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Evaluating the generalization and maintenance of treatment effects through stimulus control based interventions

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**Evaluating the Generalization and Maintenance of Treatment Effects through Stimulus
Control Based Interventions**

A Thesis Presented

By

Kevin Schlichenmeyer

In Partial fulfillment of the requirements

for the degree of

Master of Science

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**Evaluating the Generalization and Maintenance of Treatment Effects through Stimulus
Control Based Interventions**

A Thesis Conducted

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Abstract

Stereotypy is a prevalent response pattern exhibited by children with an Autism Spectrum Disorder (ASD) and is associated with academic and social impairments. We conducted a functional analysis and treatment assessment for stereotypy exhibited by four children diagnosed with an ASD. For three participants exhibiting motor stereotypy, we evaluated the efficacy of a 10s hands down procedure. For one participant exhibiting vocal stereotypy, we evaluated the efficacy of a response interruption and redirection procedure. In an effort to promote generalization of treatment effects, we evaluated the effects of pairing a stimulus cue during intervention test sessions to determine whether inhibitory stimulus control could be established. Although all interventions successfully reduced stereotypy, we did not observe generalized suppression during non-intervention test sessions for all participants. Implications for future research are discussed.

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Introduction

One of the diagnostic behavior patterns observed among individuals with an Autism Spectrum Disorder (ASD) is repetitive behavior (DSM-IV; American Psychiatric Association, 1994). Stereotypy, one form of repetitive behavior commonly exhibited by individuals with an ASD, has been broadly defined as repetitive or invariant behavior that does not serve a social function (Lewish & Baumeister, 1982). In a study conducted by Bodfish, Symons, Parker, and Lewis (2000), researchers indicated that stereotypy was more prevalent among children diagnosed with an Autism Spectrum Disorder than in individuals diagnosed with intellectual disability.

Stereotypy may be problematic for a variety of reasons. First, stereotypy has been shown to interfere with skill acquisition. For example, Koegel and Covert (1972) showed that high levels of stereotypy were associated with low levels of accurate responding during a discrimination task. By contrast, when stereotypy decreased during an interruption procedure, increases in accurate responding occurred. These findings suggest that stereotypy may interfere with educational programming. Second, stereotypy may be associated with adverse social consequences. Jones, Wint, and Ellis (1990) conducted a survey to assess high school students' perceptions of individuals engaging in stereotypy and found that respondents had negative responses when viewing video of individuals engaging in stereotypy, suggesting that stereotypy may be associated with social consequences. Third, some researchers have suggested that high levels of stereotypy can be disruptive in the context of general education settings (Conroy, Asmus, Sellers, & Ladwig, 2005; Wolery, Kirk, & Gast, 1985).

Stereotypy has frequently been shown to be maintained by automatic reinforcement (e.g., Ahearn, Clark, MacDonald, & Chung, 2007; Athens, Vollmer, Sloman, & St. Peter Pipkin, 2008;

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Hanley, Iwata, Thompson, & Lindberg, 2000; Sidener, Carr, & Firth, 2005). Because the maintaining reinforcer is nonsocial, the consequence cannot be directly manipulated, often presenting a challenge for identifying effective treatment (Vollmer, 1994). Reinforcement-based interventions for automatically reinforced problem behavior require the identification of alternate reinforcers that may compete with the self-generated reinforcers maintaining the behavior. In noncontingent reinforcement (NCR) interventions, a therapist presents participants with continuous access to leisure items that may compete with the target behavior (e.g. Piazza et al., 1998). In differential reinforcement procedures, a therapist delivers a reinforcer for an either an alternative behavior (e.g., DRA; Hanley, Iwata, Thompson, & Lindberg, 2000) or the absence of stereotypy (e.g., DRO; Barton, Brulle, & Repp, 1986).

Although NCR and differential reinforcement have sometimes been found effective for reducing automatically reinforced stereotypy, they are not always effective. Therefore, more direct interventions, such as overcorrection (Foxx & Azrin 1973), response blocking (Fisher, Lindauer, Alterson, & Thompson, 1998) and response interruption and redirection (RIRD) (Ahearn, Clark, MacDonald, & Chung, 2007) may be required. Foxx and Azrin (1973) evaluated overcorrection by requiring participants to engage in motor compliances (e.g., “Put your hands in your pockets.”) for 5 min contingent on stereotypy. If the participants did not immediately respond to the request, they were physically prompted to comply with the instruction. By using a reversal design, the authors demonstrated that overcorrection successfully decreased stereotypy for 4 participants.

Response blocking typically involves physically prompting the participant's hands to the participant's lap for a set amount of time. Fisher et al. (1998) evaluated the effects of response blocking for a participant's stereotypical property destruction and found that it produced

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significant decreases in overall rates of property destruction, and the effects were replicated in a reversal design. In addition, collateral increases of appropriate toy manipulation were observed.

RIRD typically involves contingent interruption of stereotypy and redirection to an appropriate alternative. For example, Ahearn et al. (2007) required participants to comply with three vocal directives (e.g., “What is your name?”) in the absence of stereotypy contingent on vocal stereotypy. RIRD was associated with significant decreases in vocal stereotypy and collateral increases in appropriate vocalizations.

Although direct interventions such as response blocking, overcorrection, and response interruption have been shown to be effective in reducing stereotypy, the clinical effects of these interventions are generally short-lived when the contingencies are withdrawn (Lerman and Vorndran, 2002). As such, some strategies have been developed as a way to promote maintenance of treatment effects. One such strategy involves establishing neutral stimuli as conditioned punishers through stimulus-stimulus pairings (i.e., respondent conditioning). For example, Salvy, Mulick, Butter, Bartlett, and Linschied (2004) evaluated the effects of pairing a neutral stimulus (i.e., a reprimand “no hitting”) just prior to the delivery of an effective punisher (i.e., contingent shock) for reducing participants’ self injury. After pairings, the researchers found that the reprimand effectively suppressed participants’ self injury for more than 60 days following treatment, suggesting that it effectively functioned as a conditioned punisher.

Vorndran and Lerman (2006) evaluated the effects of stimulus-stimulus pairings by presenting a neutral stimulus (nudging the participant’s shoulder) just prior to the delivery of contingent walking, a face shield, or hands-down procedure (for each participant, respectively). Following just 15 pairings, the authors found that a shoulder nudge functioned as conditioned

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punisher for 1 participant. In addition, a shoulder nudge continued to function as a conditioned punisher for over 50 sessions, across two environments. For the other participant, a nudge to the shoulder functioned as a conditioned punisher, but the effects did not generalize to an additional setting. In addition, several re-pairings were required in order to re-establish shoulder nudging as a conditioned punisher. Although these findings suggest one potential strategy for fading the intensity of an intrusive punisher, the results were somewhat mixed, warranting further research in the development of strategies for promoting maintenance of treatment effects.

Another potential strategy for enhancing durability of treatment effects is stimulus fading. An example of this strategy was illustrated by Lerman, Iwata, Shore, and DeLeon (1997), who systematically faded time out or restraint (hands held to participants' sides) from a fixed-interval (FI) 30 s to an FI 300 s for two out of five participants' self-injury. Specifically, researchers faded the schedule a pre-specified amount for each participant, when SIB was below 1.5 responses per minute. For two other participants, contingent stimuli only functioned as punishers under fixed-ratio (FR) 1 schedules. For the fifth participant, contingent stimuli functioned as a punisher under the terminal schedule of FI 300 s without systematic fading.

