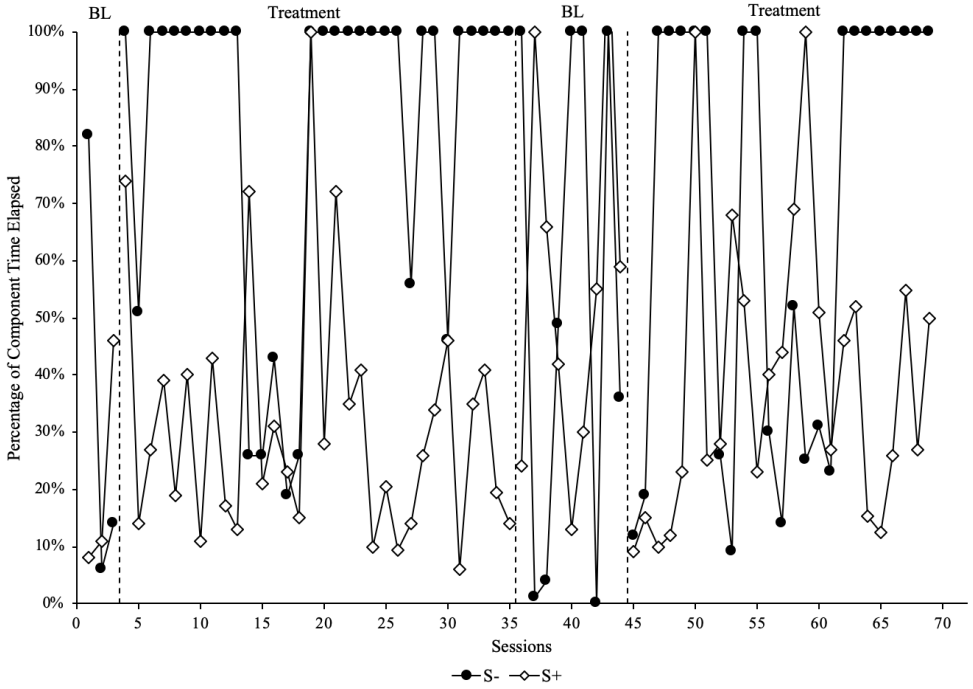

Figure 11. Latency to the first instance of motor stereotypy per session in the S+ and S- components for Frank.

