
A STIMULUS CONTROL PROCEDURE TO DECREASE MOTOR AND VOCAL STEREOTYPY

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A changing criterion design was used to examine the effects of two stimuli (a green card and a red card), conditioned via discrimination training, on reducing motor and vocal stereotypy in a youngster with autism while he looked at books. During discrimination training, motor and vocal stereotypy was not interrupted in the presence of a green stimulus, but was interrupted in the presence of a red stimulus using manual guidance and appropriate behavior was reinforced. After the participant demonstrated successful discrimination of the stimuli (i.e., the absence of stereotypy in the presence of a red stimulus and the engagement in stereotypy in the presence of a green stimulus), intervention began. During intervention, upon meeting criterion for latency to engage in motor and vocal stereotypy in the presence of the red stimulus for a target duration, the participant was provided access to the green stimulus, which signaled that motor and vocal stereotypy would not be interrupted. The criterion latency to engage in stereotypy in the presence of the red stimulus was systematically increased. Simultaneously, the duration of access to the green stimulus was systematically decreased. The red and green stimuli were faded from poster boards to colored 10 × 10 cm cards, and stimulus control was generalized to the participant's classroom and to a community setting (i.e., public library). Results are discussed in terms of discrimination training as a useful intervention for reducing motor and vocal stereotypy. Copyright © 2011 John Wiley & Sons, Ltd.

Research in the treatment of stereotypy has produced promising outcomes with a wide variety of treatment methods focusing on both antecedent and consequent interventions. With respect to consequent interventions, the successful use of differential reinforcement has been demonstrated when stimuli that match the sensory properties produced by stereotypy can be identified and applied contingently on the absence of stereotypy (Taylor, Hoch, & Weissman, 2005). Additionally, punishment procedures such as, overcorrection (Foxy & Azrin, 1973) and more recently, response interruption and redirection (Ahearn, Clark, MacDonald, & Chung, 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Casella, Sidener, Sidener, & Progar, 2011) have also provided informative evaluations of the contingent presentation of demands on

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rates of stereotypy. The combined use of both reinforcement and punishment procedures have been experimentally evaluated and often determined effective for the reduction of stereotypy, as well (Fellner, Laroche, & Sulzer-Azaroff, 1984; Lerman, Kelly, Vorndran, & Van Camp, 2003). Evidence also exists that supports the use of antecedent interventions as a means of reducing stereotypy. Antecedent interventions have attempted to reduce stereotypy by improving the implementation of discrete trial instruction (Dib & Sturmey, 2007), using non-contingent reinforcement (Lanovaz & Sladeczek, 2011), and establishing stimulus control over the occurrence and non-occurrence of stereotypy using discrimination training (Haley, Heick, & Luiselli, 2010).

Discrimination training is a teaching procedure that reinforces specific behavior in the presence of certain antecedent stimuli and withholds reinforcement of that same behavior in the presence of other antecedent stimuli (Cooper, Heron, & Heward, 2007). The result of such training produces reliable responding in the presence of stimuli predictive of reinforcement while simultaneously eliminating responding in the presence of stimuli predictive of extinction or punishment. Researchers and clinicians have relied on this type of stimulus control procedure to teach numerous adaptive responses to individuals with autism including cognitive, communication, social, academic, vocational, and self-care skills (Green, 2001; Miller & Lignugaris-Kraft, 2002). Although not as abundant, studies are emerging documenting the effects of decreasing maladaptive behavior using discrimination training (Brusa & Richman, 2008; Doughty, Anderson, Doughty, Williams, & Saunders, 2007; Haley et al., 2010; McKenzie, Smith, Simmons, & Soderlund, 2008; Rapp, Patel, Ghezzi, Flaherty, & Titterington, 2009). Stimulus control procedures might be a viable alternative to consequent procedures that are often difficult to design and implement effectively because of the competing contingency of automatic reinforcement produced by engaging in stereotypy.

As a case in point, Doughty et al. (2007) examined the question of whether or not the suppression of automatically reinforced stereotypy can be brought under the control of a discriminative stimulus for punishment. The researchers used a differential punishment procedure to decrease motor stereotypy. Specifically, in the presence of a particular stimulus (e.g., wristbands), a 'hands-down' punishment procedure was implemented. In the absence of that stimulus, no programmed consequences were applied for the occurrence of stereotypy. Results indicated that stereotypy came under the control of the discriminative stimulus (i.e., wristbands) for punishment, occurring less frequently in its presence than in its absence.