Similarly, Lerman and Iwata (1996) systematically faded the schedule of response blocking for an individual's automatically reinforced hand mouthing. After showing that response blocking functioned as a punisher under FR 1 schedules, researchers faded the schedule from FR 1 to FR 2, and then to FR 4. The response rate for hand mouthing was similar across all schedules, suggesting that for this intervention response blocking functioned as punishment. In a similar study, Smith, Russo, and Le (1999) systematically faded the schedule of response blocking for a participant's automatically reinforced eye poking. In contrast to the study conducted by Lerman and Iwata (1996), as the schedule was faded, eye poking increased to

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levels similar to those observed in baseline. The authors concluded that blocking may have effectively suppressed eye poking during the FR 1 schedule due to sensory extinction rather than punishment. Given the inconsistent findings across these studies, further research is needed in order to better identify the conditions under which maintenance of treatment effects are obtained.

In addition to stimuli that may function as conditioned punishers, researchers have also investigated the conditioning of inhibitory stimuli. This strategy may be useful for promoting generalization of treatment effects across settings in addition to enhancing maintenance. Piazza, Hanley, and Fisher (1996) illustrated use of an inhibitory stimulus (i.e., a purple card) for enhancing generalization of treatment effects of a participant's automatically reinforced pica. During training trials, the experimenters presented the purple card only when delivering reprimands contingent on pica. Immediately following 10 training trials, the researchers conducted a stimulus control test session (no consequences were in effect for pica). During test sessions, the authors delivered no programmed consequences and alternated a purple card and a yellow card (no history with treatment) using a reversal design. The participant exhibited pica only when the yellow card was present. Because responding did not occur in the presence of the purple card, the authors concluded that the purple card functioned as an inhibitory stimulus. The effects observed in controlled settings were also observed across novel environments. A potential limitation of Piazza et al. (1996) was that the authors conducted 10 training sessions immediately before each 10-min test session, making it unclear whether the purple card would have functioned as an inhibitory stimulus following fewer training sessions.

Maglieri, Deleon, Rodriguez-Catter, and Sevin (2000) evaluated the effects of establishing an inhibitory stimulus for treating the covert food stealing in an individual diagnosed with Prader-Willi syndrome. In this analysis, the dependent measure was grams

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consumed per session, calculated by weighing food containers before and after sessions. After the authors demonstrated that post-session reprimands (i.e., reprimands delivered at the end of the 10-min session) effectively functioned as a punisher, they initiated training sessions. During training these sessions, two food containers were present in the room, one with and one without an orange sticker. Researchers delivered post-session reprimands for food stealing from only the orange container. After food stealing consistently occurred from only the container without the orange sticker, researchers placed orange stickers on both containers in the room and found that food was not stolen from either container during post-session weighing. Although the authors did not assess food stealing in the absence of the punishment contingency during their final test phase, no food stealing was observed, suggesting that the orange stickers may have exerted inhibitory control over the participant's food stealing. The Piazza et al. and Maglieri et al. studies suggested that previously neutral stimuli that were paired with punishers could acquire inhibitory stimulus control over the target response. However, because these studies included only one participant, the generality of the findings is somewhat limited.

Doughty, Anderson, Doughty, Williams, and Saunders (2007) extended previous work on inhibitory stimulus control of stereotypy by incorporating latency data into their analysis. The authors alternated 5 min punishment (contingent response blocking) and no punishment components using a multiple schedule. Neutral stimuli (i.e., wristbands) were only present during the punishment condition. Motor stereotypy occurred at lower levels during the punishment component relative to the no punishment component, and this pattern continued when component durations were reduced from 5 min to 2.5. A noteworthy feature of this study was that the authors included latency data and found differentially longer latencies during the punishment component. Because these data indicated response suppression prior to contact with

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the punisher, they support that the previously neutral stimuli effectively functioned as inhibitory stimuli. For one participant, researchers assessed maintenance of inhibitory control by the wristbands. Specifically, researchers presented the previously paired stimuli in the absence of the intervention. Responding maintained at low levels for three sessions, suggesting that low levels of responding could maintain for 15 min without additional stimulus-to-stimulus pairings. After withdrawal of blocking, responding returned to baseline levels after 3 sessions.

Although Doughty, Anderson, et al. (2007) and some others have reported positive treatment outcomes when attempting to establish inhibitory stimulus control, not all authors have obtained successful outcomes. For example, Doughty, Doughty, et al. reviewed 67 studies in which inhibitory stimulus control was attempted. Of particular interest is that only 5 studies provided conclusive evidence of inhibitory stimulus control. More recently, research conducted by Rapp, Patel, Ghezzi, O'Flaherty, & and Titterington (2009) provided unambiguous demonstrations of inhibitory control for only 1 of 3 participants exhibiting vocal stereotypy. A major limitation of the Rapp et al. (2009) study, is that researchers did not utilize latency data in order to determine whether or not responding had been suppressed before the initial punisher delivery. It is possible then, that discriminative control was achieved but not assessed. On a related note, Conroy, Asmus, Sellers, and Ladwig (2005) assessed the utility of presenting stimulus cues for reducing stereotypy. Specifically, researchers conducted two conditions using a multielement design. In one condition, the experimenter presented verbal reminders and gestures to a "no" card contingent on stereotypy, whereas in the other condition, the experimenter presented a "yes" card and delivered no programmed consequences for stereotypy. Differentially lower levels of stereotypy occurred during the verbal reminder condition, suggesting that verbal reminders effectively functioned as a punisher for stereotypy. Because the cards were always

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paired with verbal reminders, one could not conclusively determine whether the “no” card acquired inhibitory control. In addition, contact with the punisher may have established inhibitory control, accounting for the decreases observed in the intervention component.

Although authors have shown that previously neutral stimuli can inhibit responding stereotypy following stimulus-stimulus pairings, the ratio of training to testing sessions required to maintain this effect is unknown. When Doughty, Anderson, et al. (2007) assessed maintenance for one participant, the inhibitory effects of wristbands maintained for only three testing sessions in the absence of additional training sessions, suggesting that inhibitory control is unlikely to maintain without additional pairings. Therefore, the extent to which pairing a neutral stimulus with an effective intervention promotes maintenance and generalization of treatment effects is relatively unknown. The purpose of this study was to extend previous research on establishing inhibitory control by assessing an inhibitory control pairing procedure using a multiple baseline across settings design with an embedded reversal. We evaluated the effects of the punisher component and conducted stimulus pairing training sessions using a multi-element design, and the generalization of treatment effects using the multiple baseline design. In addition, we visually inspected latency data to evaluate whether the previously neutral stimuli had acquired inhibitory control.

Method

Participants, Setting and Materials

Four individuals who exhibited stereotypy participated in the study. All participants attended a residential program for individuals with developmental disabilities. Davey was a 9-year-old boy diagnosed with an ASD. He primarily communicated using PECS but could request

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several items in the form of sentences. Wayne was a 10-year-old boy diagnosed with an ASD. He primarily communicated vocally and could emit three-to-five word sentences. Jason was a 14-year-old boy diagnosed with an ASD. His primary communication was through one-word vocalizations. Rocky was a 36-year-old man diagnosed with an ASD. He primarily communicated vocally and could emit three-to-five word sentences. He was able to respond to several vocal questions such as, “What’s your name?”

