Behavior Analysis in Practice (2021) 14:367–377
https://doi.org/10.1007/s40617-020-00516-w

RESEARCH ARTICLE

The Effects of a Procedure to Decrease Motor Stereotypy on Social Interactions in a Child With Autism Spectrum Disorder

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Accepted: 14 September 2020 / Published online: 7 January 2021

Abstract

Repetitive and stereotypic motor movements and vocal behavior are among the diagnostic characteristics of autism spectrum disorder (American Psychiatric Association, 2013, *Diagnostic and Statistical Manual of Mental Disorders* [5th ed.]. Washington, DC: Author). Motor stereotypy can interfere with the acquisition and demonstration of many adaptive skills and may socially stigmatize individuals, limiting the development and maintenance of peer relationships. The current study evaluated the effects of a differential reinforcement procedure used to establish discriminative stimulus control over the rate of motor stereotypy. In the second experimental phase, the child was taught a multistep self-management program using the differential reinforcement procedure. The data indicate that the procedure was effective in decreasing the rate of motor stereotypy across all evaluated settings for an increased duration. Although motor stereotypy was not completely eliminated by the procedure, a large reduction in rate was observed, as well as a large increase in the initiation of and response to social interactions. The findings are discussed in terms of social validity and the establishment and transfer of stimulus control.

Keywords Differential reinforcement · Motor stereotypy · Self-management · Social interactions · Stimulus control

Repetitive and stereotypic motor movements and vocal behavior are diagnostic characteristics of autism spectrum disorder (ASD; American Psychiatric Association, 2013). Many studies suggest that the prevalence of children with ASD who display stereotypy is high; however, specific prevalence studies have not been conducted (Lanovaz, Robertson, Serono, & Watkins, 2013). Repetitive and stereotypic behaviors include different topographies (vocal and motor) such as noncontextual speech (Ahearn, Clark, MacDonald, & Chung, 2007; Crutchfield, Mason, Chambers, Wills, & Mason, 2015), perseverative speech (Rehfeldt & Chambers, 2003), arm or hand flapping (Crutchfield et al., 2015), lining up objects (Boyd, McDonough, & Bodfish, 2012), mouthing (Crutchfield et al., 2015), and body rocking (Mulligan, Healy, Lyndon, Moran, & Foody, 2014). These behaviors can interfere with the individual's ability to appropriately interact in social situations (Boyd et al., 2012; Loftin, Odom, & Lantz, 2008; Wilke et al., 2012), be socially stigmatizing (DiGennaro Reed, Hirst, & Hyman, 2012; Loftin et al., 2008), decrease opportunities for interactions with peers (DiGennaro Reed et al., 2012), have social impacts in general education placement (Loftin et al., 2008), reduce the individual's ability to attend to academic instructions (Ahearn et al., 2007; Boyd et al., 2012; Loftin et al., 2008), interfere with appropriate engagement in toy play (Loftin et al., 2008), negatively affect family engagement (Boyd et al., 2012; Wilke et al., 2012), and limit engagement in vocational activities (Wilke et al., 2012).

To assist with the development of effective and valid interventions, research suggests the implementation of a functional assessment prior to starting an intervention (Iwata et al., 2000). Functional assessments are not only recommended for research purposes but also required prior to intervention for problem behavior, according to the Behavior Analyst Certification Board's (2014) *Professional and Ethical Compliance Code for Behavior Analysts*. However, many published studies omit this requirement. One review by DiGennaro Reed et al. (2012)

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found that 56% of studies reviewed on the topic of stereotypy did not utilize a functional assessment. Another study that conducted an assessment with 53 children with ASD demonstrated that 90% of the individuals' stereotypy was maintained by automatic reinforcement (Wilke et al., 2012), and in a review by Hanley, Iwata, and McCord (2003), it was noted the stereotypy was automatically maintained in 63% of reviewed articles. If the behavior is identified to be maintained by automatic reinforcement through functional assessment procedures, the specific sensory consequence of that behavior then needs to be identified with further assessments (Rincover, Cook, Peoples, & Packard, 1979).

Some barriers to implementing a treatment based on automatically reinforced stereotypy include determining the particular response–reinforcer relation maintaining the response form, controlling the delivery of the reinforcer for the response, and determining and providing a functionally equivalent reinforcer for a socially acceptable behavior (Potter, Hanley, Augustine, Clay, & Phelps, 2013). Oftentimes, these barriers result in researchers implementing a non-function-based intervention for automatically maintained stereotypy (Mulligan et al., 2014). A review by Mulligan et al. (2014) noted that function-based treatments were only identified in just over half, 37 of 71, of the articles reviewed.

A variety of function-based antecedent and consequence strategies have been implemented to reduce the occurrence of stereotypy (DiGennaro Reed et al., 2012). In a review of stereotypy treatments, DiGennaro Reed et al. (2012) noted the frequent use of a combination of approaches. Antecedent interventions that include matched or unmatched stimulation and environmental enrichment have demonstrated effectiveness in the treatment of stereotypy (Mulligan et al., 2014). In other studies, reinforcement or skills-based interventions have demonstrated effectiveness to reduce rates of stereotypy, such as the use of differential reinforcement, self-management, functional communication training, and play skills training (Mulligan et al., 2014).