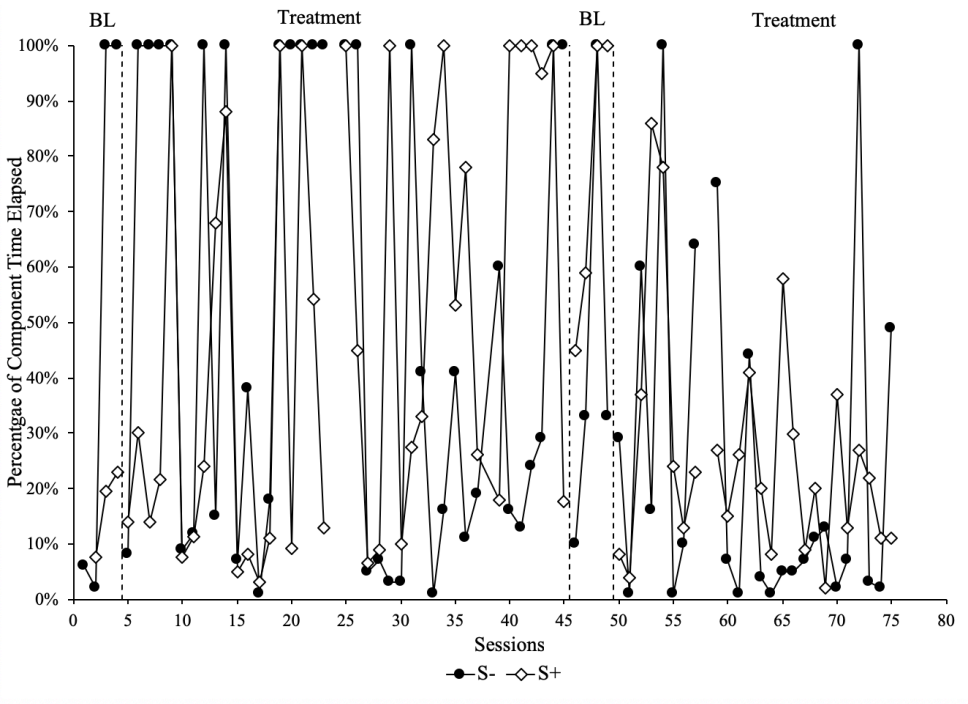

Figure 12. Latency to the first instance of vocal stereotypy per session in the S+ and S- components for Louie.

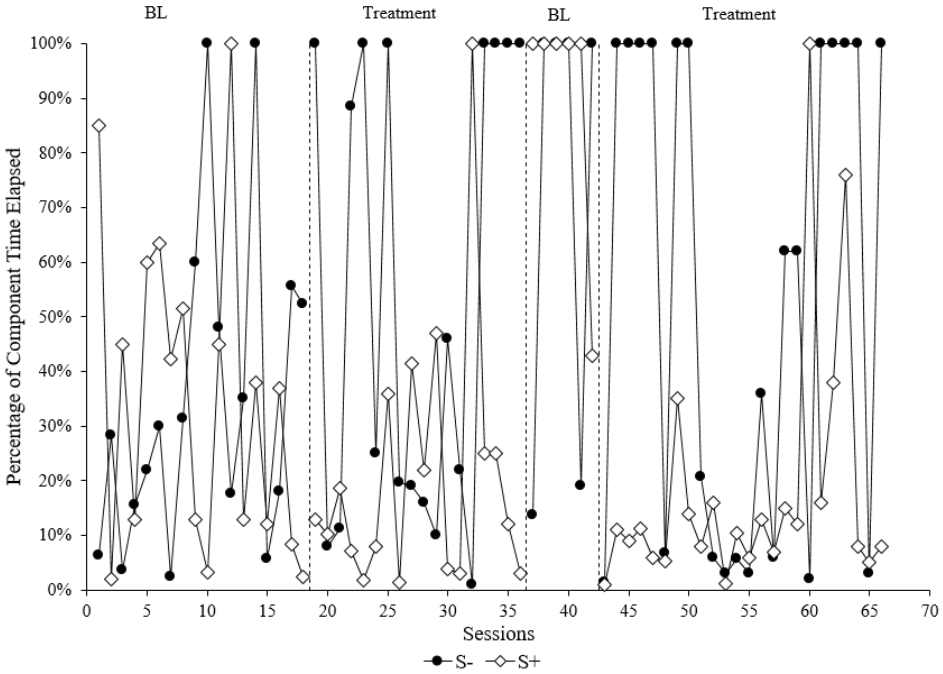

Figure 13. Latency to the first instance of vocal stereotypy per session in the S+ and S- components for Jon.