All sessions were conducted in a room (1.5 m x 3 m) with a table and two chairs. A camera with a wide angle lens was mounted in the corner of the room. Additional materials were wristbands that would later be paired with an effective intervention. In addition to sessions conducted in a controlled room, sessions were conducted in two additional settings during the treatment evaluation in order to evaluate the extent to which stimuli paired with the effective intervention promoted generalization of treatment effects. The settings varied for each participant and were chosen by the clinical team. For Davey, the generalization settings were his classroom and the gym. For Wayne and Jason, generalization settings were the Community Development Center (CDC), and their classrooms. For Rocky, generalization settings were his bedroom and the living room.

Functional Analysis

Response Measurement and Inter Observer Agreement

Motor stereotypy was evaluated for 3 of 4 participants, and was defined as any instance of repetitive responding which had no apparent social function. For Davey, motor stereotypy consisted of repetitive finger movements. For Jason, motor stereotypy consisted of any instance of mouthing, body rocking, foot shaking, and nose picking. For Wayne, motor stereotypy

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consisted of object twirling and hand flapping. Wayne's clinical team required that he wore a small "P" attached to his belt loop as part of a treatment for pica. Consequently, Wayne would also engage in high levels of stereotypy with the "P". Vocal stereotypy was evaluated for Rocky and was defined as any instance of repetitive non-functional speech.

All functional analysis sessions were 5 min, and observers recorded motor stereotypy using a continuous duration. These data were summarized as percentage occurrence by dividing the total number seconds of stereotypy in each session by the total number of seconds in each session (300 s) and multiplying the quotient by 100%. Observers recorded vocal stereotypy using a momentary time sample measure and the data were summarized as percentage of session by dividing the total number of occurrence intervals by the total number of intervals per session (30 intervals) and multiplied the quotient by 100%. Interobserver agreement for motor stereotypy was calculated by dividing the session into consecutive 10s intervals. Percentage agreement was calculated by dividing the smaller duration of responding by the larger duration of responding in each 10 sec interval, averaging these fractions across the session, and multiplying by 100%. Interobserver agreement for vocal stereotypy was calculated by dividing the number of agreement intervals by the total number of intervals and multiplying by 100%. Agreement was scored for a minimum of 33% of sessions of each condition for each participant. Agreement results are as follows: Davey, M=93.4% (range 86.8% to 98.7%); Jason, M=92.2% (range 81.5% to 96.5%); Wayne, M= 93.2% (range 81.5% to 86.7%); Rocky, M=89.9% (range 82.4%-96.8%).

Procedure

The functional analysis was conducted employing a multi-element design in order to identify the function of the participants' stereotypy. The functional analysis was similar to

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procedures described by Iwata et al. (1982/1994). Conditions included were alone, attention, play, and demand. In addition, a series of repeated alone sessions were conducted for each participant, and a minimum of three sessions were conducted each day, to evaluate whether responding would persist in the absence of social contingencies.

Treatment Analysis and Inhibitory Control Evaluation

Response Measurement and Inter Observer Agreement

During treatment, observers recorded motor and vocal stereotypy using a continuous duration measure, as described above. Data were also collection on the duration of intervention implementation. In addition, to assess whether the wristbands established inhibitory control, observers collected latency data for stereotypy. Latency data were collected by adding the total number of seconds that elapsed before the first instance of stereotypy for each session.

Two independent observers recorded responding for a minimum of 33% of sessions as described in functional analysis sessions. Mean total agreement for stereotypy was 88% for 92.8% for Jason, 94.3% for Wayne, and 88.9% for Rocky.

Motor and Vocal Directive Assessments

The purpose of the assessment was to identify motor directives (e.g., “Touch your head.”) or vocal directives (e.g., “What’s your name?”) that the participant readily complied with following a vocal or model prompt. The assessment included two sessions, and each session consisted of either 140 (Davey) or 150 trials (Rocky) (10 consecutive trials with each 15 different directives). During each trial, the therapist delivered a vocal prompt. If the participant did not respond within 5 s of the vocal prompt, then the therapist presented a model of the

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correct response. If the participant did not respond within 5 s of the model prompt for a motor directive, then the therapist physically guided the participant to engage in the correct response. Compliance with the directive was scored if the individual engaged in the correct response following the vocal prompt or model. Directives that resulted in greater than 90% of trials with compliance were included in redirection sessions.

Experimental Design

The effectiveness of the intervention for each participant was evaluated in a multi-element design. In one component, the intervention was present with stimuli (i.e., wristbands), whereas in the other component the intervention and stimuli were absent. In addition, the extent to which the stimuli promoted generalized response suppression was evaluated using a multiple baseline across settings design. Specifically, the stimuli previously paired with the intervention were presented in two novel environments in the absence of the intervention.

Procedure

No interaction baseline (no stimuli). At the beginning of sessions the therapist delivered the instruction, “We can’t talk for 5 minutes.” The therapist then ignored the participant for the remainder of the session.

No interaction baseline (stimuli present). Sessions were conducted as described above for no interaction baseline (no stimuli) sessions, with the exception that wristbands were placed on the participants. Specifically, immediately prior to the start the session, the experimenter placed the wristbands on both the participant’s wrists, and then cued the session. The purpose of this baseline condition was to assess whether the wristbands were previously neutral (i.e., did not exert inhibitory control of participants’ stereotypy prior to intervention).

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Intervention (Stimuli Present)

Upon starting the session, the therapist stated, “We can’t talk for 5 minutes.” During these sessions, RIRD, RIRD + Blocking, RIRD + Blocking + Physical, or a Hands Down procedure was in effect (see below for procedural descriptions).

RIRD. The therapist presented motor (Davey) or vocal (Rocky) directives (identified during directive assessment) contingent on stereotypy. For Davey, the therapist presented motor directives by presenting a vocal prompt (e.g., “Touch nose”). If Davey did not comply within 5 s, the therapist modeled the appropriate response and repeated the instruction. If Davey did not comply within 5 s, the therapist repeated the instruction every 2 s until Davey complied. The purpose of repeating the instruction every 2s, rather than moving to a more restrictive prompt, was so that we could identify a procedure which would be minimally intrusive. For Rocky, stereotypy was interrupted as described for Davey, with the exception that the therapist presented vocal directives (e.g., “What’s your mom’s name?”). The interruption procedure continued for both participants until the participant complied with three directives in the absence of motor stereotypy.

RIRD + Blocking. Although RIRD was effective in reducing Wayne’s stereotypy, his stereotypy continued to occur, requiring frequent implementation of the RIRD procedure. Therefore, we added a blocking component to further suppress stereotypy. Contingent on the occurrence of stereotypy, the therapist placed Dwanye’s hands in his lap for 1-2 s. Following this, the therapist presented motor directives as describe above for the RIRD procedure .

RIRD + Blocking + Physical. When blocking was initiated for Davey, his compliance with motor directives decreased. Therefore, we added a physical interruption component.

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Specifically, if Davey did not comply with the model prompt he was physically prompted to comply.

Hands down. For all participants who exhibited motor stereotypy, we assessed the effects of a 10-sec "hands down" procedure. For Davey, we eventually evaluated the hands down procedure because implementation of RIRD was required at high rates of delivery in order for the suppressive effect to maintain. For Wayne and Jason, we employed the hands down procedure because previous treatment analyses had indicated blocking to be effective in reducing motor stereotypy. During these sessions, contingent on stereotypy, the therapist placed and held the participant's hands in the participant's lap for 10 s.

Generalization Evaluation

In order to evaluate whether the wristbands established inhibitory control and to determine whether they may have promoted generalization of treatment effects, the therapist placed the wristbands on the participants in non-treatment settings while no programmed consequences were in effect for stereotypy (similar to the no interaction baseline with stimuli condition).