Many treatments for automatically maintained motor stereotypy consist of using differential reinforcement procedures to limit reinforcement when stereotypy occurs while also providing reinforcement for alternative or other adaptive socially appropriate skills (Lanovaz & Argumedes, 2010; Nuernberger, Vargo, & Ringdahl, 2013). A review article by Chowdhury and Benson (2011) discussed various differential reinforcement procedures used to treat stereotypy and found that these procedures were successful in reducing stereotypy. Differential reinforcement procedures are less intrusive treatment options compared to response-blocking and punishment procedures because they are based on reinforcement and effective in reducing problem behaviors and limit interruption to ongoing activities (Chowdhury & Benson, 2011). When stereotypy occurs at a high rate, two limitations of differential reinforcement procedures include continuous involvement from the caregiver and low levels of reinforcement due to limited intervals with the absence of stereotypy (Chowdhury & Benson, 2011).

Adding a stimulus to signal the use of a differential reinforcement procedure increases the stimulus control of the procedure (Haley, Heick, & Luiselli, 2010; Langone, Luiselli, & Hamill, 2013). These procedures require teaching the individual that in the presence of a specific stimulus, delivery of (or access to) reinforcement is contingent on the behavior not occurring. The stimulus can be an additional auditory stimulus, such as a tone, or a visual stimulus, such as a colored card or bracelet. Haley et al. (2010) examined the effects of a stimulus control procedure with a child with ASD in a general education classroom using colored cards as the discriminative stimulus. The procedure successfully reduced the child's vocal stereotypy in the target setting, and the stimulus control generalized to a second setting (Haley et al., 2010). Similarly, Langone et al. (2013) studied the effects of a stimulus control procedure that utilized response blocking by having the participant wear a tennis wristband as the discriminative stimulus. They found that wearing the tennis wristband, even without response blocking implemented, maintained low rates of the participant's motor stereotypy (Langone et al., 2013).

The use of discriminative stimuli can also be implemented as part of a self-management program (Cooper, Heron, & Heward, 2020). Self-management involves teaching the individual to observe his or her own behavior and apply behavior-change strategies. Oftentimes, the discriminative stimulus will cue the individual for responses in the future, such as setting an alarm or writing a reminder. The observation of one's own behavior and recording its occurrence or nonoccurrence (self-monitoring) have been implemented to change a variety of behaviors, and have been implemented more often than any other self-management strategy (Cooper et al., 2020). Reactivity to the self-monitoring procedure increases the therapeutic effects of self-monitoring (Cooper et al., 2020). However, the therapeutic effect can be further increased when combined with other contingencies (Cooper et al., 2020). Adding consequences, such as reinforcement, increases the effectiveness of self-management programs and gives the individual control of his or her own behavioral programming (Cooper et al., 2020). The benefits of self-management include the ability for it to be used for an extended amount of time, in the absence of a treatment provider, and in a wide variety of settings (Cooper et al., 2020).

Koegel and Koegel (1990) examined the effectiveness of a self-management procedure to reduce stereotypy in students with profound disabilities. They found that all students learned to use the self-management procedure, and as a result, all of their stereotypic behaviors reduced in rate. The procedure generalized to a new setting and in the absence of a treatment provider. Fritz, Iwata, Rolider, Camp, and Neidert (2012) replicated and conducted a component analysis of the

self-management procedure in Koegel and Koegel (1990) to determine which aspect of the procedure was responsible for the behavior change. They found that the components that resulted in the decrease were instructional control or differential reinforcement, but that the component of self-recording had little effect on stereotypy (Fritz et al., 2012).

Some researchers who focused on targeting adaptive (desirable) behaviors for increase have noted a collateral effect of decreased stereotypy. Pierce and Schreibman (1994) noted that upon a treatment designed to increase daily living skills, a decrease in stereotypic behaviors was observed without being directly targeted. Loftin et al. (2008) examined a procedure to increase social interactions in children with ASD that also resulted in a reduction in their motor stereotypy. Given the limitations that motor stereotypy presents to the individual, it is essential that researchers continue to assess and treat motor stereotypy either as the target behavior of the intervention or as a collateral behavior.

Due to the high prevalence of stereotypy in children with ASD and the significant social impact of the behavior, it is critical that more research be completed. This research should focus on determining effective procedures that reduce stereotypic behaviors and enhance social interactions among these individuals and their peers, families, and communities. The purpose of the current investigation was to evaluate the effects of a stimulus control and self-management procedure on the rate of motor stereotypy in a child with ASD, as well as the collateral effects the procedure had on social interactions.

Method

Participant, Setting, and Materials

Luke was a 5-year-old Caucasian male diagnosed with ASD. He was a member of a middle-class English-speaking family. He was receiving intensive home-based applied behavior analysis through the course of the study and attended a full-day integrated preschool program through his city's public school (a suburb in the northeastern United States). He was a verbal communicator and was able to spontaneously mand and tact, as well as emit intraverbal behavior of various forms. No formal interventions to address his motor stereotypy had been implemented prior to this study, as other interfering behaviors were successfully targeted for decrease. Motor stereotypy was reported by Luke's clinical team and parents to occur at unacceptable levels that interfered with his participation in social activities both within and outside the home. It was reported by Luke's clinical team and family that Luke did not interact with peers or adults while engaged in motor stereotypy. In approximately one year from the start of the study, Luke was to begin school in a mainstream classroom. Therefore, his parents and clinical team determined his motor stereotypy was a priority that needed to be addressed.