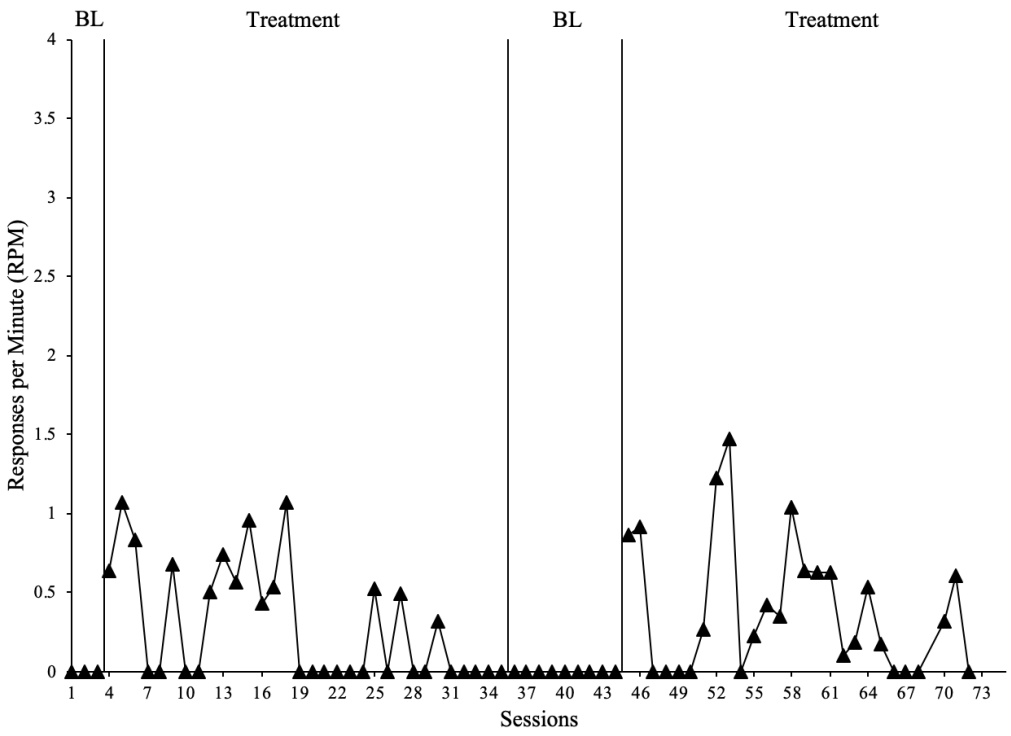

Figure 14. Rate of therapist's response blocking for Frank's motor stereotypy.

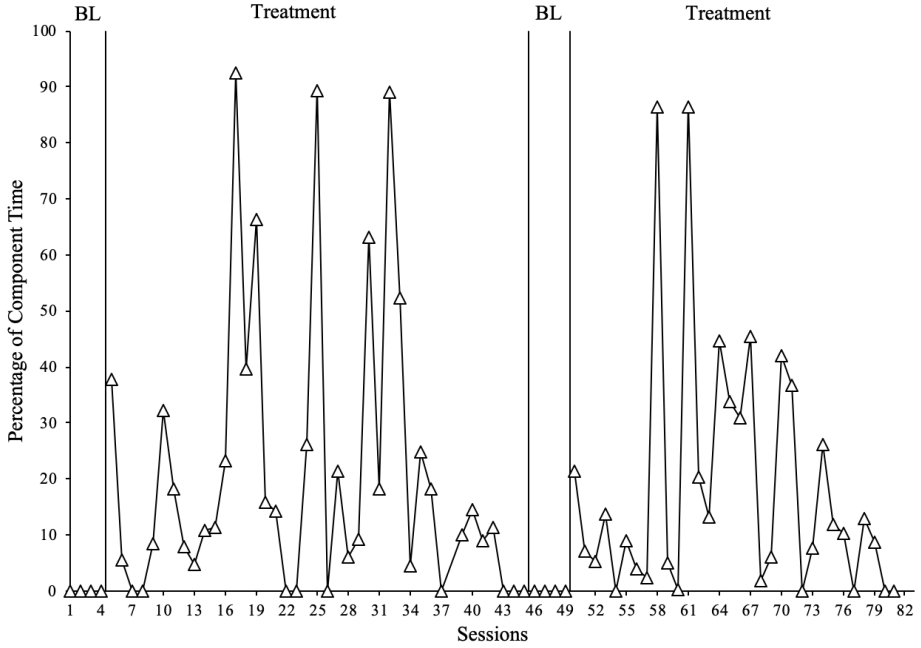

Figure 15. Percentage of component time therapist implemented RIRD for Louie's vocal stereotypy.