Results

Functional Analysis

Functional analysis results are depicted in Figure 1. For all participants, responding was high and undifferentiated across conditions. During a series of repeated Alone sessions, stereotypy maintained, providing support that participants' stereotypy may be maintained by automatic reinforcement.

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Treatment Analysis

Figure 2 shows the results of Davey's treatment. During baseline, motor stereotypy occurred at moderate levels ($M = 22.19\%$), and similar levels of responding were observed across signaled and unsignaled components across the three settings. During RIRD (labeled RD), decreases in stereotypy were observed during only RIRD ($M = 4.7\%$) relative to no interaction ($M = 29.1\%$). Although clinically significant reductions were observed, it was noted that the intervention was highly intensive, with at least two-to-three implementations of redirection occurring per min (see Figure 6). Therefore, we assessed the effects of adding response blocking.

Upon implementation of RIRD + blocking, slightly lower levels of motor stereotypy were observed ($M = 3.6\%$) relative to the preceding redirection only phase and levels were much lower than levels of stereotypy during the no interaction component ($M = 29.9\%$). Although RIRD + blocking further reduced stereotypy, lower levels of compliance were observed. Therefore, we added a physical prompt during the redirection component to facilitate increases in compliance. During these sessions, response suppression maintained and occurred at lower levels during intervention ($M = 2.1\%$) relative to no interaction baseline (20.3%). Although reductions in stereotypy were observed, the procedure was still intensive in that it required frequent repetition. Therefore, after a brief reversal to baseline where responding returned to moderate levels ($M = 37.5\%$), we evaluated the effects of a 10-s hands down procedure to assess whether this intervention may reduce the rate of implementation required. When the 10-s hands down procedure was implemented, lower levels of stereotypy were observed during the intervention ($M = 8.4\%$) relative to no-interaction baseline (33.9%). However, decreases in the rate of implementation were not observed.

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In addition to the treatment evaluation, we assessed the effects of pairing the wristbands with a punisher by conducting test sessions in two novel settings; the classroom and gym. Prior to presenting the wristbands, stereotypy occurred at moderate levels in both the classroom and in the gym. When wristbands were presented, stereotypy remained at moderate levels, suggesting that pairing the stimuli with the intervention did not promote generalization of treatment effects nor was inhibitory control observed. Differential latencies to stereotypy during training sessions when the stimuli were (treatment only) and were not present (no interaction baseline) were also not observed (Figure 7, top left panel).

Figure 3 shows the results of the treatment evaluation for Wayne. During baseline, motor stereotypy occurred at low-to-moderate and variable levels. In addition, similar levels of stereotypy occurred across between the signaled and unsignaled no-interaction baseline components and across settings, suggesting that the wristbands did not have an inhibitory effect prior to treatment. When response blocking was introduced, although immediate decreases relative to the preceding baseline were not observed, the variability of responding was reduced (range 0.5-8.0%). During treatment lower levels of stereotypy were observed during blocking ($M = 4.3\%$) relative to no-interaction ($M = 38.5\%$), suggesting that blocking functioned as an effective punisher. Prior to presenting the wristbands, stereotypy occurred at moderate levels in the generalization settings. When wristbands test probe sessions were presented in the generalization settings following 14 training sessions, stereotypy remained at moderate levels, suggesting that pairing the stimuli with blocking did not promote generalization of treatment effects, replicating the findings observed with Davey. Differential latencies to responding during intervention (signal present) versus no intervention (signal absent) components in the training environment were not observed (Figure 7, top right panel).

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Figure 4 shows the results of the treatment evaluation for Jason. During baseline, motor stereotypy occurred at moderate levels in both signaled and unsignaled components, with slightly lower levels of responding observed during signaled components ($M = 28.8\%$) relative to unsignaled components ($M = 51.3\%$). Following the introduction of blocking, stereotypy immediately decreased in the intervention component only ($M = 5.7\%$, range 2.8-11.2%, relative to the no interaction (stimuli absent) component ($M = 33.6\%$; range 8.3-38.0%). Levels of responding in the CDC and classroom did not appear to be affected by implementation of blocking in the training environment. Responding during probe sessions appeared to be unaffected by presentation of the wristbands previously paired with the intervention. Differential latencies to responding during signaled vs. unsignaled components in the training environment were not observed (Figure 7, bottom left panel).

Figure 5 shows the results of the treatment evaluation for Rocky. During baseline increasing trends of vocal stereotypy were observed across signaled and unsignaled components. In addition, overlapping levels of responding were observed between signaled versus unsignaled components, suggesting that wristbands did not have an inhibitory effect on vocal stereotypy prior to implementation of treatment. Upon implementation of RIRD, significant reductions of vocal stereotypy were observed ($M = 7.14\%$; range 3.0-33.3%) during only the treatment relative to no-interaction baseline ($M = 35.0\%$, range 3.7-79 %;). Prior to introduction of the wristbands, moderate levels of stereotypy were observed in both of the generalization settings (i.e., the bedroom and living room). During generalization probe sessions when wristbands were presented in the absence of the intervention, stereotypy remained at high levels ($M = 65.5\%$, range 46.3-84.7%), suggesting that pairing the stimuli with RIRD did not promote generalization of treatment effects.

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Figure 6 shows the rate of intervention implementation during treatment sessions for all participants. For Davey, the lowest overall rate of implementation was observed during the redirection + blocking + physical component intervention and the highest overall implementation rate was observed during the 10-s blocking procedure. For Jason and Wayne, decreasing trends of overall implementation rate were observed across sessions, with somewhat stable levels of intervention implementation occurring in the latter sessions. For Rocky, high and variable levels of implementation were observed over the course of intervention sessions.

Discussion

The current study replicated previous research in a few ways. First, we found that participants' stereotypy was maintained by automatic reinforcement. Second, RIRD and Blocking effectively reduced stereotypy maintained by automatic reinforcement. For all participants, differentially shorter latencies were not observed during intervention, suggesting that wristbands did not acquire inhibitory stimulus control over stereotypy. In addition, generalized suppression of stereotypy across settings was not observed.

Although the failure to acquire inhibitory control was not a positive finding, the results are nevertheless consistent with previous literature. For example, in a review of inhibitory stimulus control procedures, Doughty, Doughty, O'Donnell, Saunders, and Williams (2007) found that there have been very few unambiguous demonstrations of inhibitory control, especially in the applied literature. Furthermore, in an attempt to establish inhibitory control over vocal stereotypy, Rapp et al. (2009) reported failure to acquire inhibitory stimulus control for two of three participants, even in the context of an effective intervention.

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A few potential explanations may account for why inhibitory control was not observed. One potential explanation is that the test-to-training ratios were not sufficient for promoting inhibitory control. For example, Piazza et al. (1996) observed generalized response suppression in the presence of a previously neutral stimulus for a participant's cigarette pica. Experimenters conducted test sessions immediately following 10 training sessions. In our study, we conducted only two training sessions prior to each test session. It is possible that increasing the ratio of training to testing sessions would have enhanced the likelihood of establishing inhibitory control. Another potential explanation for why inhibitory control was not observed is that we did not ensure that the participants attended to the stimuli prior to signaled components. It is possible that requiring the participants to differentially attend or respond to the stimuli in some way (e.g., a point, tact) would have increased the likelihood of acquiring inhibitory control during training sessions. Finally, it is possible that the stimuli selected were not salient enough for our participants. It is possible that we may have been more likely to have observed inhibitory control if we had paired a more salient stimulus (e.g., different room colors or therapists) with the intervention. Doughty, Anderson, et al. (2007) commented that they included different stimuli for each participant because certain stimuli failed to produce discriminated responding.