Sessions for the functional behavior assessment and baseline and treatment conditions, for all phases of the study, were conducted in Luke's bedroom (where Luke's home services typically occurred). The bedroom was furnished with his bed, a dresser, a bookshelf full of books, a trunk full of toys, a small table, and a set of chairs. All sessions were videotaped in order to be scored. Generalization probes were conducted in other rooms of his home, his yard, and the community. Materials used included leisure items, a bracelet (or watch), visuals, a timer, a self-management token board, and preferred items as identified in the preference assessment.

Response Definitions and Interobserver Agreement

Phase 1 The primary dependent variable was motor stereotypy. Motor stereotypy was defined as any episode of Luke putting one or more of his fingers in contact with the palm of his hand(s), in a tapping or clenching motion, or waving his hands at the wrist by twisting his hands up and down or side to side for three consecutive seconds or longer. Episodes ended when he was no longer engaged in the hand movements for three consecutive seconds. The independent variable for Phase 1 was the bracelet discrimination procedure using differential reinforcement of alternative behaviors.

Data on motor stereotypy were collected, for the functional assessment and Phase 1, using a 10-s partial-interval data sheet. Partial-interval data collection was selected due to Luke's engagement in motor stereotypy occurring at various durations, and occurrences may have been underestimated if other interval measurements were used. The percentage of intervals with motor stereotypy was calculated.

Phase 2 For Phase 2, the primary dependent variable was the rate of motor stereotypy, and the secondary dependent variable was the duration of treatment. The duration of treatment was defined as the amount of time Luke wore the bracelet and implemented the self-management procedure. The independent variable for Phase 2 was the implementation of a self-management procedure with the bracelet discrimination procedure. During baseline and treatment conditions in Phase 2, the rate of motor stereotypy and the duration of treatment were measured.

Phase 3 For Phase 3, data were collected on the rates of social initiations and social responding. Social initiations were defined as any instance of Luke spontaneously emitting a vocal statement paired with eye gaze toward the communicative partner and/or the presentation of an item. Social responding was defined as Luke emitting a vocal and/or motor behavior within 5 s of the presentation of a vocal question or comment from the communicative partner. Data for Phase 3 were collected via videotaped sessions of Phase 1 and Phase 2. During

Phase 3, data were collected on the rate of social initiations per minute and the percentage of responding per opportunity for social responding.

Interobserver agreement Interobserver agreement (IOA) data were collected by a secondary observer who independently scored 50% of sessions for the functional analysis, 45% of sessions for Phase 1, 25% of sessions for Phase 2, and 35% of sessions for Phase 3. The secondary observer collected data in vivo for the functional analysis, in vivo or via video for Phase 1 and Phase 2, and via video for Phase 3. IOA was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Agreement was high across the functional assessment and all three phases of the study and averaged 97% (range 85%–100%).

Experimental Design

For Phase 1, the effects of the bracelet discrimination procedure on the percentage of occurrence of motor stereotypy were evaluated using an A-B-A-B reversal design. Condition A referred to baseline, and Condition B to treatment (bracelet discrimination procedure). For Phase 2, the effects of the self-management procedure on the rate of stereotypy were evaluated using a changing-criterion design. For Phase 3, the effects of the procedure to reduce motor stereotypy on the occurrence of social interactions were examined using an A-B-A-B reversal design. Condition A referred to baseline, and Condition B to treatment (procedure to reduce motor stereotypy).

Functional Behavior Assessment

A multiple-stimulus without-replacement (MSWO) preference assessment (DeLeon & Iwata, 1996) was conducted with a variety of toys. The leisure item with the highest score was used for all training sessions and during the functional assessment. For Luke, the highest scored item was the iPad. Lower scoring items, such as action figures and books, were used during generalization trials.

A functional behavior assessment was conducted to determine the primary function of the target behavior. A descriptive assessment consisting of observational data on motor stereotypy was collected using the Beacon Consequence Analysis Form (a direct observation data sheet). This data sheet enables the observer to record the occurrence or nonoccurrence of any of the four consequences (attention, escape, tangibles, or no environmental change/automatic) provided to Luke immediately following the occurrence of the target behavior. Thus, the results of these data provide objective information from which to develop a hypothesis of function. The consequences most frequently noted after the occurrence of motor stereotypy suggested either an attention or sensory function of Luke's stereotypy (data are not presented but are available upon request from the first author).

In order to clarify a possible primary function, a free-operant modified preference assessment was conducted (Roane, Vollmer, Ringdahl, & Marcus, 1998). In the free-operant modified preference assessment, Luke was given free access to either sit at his table or sit on his bed. Each area was assigned one of the tested consequences (attention and sensory). The locations for each consequence were randomized across sessions, and Luke was verbally informed about which area resulted in which consequence at the start of each session. If Luke did not select one of the areas, he would have been prompted to make a selection, but this did not occur. The percentage of intervals that Luke selected a consequence and the percentage of stereotypy were scored. Results of the functional behavior assessment (Fig. 1) suggest that stereotypy was maintained by automatic reinforcement.

Phase 1 Procedures

Baseline Sessions were 5 min in length and were conducted 1 to 2 days per week, based on participant availability, with one to two sessions per day. Luke was given free access to the leisure item regardless of motor stereotypy. The staff and Luke's family members were instructed to continue with what they would typically do when he engaged with the leisure item but no one was to react or respond to occurrences of motor stereotypy. This was selected as the baseline condition as it closely represented what typically occurred.