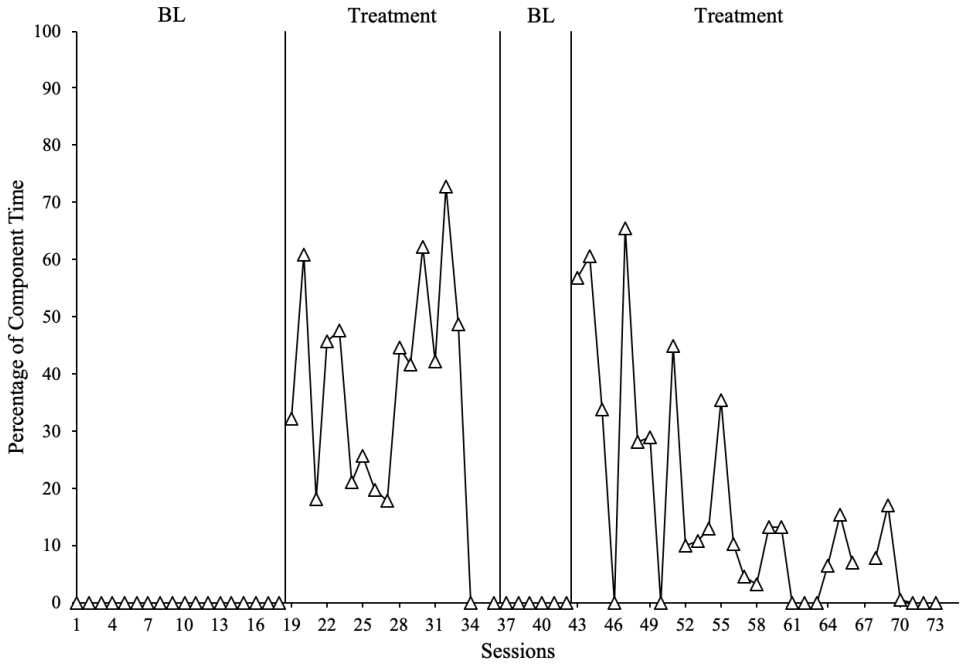

Figure 16. Percentage of component time therapist implemented RIRD for Jon's vocal stereotypy.

Discussion

Results indicate that using stereotypy as reinforcement for alternative behaviors through chained schedules of reinforcement can be effective at reducing both motor and stereotypy during the s-delta and increasing alternative novel behaviors such as leisure activities or academic skills. These results extend the research of Hanley et al., Potter et al., and Slaton and Hanley by replicating and extending similar procedures to vocal stereotypy. To the best of our knowledge, this is the first study that uses both motor and vocal stereotypy as reinforcement in a chained schedule to increase novel alternative behaviors without the use of a total response cost. Using a chained schedule to gain stimulus control over stereotypy and providing times in which individuals can engage in stereotypy contingent on more appropriate behaviors is a desirable treatment option and resembles an important pattern observed in everyday life (i.e., following a low probability behavior with a high probability, otherwise known as the Premack principle).

Using a chained schedule of reinforcement may be more effective when targeting motor stereotypy rather than vocal stereotypy due to the nature of the chained schedule and the need and difficulty of blocking all sources of automatic reinforcement during S-. It may be the case that implementing a total response cost for vocal stereotypy could may the procedures more effective at decreasing stereotypy during the S- component.

All participants demonstrated from the latency data that their stereotypy was most likely under stimulus control (i.e., the presentation of the s-delta/S- and S+ came to exert control over Frank and Jon's target stereotypy). For Louie, an argument can be made that his stereotypy was potentially under contingency control (i.e., engage in vocal stereotypy during first trial of S-, therapist implements RIRD, has lower durations or no vocal

stereotypy during second and third trials of S-). Special modifications might need to be made for such individuals whose stereotypy is under contingency control rather than stimulus control in similar interventions. One way to increase the likelihood of obtaining stimulus control over stereotypy would be to increase the saliency of the two conditions. Researchers already had programmed stimuli to help enhance the saliency between the S-, RIRD, and S+ conditions (e.g., different colored cards for components and RIRD, prompted participant to stand during RIRD contingent on vocal stereotypy in S-, prompted participant to leave table during S+ time, etc.). However, more artificial stimuli could have been added to help enhance the differences between the conditions such as having the participant wear a bracelet during the time in which stereotypy was allowed (e.g., Anderson, Doughty, Doughty, Williams, & Saunders, 2010).