Similarly, McKenzie et al. (2008) evaluated the effects of a mild punishment procedure (i.e., verbal reprimands) in conjunction with contingent application of wristbands on chronic eye poking demonstrated by a 46-year-old woman with a diagnosis of profound mental retardation. In the first condition, no wristbands were

used, and there were no programmed consequences for the occurrence of eye poking. In the second condition, wristbands were applied contingent upon the first occurrence of eye poking, and there were no programmed consequences for subsequent occurrences. In the third condition, wristbands were applied contingent upon the first occurrence of eye poking, and a verbal reprimand was delivered upon subsequent occurrences of eye poking. Results demonstrated that contingent verbal reprimands in the presence of a wristband decreased eye poking and the application of the wristband served as a discriminative stimulus for punishment.

Rapp et al. (2009) also demonstrated that environmental stimuli can exert inhibitory control over automatically reinforced behavior following discrimination training. The researchers paired a red card with the use of a verbal reprimand (i.e., positive punishment) or removal of toys (i.e., negative punishment) contingent on vocal stereotypy. Additionally, no programmed consequences were applied to the occurrence of vocal stereotypy in the presence of a green card (i.e., vocal stereotypy was permitted). The results showed that vocal stereotypy came under the control of the red and green cards, occurring less in the presence of the red card and more in the presence of the green card.

In a similar study, Brusa and Richman (2008) established stimulus control over automatically maintained string play displayed by a youngster with autism by pairing a green stimulus with free access to stereotypy and a red stimulus with redirection and response blocking. The purpose of the current study was to replicate this procedure by pairing a green stimulus with free access to motor and vocal stereotypy and a red stimulus with blocking and redirection. As an extension of Brusa and Richman (2008), we assessed the function of the green stimulus as a conditioned reinforcer following discrimination training by applying it contingently upon increases in the latency to engage in motor and vocal stereotypy within a changing-criterion design. Additionally, the red and green stimuli alone continued to demonstrate differential control throughout the treatment condition even though programmed consequences were no longer paired with their presentation (i.e., response blocking and reinforcement were not used when the red stimulus was present). Following the changing criterion design, we also measured latency to engage in stereotypy in different settings including the participant's classroom and at a public library.

METHOD

Participant

An 11-year-old male child participated in this study. Diego had previously received a diagnosis of autism from an independent agency and attended the Alpine Learning Group (a behavior-analytic school program for individuals with autism).

Diego was enrolled in this school for approximately 1 year prior to the start of this study. He was able to make simple visual and auditory discriminations and was able to mand for tangible items and activities. Diego had limited play and leisure skills and engaged in vocal and motor stereotypy while looking at books (e.g., tapping the book, repeating non-communicative vocalizations). An informal descriptive functional assessment conducted using an ABC analysis indicated that vocal and motor stereotypy with books occurred across all environments, including when Diego was alone. Thus motor and vocal stereotypy was hypothesized to be automatically maintained by sensory consequences.

Setting

Baseline sessions were run in a clinic room (i.e., a small room furnished with desks, chairs, and various toys and games). Discrimination training sessions occurred in the clinic room as well as Diego's classroom. Present in Diego's classroom were three other students working one-on-one with staff. Intervention sessions took place in the clinic room, classroom, and public library.

Materials

Red and green colored stimuli were used during discrimination training. Throughout discrimination training and sessions 11 through 41 of intervention, the participant was seated at a desk covered in a colored poster board and surrounded by a colored trifold presentation board. A 10 × 10cm colored card was also present on the desk. For session 42 of intervention, the stimuli were faded to the colored poster board and 10 × 10cm colored card on the desk. For sessions 43, 44, and 45 of intervention, the stimuli were faded further to just a 10 × 10cm colored card on the desk.

During discrimination training, the red stimuli signaled that attempts to engage in motor and vocal stereotypy would be blocked and that appropriate book play would be prompted and reinforced with edibles and social praise. The green stimuli signaled that attempts to engage in motor and vocal stereotypy would not be blocked.

Data Collection and Dependent Variables

For all conditions of the experiment, *stereotypy* included both motor and vocal stereotypy in the presence of books. Motor stereotypy was defined as tapping pages, folding pages, running fingers along pages, firmly clasping hands together, and hand flapping. Vocal stereotypy was defined as non-communicative vocalizations (e.g., saying, 'horse' repeatedly in a high-pitched voice). Hereafter, the term *stereotypy* will be used to refer to the occurrence of motor and/or vocal stereotypy. Although

appropriate behavior with books was not directly measured, it was defined for the purposes of prompting and reinforcing it during the red condition of discrimination training. *Appropriate behavior* was defined as turning the pages of the book or sitting with hands on lap while looking at the book.