Treatment Sessions were 5 min in length and were conducted 1 to 2 days per week, based on service session length and participant availability, with three sessions per day. At the start of each treatment session, the staff put the bracelet on Luke's wrist and presented a visual to review the intervention condition rule. This rule was presented on a piece of lined notebook paper and indicated with a simple drawing that no motor stereotypy equaled access to the iPad. Immediately following the review, if Luke demonstrated calm hands and the absence of motor stereotypy, he was given access to his iPad, which he maintained access to as long as he continued to display calm hands. Upon the occurrence of motor stereotypy, the iPad was removed until Luke had 15 s of calm hands and the absence of motor stereotypy. Luke did not receive any attention or further instruction when the iPad was removed. Upon 15 s of calm hands and the absence of motor stereotypy, the iPad was represented and remained presented as long as Luke demonstrated calm hands and the absence of motor stereotypy or the session ended after 5 min elapsed.

Generalization Generalization probes were conducted throughout the treatment condition. The generalization probes

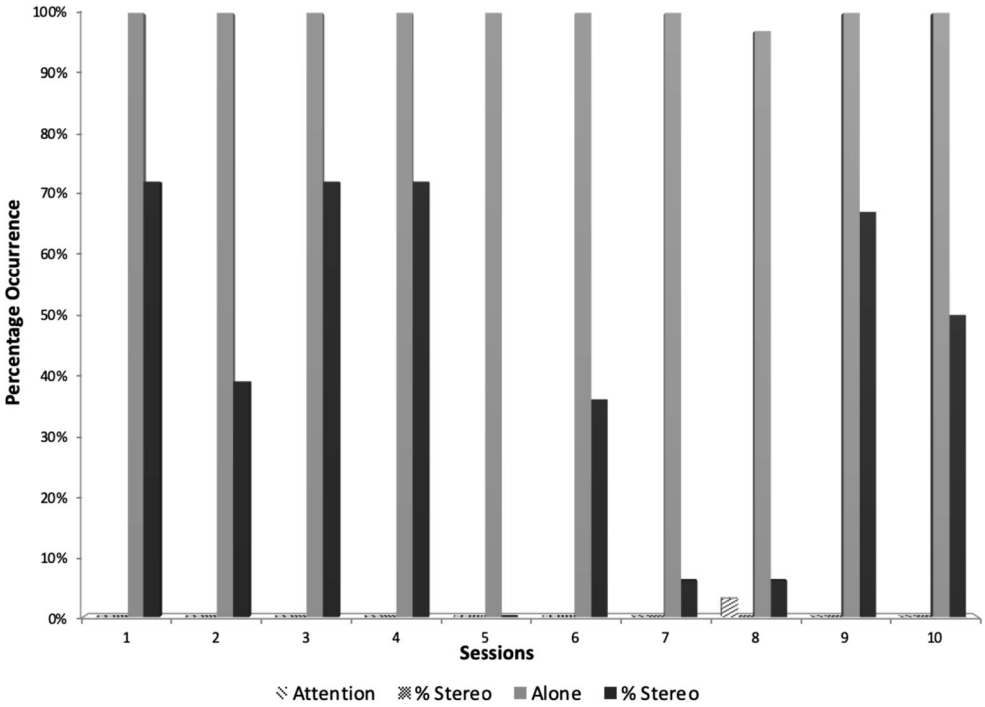

Fig. 1 Results of the functional behavior assessment; Stereo = stereotypy

varied from the treatment sessions in the following ways: the reinforcing items used (items from the MSWO that scored lower than the iPad), the setting (other rooms within Luke's home), and the people present (family and staff members). First, generalization focused on the location within his room, the floor and his bed, and with toys at the table in his bedroom. Then, generalization sessions occurred in other locations in the house, the dining room and living room, and then with his parent running the sessions.

Phase 2 Procedures

Baseline Throughout the baseline phase, sessions were 5 min in length, conducted 1 to 2 days per week with one to two sessions per day. Baseline sessions for Phase 2 were conducted in a manner identical to baseline for Phase 1.

Treatment Due to Luke's upcoming transition to a mainstream classroom, as well as the removal of his one-to-one staffing support, it was important for the treatment of his stereotypy to increase in duration and for Luke to self-manage his own intervention. To assist with this transition, a self-management program was implemented using the bracelet discrimination procedure from Phase 1.

Sessions were conducted one to two times per week with three to six sessions per day when the interval duration was 3 min or less, and one to three sessions per day when the interval duration was 4 min or greater. At the start of each treatment session, the staff put the bracelet on Luke's hand and presented Luke with his self-management token board and timer. The staff notified Luke of the timer interval to be used and wrote it on the token board. Luke then set his timer to the noted interval. At the end of each interval, Luke stopped his timer and gave himself a token for each step completed of the self-management program (setting the timer, stopping the timer, and not engaging in stereotypy). No further recording by Luke was required.

The initial interval used for the self-management procedure was 1 min. This was chosen as there were five intervals per token board and he had previously demonstrated low rates of stereotypy for 5 min during Phase 1. Intervals were then systematically increased as the criterion was met. The criterion for increase was 2 consecutive days with zero rates of stereotypy for a minimum of five sessions total. As the criterion was met, the interval was increased by 1 min. Upon the completion of the 4-min interval, Luke was given the opportunity to choose the interval duration. This was done because research suggests that providing the participant with a component of choice may increase the acceptability of the intervention by the participant and enhance the development of self-control (Dixon and Tibbetts, 2009).