One consideration is the examination of stimulus control over stereotypy. It could be argued that all participants' stereotypy was under stimulus control as shown by the participants' latency data, but what stimuli in the environment, other than the schedule-correlated overt stimuli, influenced control over their stereotypy is up for debate. Researchers did their best to control for other possible sources of stimulus control (i.e., therapist's physical proximity to participant), but there was no experimental evaluation of all the stimuli in the environment. Therefore, it is possible that the task itself in the S- component could have exerted some stimulus control over stereotypy. The same task was presented even after mastered while a new task was introduced during all S- components in the first phase. Although they were not necessarily presented in the same order every time (with the exception of Frank and the building blocks tower), it is still possible the task could have exerted some control over responding. Future studies could evaluate

more carefully the environmental stimuli that might influence stereotypy during similar discrimination training treatments.

Choice of task was also incorporated and may have had an effect on the rate of stereotypic responding. While influence of choice of task was not experimentally evaluated in this study, there is some anecdotal evidence that choice may help to reduce the rate of stereotypy. It might be that if the task if more preferred to the individual, it may work to compete with their stereotypy and decrease the need to seek that automatic reinforcement. Further studies could evaluate the influence of choice of task on rates of stereotypy while pursuing similar interventions and goals.

One important thing to note is that Louie engaged in some specific forms of behavior that resembled and met definitions for stereotypy in S- component but appeared to be socially mediated. For example, Louie would engage in vocal stereotypy on S- causing the therapist to implement RIRD procedures. On the third instance of compliance during RIRD demands, Louie would engage in this behavior resembling his other topographies of stereotypy causing the RIRD sequence to restart. Due to this behavior, Louie would stay in RIRD and be scored for larger of percentage of component time engaged in stereotypy. In order to prevent this, researchers changed Louie's RIRD task to match his S- component task, resulting in the possible extinction of this behavior. Researchers could have also attempted to more precisely define this behavior and differentiate it from his "true" stereotypy. Altogether, this finding brings into question the sensitivity to social reinforcers stereotypy might have. Whether or not this same type of behavior was seen outside of treatment evaluation sessions is unknown, but his provider

had reported higher rates of stereotypy during more aversive tasks. Further research could evaluate the complexities of stereotypy and its potential to be sensitive to social stimuli.

Another important thing to note is that although Louie had reached a FR7 for functional engagement and mastered those tasks, we decided to decrease his FR schedule to FR5 due to our hypothesis that his stereotypy might decrease if the FR requirement was reduced. One suggestion for future research or clinical application might be to increase the reinforcement period or consider the possibility of schedule strain on behaviors such as stereotypy.

Although researchers were able to decrease stereotypy on S- and demonstrate stimulus control over stereotypy for all participants, there are several limitations to this study. One possible limitation is that we did not evaluate preference for activity or work task used during S- component. While choice between two tasks was provided in the later sessions of the second phase of treatment for Louie and Jon, this did not result in a preference hierarchy for tasks. Future studies could evaluate preference for toys or activities when attempting to decrease stereotypy and increase alternative behaviors.

Another limitation is the amount of time and exposure per week to treatment evaluation sessions for each participant. Each participant received, on average, approximately 30-60 minutes of treatment sessions per week with the exception of holiday breaks. More robust treatment effects may have been observed if participants were exposed to more treatment sessions per week.

Another possible limitation involves with Frank and his evolving response topographies of motor stereotypy. As the study progressed and certain response topographies were punished during the S- component, his topographies of motor

stereotypy would occasionally shift to topographies that researchers could not physically block (e.g., repetitive facial movements). When this occurred, the therapist would prompt him to keep working by saying something like “You’re still working.” Since this topography did not match our original definitions and the therapist was unable to physically block this, it was not scored as stereotypy. Future research could evaluate the side effects of such treatments on stereotypy and how to prevent evolving topographies of stereotypy from occurring.

Despite these limitations, which can be further investigated given the suggestions above, the current study extends a small area of research in the field and provides a desirable treatment option for those individuals with high rates of automatically maintained stereotypy. We believe chained schedules can effective at gaining stimulus control over stereotypy, reducing stereotypy during the S- component, and increasing novel alternative behaviors.

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