A potential limitation of the study is that we did not extend Davey's baseline condition until stable and high levels of responding were observed. Because there was an apparent decreasing trend during baseline and significant level changes were not observed when progressing from baseline to the treatment evaluation phase, it is unclear whether RIRD was an effective punisher. However, because RIRD resulted in differentially lower levels of stereotypy relative to the no-interaction baseline in the multi-element design, experimental control of the suppressive effects of RIRD was obtained. Another potential limitation is that for Davey probe

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sessions were conducted with the intervention that appears to have been the least effective.

Specifically, the most notable decreases from baseline sessions were observed when the RIRD + Blocking + Physical intervention was in effect, but the probe sessions were conducted during the Hands Down treatment phase.

Another potential limitation in the social and ecological validity of the study is that we did not include a reinforcement component with the punishment component. Specifically, it is unlikely that participants are exposed to environments completely devoid of leisure items or tasks in naturally occurring situations. Another aspect worth noting is that the inclusion of leisure items or differential reinforcement of task engagement may have promoted the efficacy of punishment. For example, Thompson, Iwata, Conners, and Roscoe (1999) demonstrated that punishment was more effective when combined with reinforcement. Therefore, it is possible that providing alternative sources of reinforcement (leisure items) would have enhanced the efficacy of the intervention.

Future research should be conducted to identify conditions in which inhibitory control can be acquired. A component analysis of variables responsible for the development of inhibitory control (e.g., use of instructions, systematic selection of stimuli, test-to train ratios, etc) is warranted.

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References

- Ahearn, W. H., Clark, K. M., MacDonald, R. P. F., & Chung, B. (2007). Assessing and Treating vocal stereotypy in children with Autism. *Journal of Applied Behavior Analysis, 40*, 263-275.
- Athens, E. S., Vollmer, T. R., Sloman, K. N., & St. Peter Pipkin, C. (2008). An Analysis of Vocal Stereotypy and Therapist Fading. *Journal of Applied Behavior Analysis, 41*, 291-297.
- American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders. 4th ed. Washington, DC: American Psychiatric Association, 1994.
- Barton, L. E., Brulle, A. R., & Repp, A. C. (1986). Maintenance of Therapeutic Change by Momentary DRO. *Journal of Applied Behavior Analysis, 19*, 277-282.
- Bodfish, J. W., Symons, F. J., Parker, D. E., & Lewis, M. H. (2000). Varieties of Repetitive Behavior in Autism: Comparisons to Mental Retardation. *Journal of Autism and Developmental Disorders, 30*, 237-243.
- Conroy, M. A., Asmus, J. M., Sellers, J. A., & Ladwig, C. N. (2005). The use of an Antecedent Based Intervention to Decrease Stereotypic Behavior in a General Education Classroom: A Case Study. *Focus on Autism and other Developmental Disabilities, 20*, 223-230.
- Doughty, S. S., Anderson, C. M., Doughty, A. H., Williams, D. C., & Saunders, K. J. (2007). Discriminative Control of Punished Stereotyped Behavior in Humans. *Journal of the Experimental Analysis of Behavior, 87*, 325-336.

EVALUATING STIMULUS CONTROL BASED INTERVENTIONS

- Doughty, A. H., Doughty, S. S., O'Donnell, J., Saunders, K., & Williams, D. (2007). Stimulus Control of Punishment Effects: Determining the Controlling Variables. *Mexican Journal of Applied Behavior Analysis, 33*, 57-66.
- Fisher, W. W., Lindauer, S. E., Alterson, C. J., & Thompson, R. H. (1998). Assessment and Treatment of Destructive Behavior Maintained by Automatic Reinforcement. *Journal of Applied Behavior Analysis, 31*, 513-527.
- Fisher, W. W., Piazza, C. C., Cataldo, M., Harrel, R., Jefferson, G., & Conner, R. (1993). Functional Communication Training with and without Extinction and Punishment. *Journal of Applied Behavior Analysis, 26*, 23-36.
- Foxx, R. M., & Azrin, N. H. (1973). The Elimination of Autistic Self-Stimulatory Behavior by Overcorrection. *Journal of Applied Behavior Analysis, 6*, 1-14.
- Hanley, G. P., Iwata, B. A., Thompson, R. H., & Lindberg, J. S. (2000). A Component Analysis of "stereotypy as reinforcement" for alternative behavior. *Journal of Applied Behavior Analysis, 33*, 285-297.
- Koegel, R. L., & Covert, A. (1972). The relationship of self stimulation to learning in autistic children. *Journal of Applied Behavior Analysis, 5*, 381-387.
- Jones, R. S. P., Wint, D., & Ellis, N. C. (2008). The social effects of stereotyped behavior. *Journal of Intellectual Disability Research, 34*, 261-268.
- Lerman, D. C., Iwata, B. A., Shore, B. A., & DeLeon, I. G. (1997). Effects of Intermittent Punishment on self-injurious behavior: An evaluation of schedule thinning. *Journal of Applied Behavior Analysis, 30*, 187-201.

EVALUATING STIMULUS CONTROL BASED INTERVENTIONS

Lewis, M. H., & Baumeister, A. A. (1982). Stereotyped Mannerisms in Mentally Retarded Persons: Animal Models and Theoretical Analyses. *International Review of Research in Mental Retardation*, *11*, 123-161.

Maglieri, S. D., Smith, R. G., Simmons, J. N., & Soderlund, M. J. (2008). Using a Stimulus Correlated with Verbal Reprimands to Suppress Automatically Maintained Eye Poking. *Journal of Applied Behavior Analysis*, *41*, 255-259.

Piazza, C. C., Fisher, W. W., Hanley, G. P., LeBlanc, L. A., Worsdell, A. S., Lindaeur, S. E., & Keeney, K. M. (1998). Treatment of PICA Through Multiple Analysis of its Reinforcing Functions. *Journal of Applied Behavior Analysis*, *31*, 165-189.

Piazza, C. C., Hanley, G. P., & Fisher, W. W. (1996). Functional Analysis and Treatment of Cigarette PICA. *Journal of Applied Behavior Analysis*, *29*, 437-450.

Rapp, J. T., Patel, M. R., Ghezzi, P. M., O'Flaherty, C. H., & Titterington, C. J. (2009). Establishing Stimulus Control of Vocal Stereotypy Displayed by Young Children with Autism. *Behavioral Interventions*, *24*, 85-105.

Sidener, T. M., Carr, J. E., & Firth, A. M. (2005). Superimposition and Withholding of Edible Consequences as Treatment for Automatically Reinforced Stereotypy. *Journal of Applied Behavior Analysis*, *38*, 121-124.

Smith, R., Russo, L., & Le, D. (1999). Distinguishing Between Punishment and Extinction Effects of Response Blocking: A Replication. *Journal of Applied Behavior Analysis*, *32*, 367-370.

EVALUATING STIMULUS CONTROL BASED INTERVENTIONS

Thompson, R. H., Iwata, B. A., Conners, J., & Roscoe, E. M. (1999). Effects of Reinforcement for Alternative Behavior During Punishment of Self-Injury. *Journal of Applied Behavior Analysis, 32*, 317-328.

Vollmer, T. R. (1994). The Concept of Automatic Reinforcement: Implications for Behavioral Research in Developmental Disabilities. *Research in Developmental Disabilities, 15*, 187-207.

Vorndran, C. M., & Lerman, D. C. (2006). Establishing and Maintaining Treatment Effects with Less Intrusive Consequences VIA a pairing procedure. *Journal of Applied Behavior Analysis, 39*, 35-48.