For each interval of the self-management program, Luke had the opportunity to earn tokens. He could earn a token for each interval for setting the timer, stopping the timer, and having no occurrences of motor stereotypy. If motor stereotypy occurred, the interval was restarted, and he was told he could try again. Upon the completion of the token board, Luke received access to the iPad without the bracelet, which

signaled the availability to engage in motor stereotypy, for 5 min. The removal of the bracelet (access to motor stereotypy) and delivery of the iPad were used as the terminal reinforcers of the self-management procedure. These reinforcers were not used throughout the self-management procedure, as was done in Phase 1, in order to increase engagement with other activities occurring throughout his day while maintaining low levels of stereotypy. This also increased the social validity of the procedure, as it reduced the duration of iPad engagement, increased engagement with other more socially interactive activities, and increased the duration without stereotypy.

Generalization The generalization condition was implemented to extend the settings and people present, in order to increase Luke's participation in his community without stigma while maintaining the intervention's effect. The generalization condition was conducted identically to the treatment condition except that the settings varied. The settings used were Luke's home (living room, kitchen, dining room, backyard) and community (grocery store, park, playground, friend's house), and the people extended to new staff, parents, and a grandparent.

Token fading To further reduce the social stigma of stereotypy and the intervention in place, a token-fading procedure was implemented. The self-management token-fading condition consisted of Luke no longer wearing the bracelet, which was replaced by wearing a watch with a vibrating interval timer, and the removal of the self-management token board. The watch was introduced to eliminate the need for an audible timer, thus decreasing the noticeability of the intervention to the public while maintaining a discriminative stimulus similar to the bracelet for Luke. He wore the watch 45 min to 2 hr at a time, one to two times per day. Upon the first session of using the watch, Luke was told the watch was his new bracelet and had the same rules. The interval timer on the watch was set to 20 min. The watch remained on until Luke verbally requested its removal. All requests were honored. If a request occurred while Luke was engaged in an activity in the community, it would have been delayed, but this did not occur. Upon the completion of wearing the watch, Luke received access to the iPad without the watch, which signaled access to motor stereotypy, for 5 min.

Phase 3 Procedures

A postprocedural assessment was conducted via a review of videotaped sessions to evaluate the rate of social initiations and the percentage of occurrence of responses to social bids. The first session of each day was scored. Baseline sessions and Phase 1 sessions were 5 min in duration. For Phase 2, a 10-min probe at the start of the session was used, as the sessions varied in duration from 5 min to 80 min.

Results

Phase 1 Results

Figure 2 depicts Luke's percentage occurrence of motor stereotypy during all conditions in Phase 1. Stereotypy occurred during an average of 60% (range 30%–90%) of intervals, across the initial baseline condition. During the first treatment condition (bracelet discrimination procedure), the percentage occurrence of motor stereotypy decreased to an average of 3% (range 0%–17%) during training sessions and generalization sessions. A return to baseline resulted in motor stereotypy returning to near-pretreatment levels (mean = 55%; range 30%–83%). The second implementation of the bracelet discrimination procedure resulted in an immediate decrease in the percentage occurrence of motor stereotypy during training and generalization sessions (mean = 1%; range 0%–3%).

Phase 2 Results

The top panel of Fig. 3 depicts Luke's rate of motor stereotypy during all conditions of Phase 2. Luke averaged a rate of 0.87 responses per minute (range 0.4–1.2) across the initial baseline condition. Upon implementation of the 1-min interval of the self-management procedure, the rate per minute of motor stereotypy decreased to an average of 0.01 (range 0–0.10). A slight increase was observed during the 2-min interval with an average rate per minute of 0.04 (range 0–0.30). An increase in responding was observed again when the criteria changed to 3-min intervals (mean = 0.03; range 0–0.29), which resulted in sessions continuing at this level longer than other levels in order to meet the criteria for increase. A slight increase was observed during the implementation of the 4-min interval condition (mean = 0.02; range 0–0.07), but Luke quickly met the criteria to advance. A similar pattern was observed in the varied-interval condition (mean = 0.01; range 0–0.07), where Luke was able to choose the interval length for each interval. Low rates of motor stereotypy were observed in the generalization condition (mean = 0.01; range 0–0.11).

The bottom panel of Fig. 3 depicts the duration that Luke engaged in the self-management procedure per session. Baseline sessions were 5 min in duration. The 1-min interval condition averaged 12 min per session (range 11–20 min). An increase in duration over the anticipated 5 min was observed in the 1-min condition. This was due to Luke independently completing a task prior to stopping the timer or Luke taking his time to select which token he wanted to earn for that interval. The 2-min interval condition increased the duration

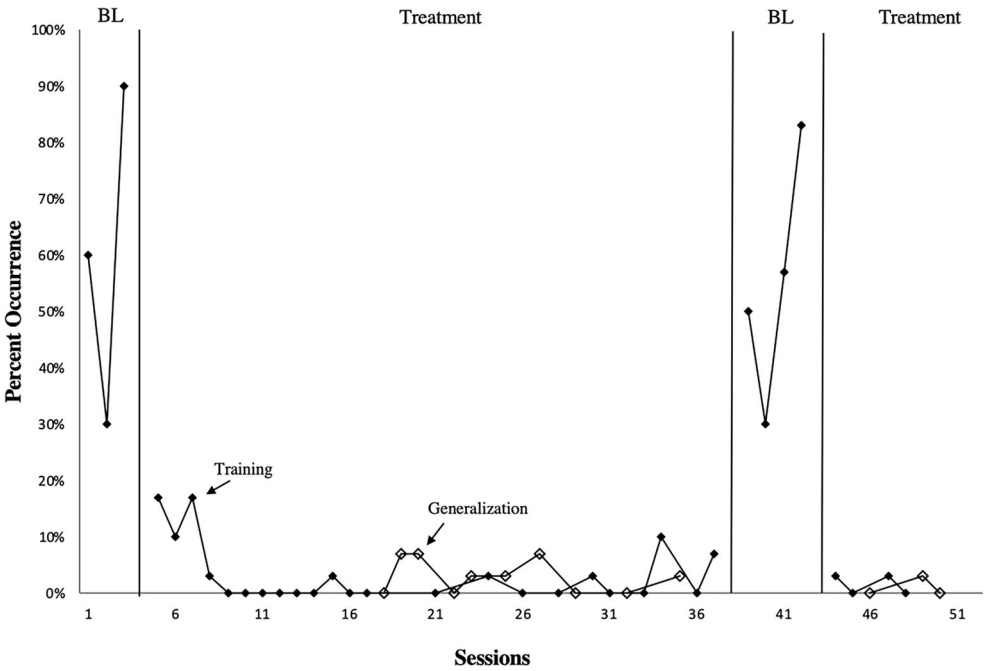

Fig. 2 Percentage of occurrence of motor stereotypy across Phase 1; BL = baseline

to an average of 15 min (range 13–18 min). A 4-min increase in average duration was observed in the 3-min interval condition, and a 5-min average increase was observed in the 4-min interval condition. In the varied-interval condition, the average duration was 30 min (range 15–65 min). In the generalization condition, another increase in duration was observed to an average of 52 min per session (range 20–76 min).

Phase 3 Results

Figure 4 depicts the results of Phase 3. The top panel represents the percentage occurrence that Luke responded to social bids. During baseline sessions, Luke averaged 51.5% responding (range 20%–83%). An increase was noted upon the implementation of Phase 1, with an average of 80% responding (range 33%–100%). A return to baseline resulted in a reduction in responding (mean = 46%; range 33%–56%). During Phase 2, Luke's responding demonstrated an increase to an average of 94% (range 77%–100%).

The bottom panel is the rate of social initiations. During baseline sessions, Luke averaged 0.5 initiations per minute (range 0.4–0.6). During Phase 1, Luke's rate of initiations increased to an average rate of 1.35 initiations per minute (range 0–4.8). During the return to baseline, Luke's rate of initiations reduced to levels previously observed in the initial baseline condition (mean = 0.6; range 0.4–0.8). In Phase 2, Luke's rate of initiations further increased from levels observed in the previous phase to an average of 2.29 (range 0.8–3.5).

Discussion

This study demonstrates that the differential reinforcement procedure using a bracelet as the discriminative stimulus was effective in decreasing rates of motor stereotypy, and that subsequent fading procedures were successful in maintaining low levels of stereotypy. Additionally, the inclusion of a self-management component in the procedure was successful in further reducing and maintaining low rates of stereotypy for extended durations and across a range of settings. The duration of self-management with the bracelet discrimination procedure increased throughout the investigation. Luke engaged in the intervention for up to 2 hr and in a range of community settings. Collaterally, social interactions were observed to increase across the intervention phases of the study.

Luke's independence in following the self-management procedure was initially variable but improved with the introduction of the varied-interval and generalization conditions (data are available upon request from the first author). Moreover, his accuracy of independent correct performance in the self-management procedure did not affect his rate of motor stereotypy. This replicates the effect of self-management regardless of accurate reporting as demonstrated by Koegel and Koegel (1990).

Significant findings of this study are the collateral effects of increased social initiations and social responding. Improved social interactions were observed across all conditions. The explanation for this finding is not clear; however, it is possible that the reduction in motor stereotypy may have increased Luke's availability to attend to social bids, as well as his responsiveness to social interactions. It is