Wolery, M., & Gast, D. L. (1985). Stereotypic Behavior as a Reinforcer: Effects and Side Effects. *Journal of Autism and Developmental Disorders, 15*, 149-161.

EVALUATING STIMULUS CONTROL BASED INTERVENTIONS

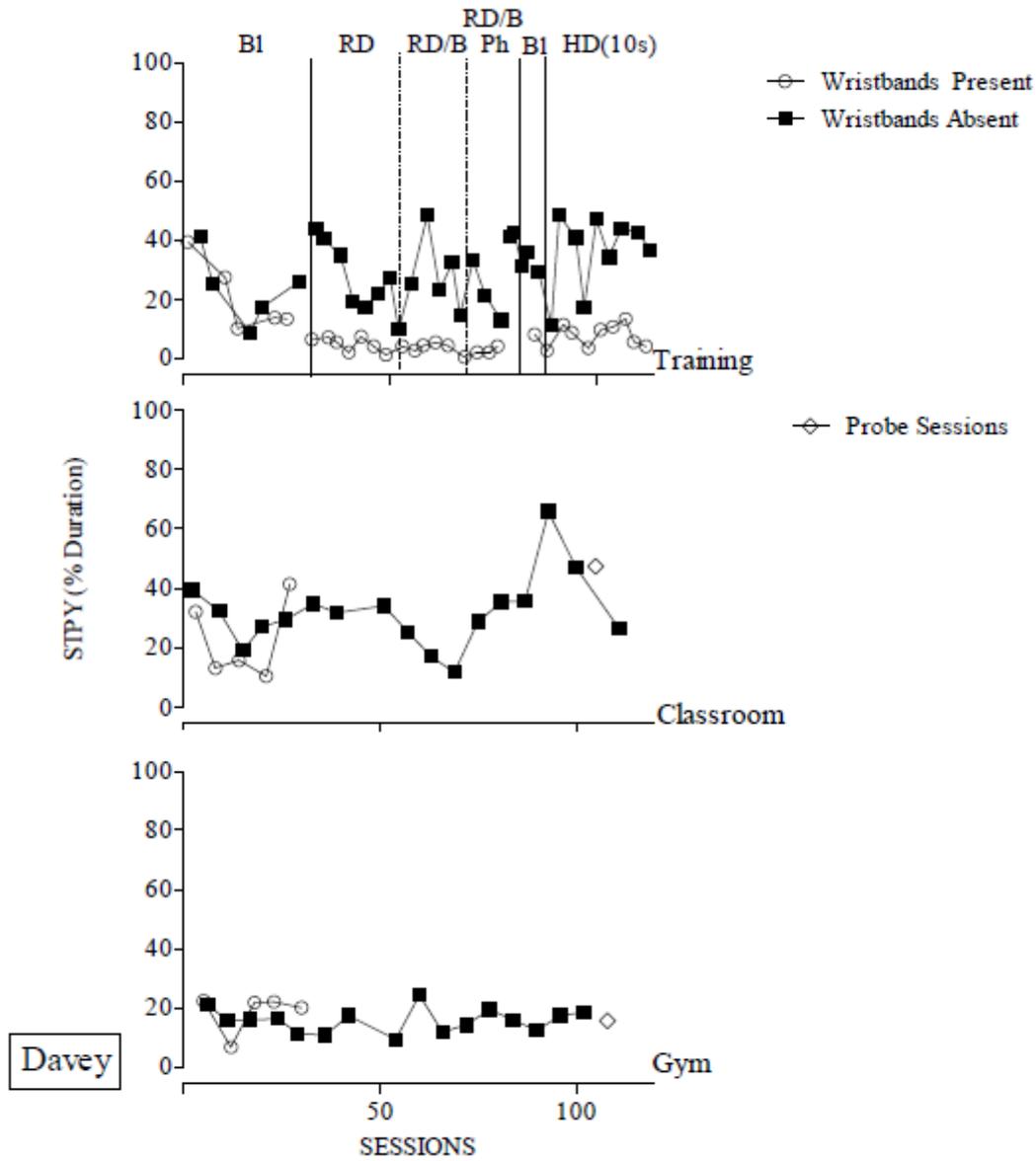


Figure 2. Percent duration of motor stereotypy across sessions for Davey. RD indicates sessions of contingent redirection. RD/B indicates sessions with blocking. RD/B/Ph indicates sessions with the physical component. HD indicates sessions with the hands down procedure.

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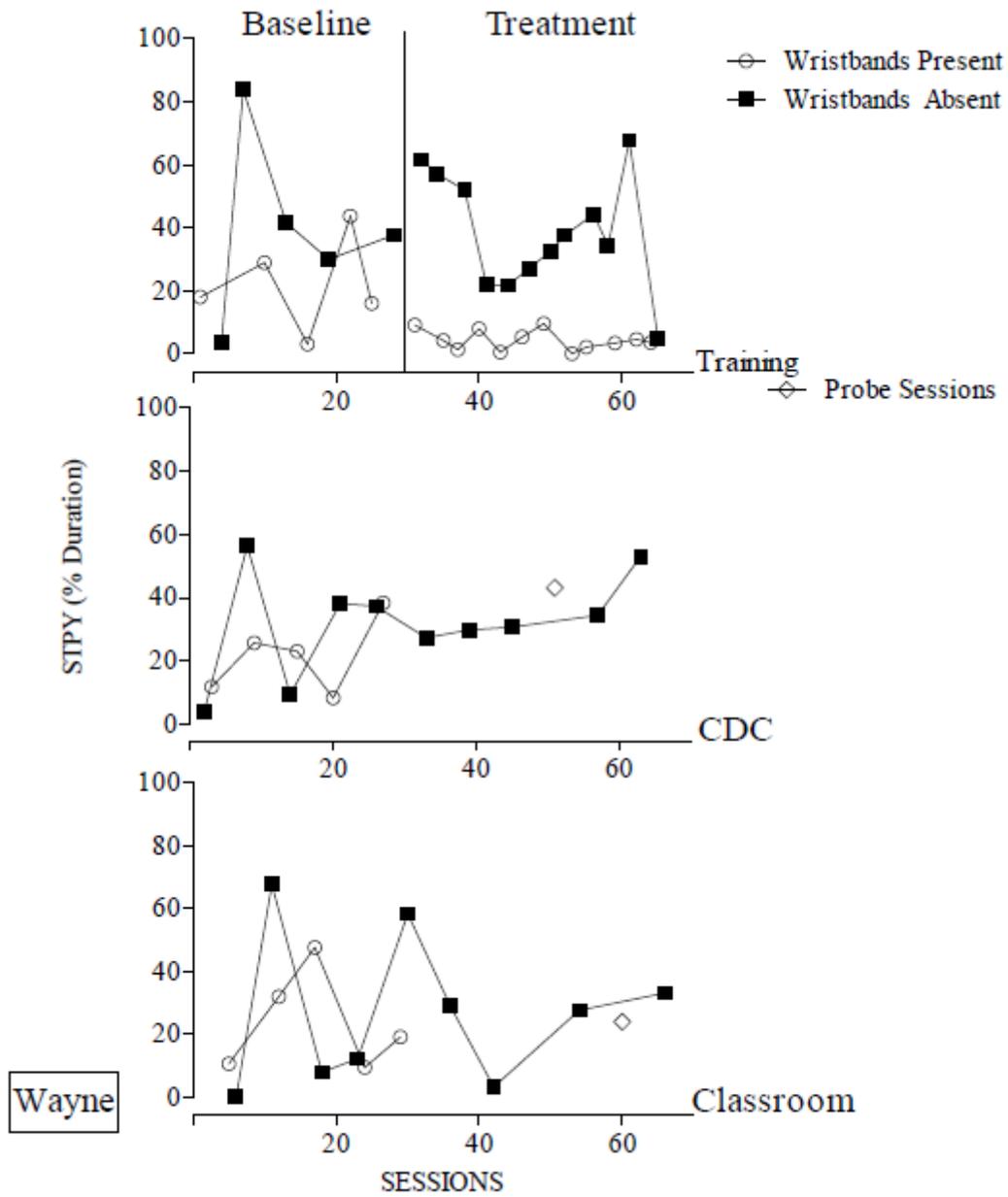


Figure 3. Percent duration of motor stereotypy across sessions for Wayne.