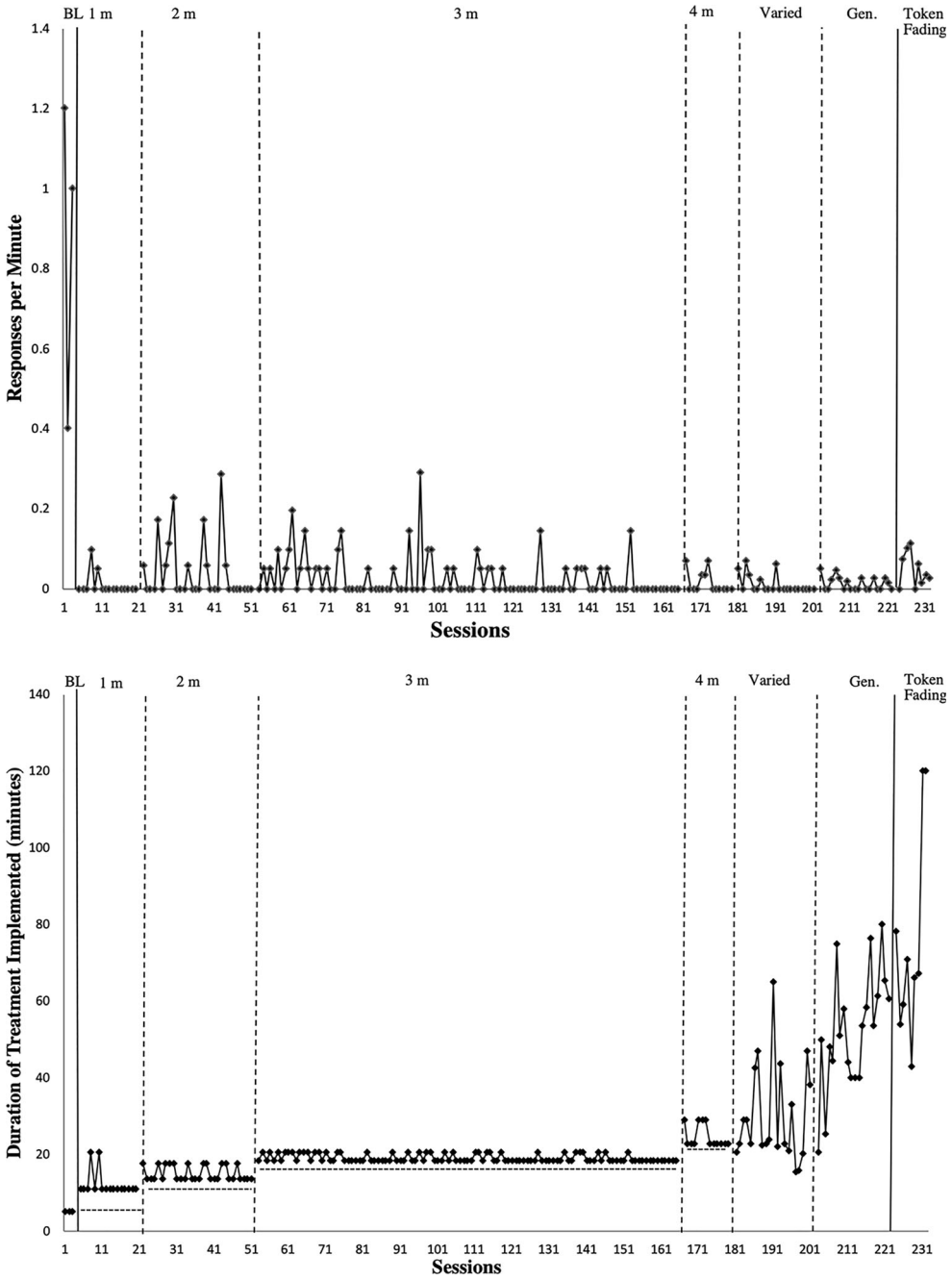

Fig. 3 Rate of stereotypy and duration of implementation across Phase 2. The top panel displays the response per minute of motor stereotypy during Phase 2. The bottom panel displays the duration in minutes for which the self-management procedure was implemented during Phase 2. Horizontal dotted lines indicate the criteria per condition in the self-management procedure; BL = baseline; Gen. = generalization

important to note that these skills were in his repertoire prior to the study and thus did not need to be established as part of this study. The reduction in motor stereotypy may simply have provided less interference in engaging in these adaptive skills with people in his environment. Luke could be described as a social child prior to this study, thus it could also be assumed that the lack of motor stereotypy made social interactions more available as an effective reinforcer. This finding, that a reduction in motor stereotypy can result in improvements in adaptive social functioning, is significant. Although previous authors have noted that stereotypic behavior impedes social functioning (Boyd et al., 2012; DiGennaro Reed et al., 2012; Loftin et al., 2008; Wilke et al., 2012), previous studies have not demonstrated a direct link between a reduction in motor stereotypy and improved social initiation and responsiveness to social bids.

A further interesting point is that the greatest increase in social interaction was observed in the self-management phase of the current investigation. While Luke was engaged in observing and recording his own behavior, improvements in

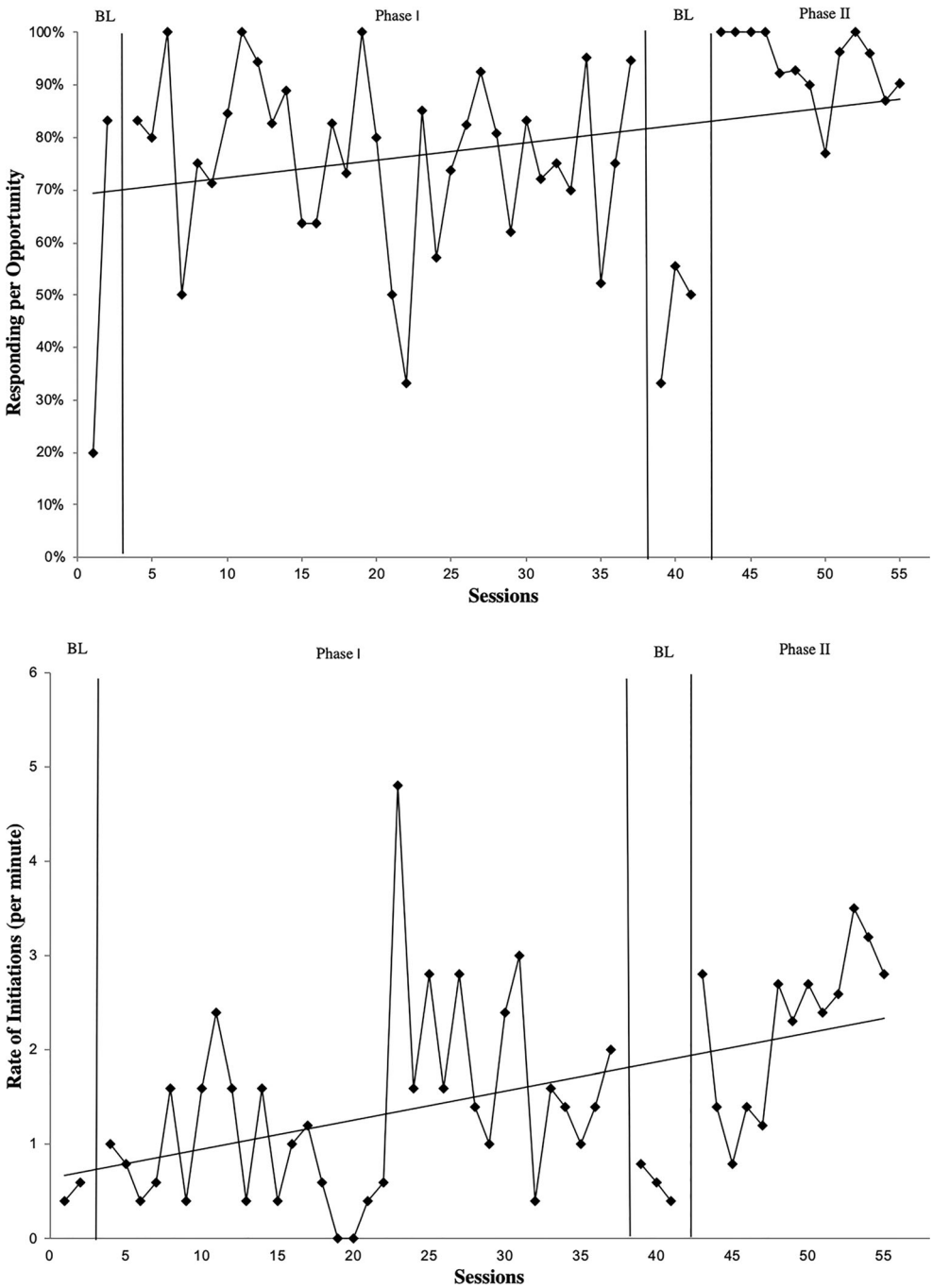

Fig. 4 Social interactions across phases. The top panel displays the percentage of responding per opportunity across phases. The bottom panel displays the rate of social initiations across phases; BL = baseline

social behavior appeared to be greatest. Further research should investigate the variables that may have contributed to this increase by conducting a component analysis of the intervention.

This intervention was not able to completely eliminate motor stereotypy from Luke's repertoire. However, the procedure reduced stereotypy to a level where it did not noticeably interfere with social engagement or occur to a degree that made him stand out significantly from his peers. Moreover, the intervention ultimately enhanced Luke's ability to self-manage his motor stereotypy. This new ability resulted in increased opportunities for Luke to engage with peers in the community.

Following the token-fading condition, his family was informally surveyed regarding the impact of this intervention. They reported satisfaction with the procedure and the results. They stated they were able to independently and successfully implement the procedure outside of sessions in the home and in novel settings, such as in the community (i.e., grocery store). At the conclusion of the study, Luke was integrated into a mainstream classroom at his public school. During the

school day, he continued wearing the watch (from the token-fading phase), and his teacher reported low rates of motor stereotypy and high levels of interactions with his peers.

The shift from an interventionist-implemented procedure to a self-management procedure not only increased the duration the intervention could be in place but also appears to have enhanced its effects. However, this process has a number of logistical implications. To implement the self-management procedure in the community, it required two important modifications: first, a token-fading procedure, and second, the use of a tactile timer (the vibrating watch). The implementation of the token-fading condition assisted with the maintenance of low rates of motor stereotypy, while allowing for ease of application in naturalistic settings such as in the community. It also assisted with reducing the stigma of the audible timer and token board when Luke was with his peers. Further analysis of the transfer of stimulus control to the vibrating interval timer watch should be examined with a systematic investigation using fading of each component. This would add to the current literature and clinically support the aspects required to reduce and maintain low levels of stereotypy.

Another important consideration is that the current investigation was implemented for approximately one year. The procedure involved contrived systematic manipulations to increase the environments in which the procedure was effective and to increase distractions within the environment (i.e., people present) while maintaining its effectiveness. This duration of intervention is consistent with research that has targeted automatically maintained behavior, suggesting that extensive time and effort are required for a change in repertoire of automatically reinforced stereotypy (Potter et al., 2013). Future research should further examine the systematic manipulation of variables to determine the rate that would be effective and efficient for interventions focused on automatically reinforced stereotypy. Additionally, a systematic literature review of the current studies reducing stereotypy and the levels achieved with each intervention would further assist in determining the expected levels of effect with various treatments and the acceptability of the treatment by those affected by it.

Teaching children with ASD to utilize self-management interventions is an important skill, as it can lead to essential social opportunities in society, as demonstrated in this study (Koegel & Koegel, 1990). Replications of the current study are recommended, as the current investigation was only implemented with one participant with strong vocal communication skills, and further support is needed to determine the effect across participants and participant characteristics.

Funding No funding was provided for this project

Compliance with Ethical Standards

Conflict of interest We have no known conflicts of interest to disclose.

Ethical approval Study-specific approval was granted from an ethics committee due to the research involving humans.

Informed consent Informed consent to participate in the research was received.

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