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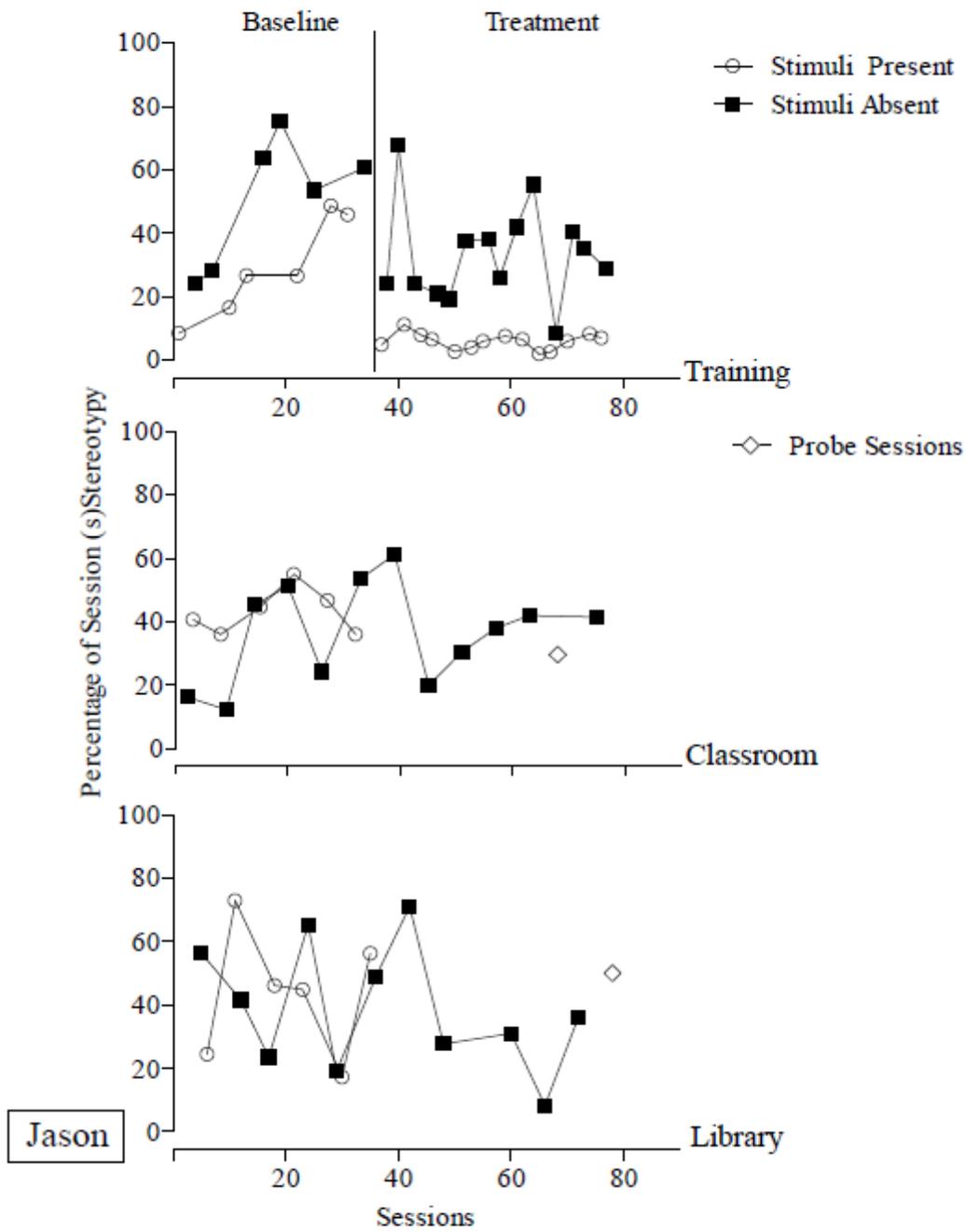


Figure 4. Percent duration of motor stereotypy across sessions for Jason.

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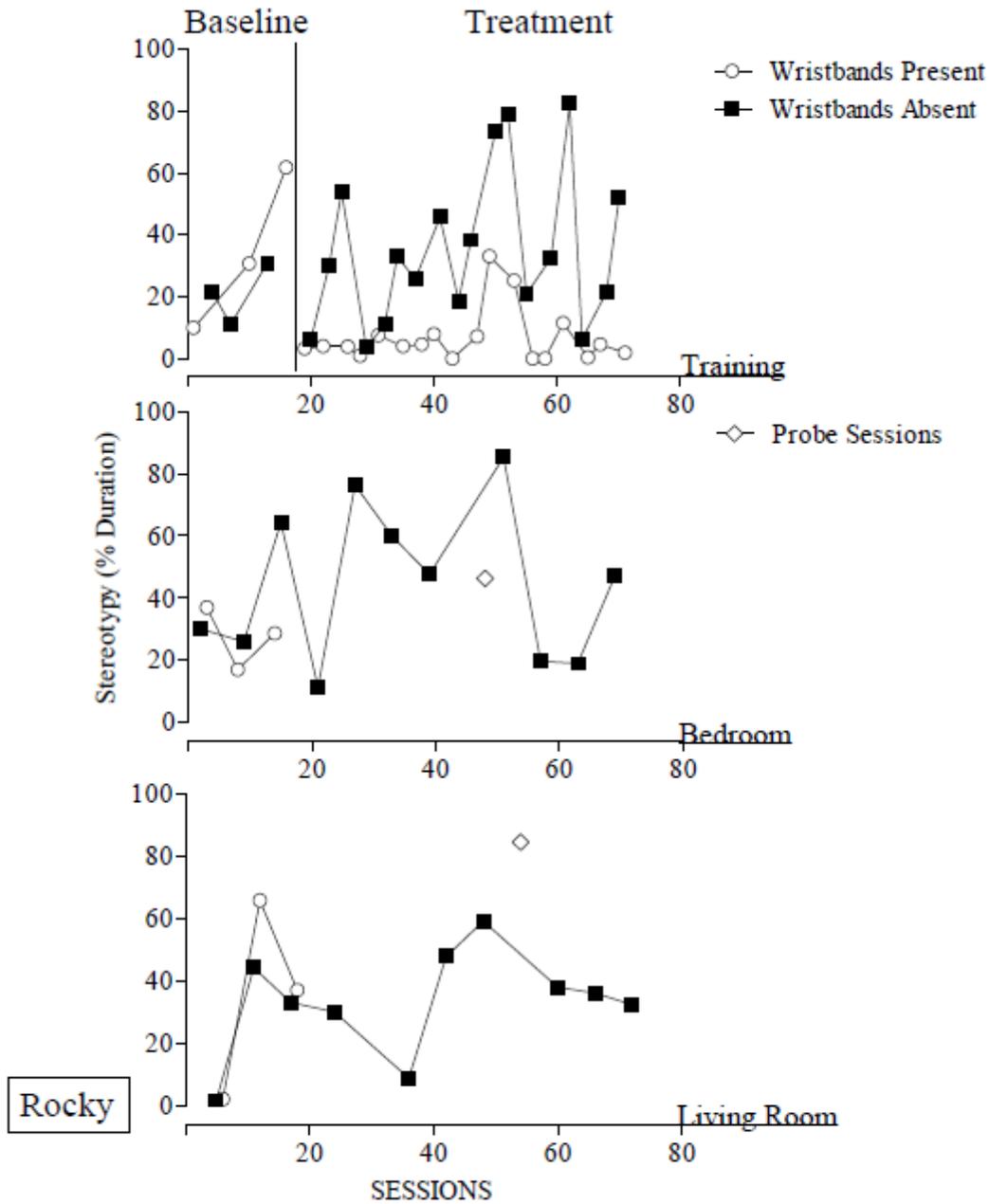


Figure 5. Percent duration of vocal stereotypy across sessions for Rocky.

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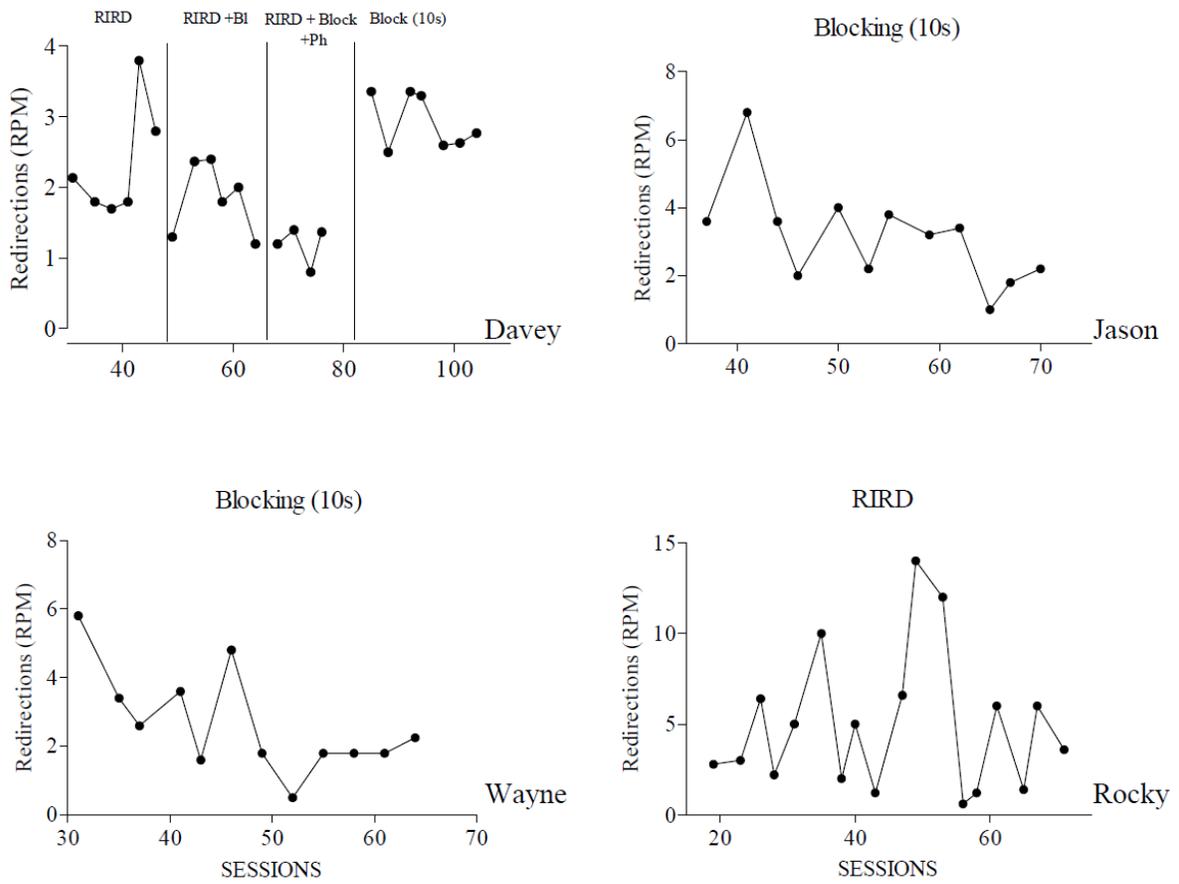


Figure 6. Rate of intervention implementation across treatment sessions for all participants.

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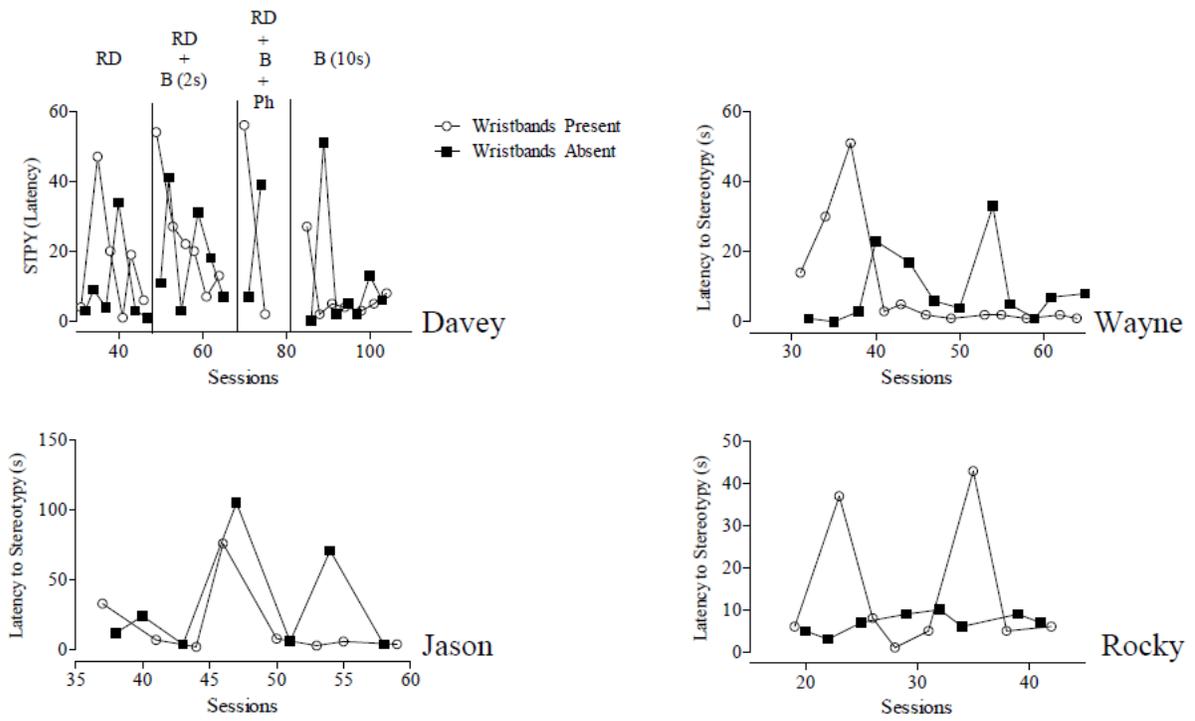


Figure 7. Latency to stereotypy between signaled and unsignaled components for all participants.