For discrimination training, the dependent measure was the percentage of 10-s intervals engaged in stereotypy. Stereotypy was scored on a 10-s partial interval basis. That is, if the participant engaged in stereotypy at any point during the 10-s interval, the entire interval was scored as a plus (+); only if the participant did not engage in stereotypy for the entirety of the 10-s interval was it scored as a minus (–). Data from each discrimination training session were summarized as the percentage of 10-s intervals that Diego engaged in stereotypy in the presence of the red and green stimuli. Data were collected during nine probe sessions that occurred over a 7-week period.

During baseline and intervention, the dependent measure was latency to engage in stereotypy. The experimenters started a timer as soon as Diego was given a book. When Diego engaged in stereotypy, the elapsed time was noted as the latency to engage in stereotypy.

Interobserver Agreement and Treatment Integrity

Interobserver agreement was calculated for discrimination training on an interval-by-interval basis by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. For baseline and intervention, interobserver agreement was calculated as either 100% agreement or 0% agreement for total duration of latency to engage in stereotypy. A second observer independently scored 30% of sessions at a mean of 100% agreement.

Treatment integrity data was collected for both discrimination training and intervention sessions. A second observer independently scored each step of the experimenter's procedure as implemented correctly or incorrectly, not observed, or not applicable. Treatment integrity data was collected for 14% of sessions at a mean score of 100% accuracy.

Experimental Design

There were three conditions implemented during this study. First, a baseline procedure was conducted, followed by discrimination training, and finally an intervention phase. During the intervention phase, a changing-criterion design was used to evaluate the effectiveness of the intervention on increasing the latency to engage in stereotypy.

Procedure

Baseline

During the baseline condition, Diego was seated at a table in the clinic room for 1-min sessions. The researcher not only gave Diego a book but also allowed him to have access to various toys and games in the room. He was left alone in the room, and the experimenters observed through a one-way mirror. Stereotypy was not interrupted and no prompts or reinforcers were provided for appropriately looking at books. The red and green stimuli were not present.

Discrimination Training

The purpose of discrimination training was to establish stimulus control over stereotypy by pairing programmed consequences with red and green stimuli.

During the red condition, Diego was seated at a desk outfitted with the red stimulus and presented with a book. The researcher pointed to the red stimulus and stated 'It's red, read nicely.' Throughout this condition, the researcher remained positioned 1ft behind Diego, and all attempts at motor stereotypy were blocked through redirection. For instance, if Diego attempted to tap on the pages of the book, the experimenter manually guided his hands down and placed them on his lap. If vocal stereotypy occurred, access to the book was paused: Diego was guided to sit back in his chair away from the book until the cessation of vocalization. When Diego was engaged appropriately with the books (i.e., turning pages or sitting with hands on lap while looking at a book in the absence of stereotypy), he was provided with both edible reinforcers and social praise on a variable interval (VI) schedule as defined by each phase.

The green condition immediately followed the red condition. Diego was seated at a desk containing the green stimulus and was presented with the same book he used in the red condition. The researcher pointed to the green stimulus and stated, 'It's green, play,' and waited outside of the room. There were no programmed consequences for stereotypy or appropriate book play.

During phase 1, reinforcement for appropriate behavior with books was provided during the red condition on a VI 10s schedule. Red condition sessions were conducted in the classroom, and green condition sessions were conducted in the clinic room in order to aide in discrimination. Similarly, during phase 2, reinforcement for appropriate behavior with books was provided on a VI 10s schedule; however, both red and green conditions were conducted in the same room in order to ensure that it was the red and green stimuli and not location that acquired control over stereotypy. Once zero rates of stereotypy were observed in the red condition, the reinforcement schedule was thinned to a VI 15s schedule in phase 3, then to a VI 20s schedule in phase 4, and finally, no prompts or reinforcers were provided in the red condition in phase 5.

Intervention

Intervention commenced after phase 5 of discrimination training was completed. During intervention, sessions were a fixed length of 5 min. A changing criterion design was used to evaluate the effectiveness of the green stimulus (i.e., access to stereotypy) as a reinforcer for systematically increasing the latency to engage in stereotypy. Upon meeting criterion for a varied number of sessions, the participant was required to refrain from engaging in stereotypy for longer intervals of time before accessing the green stimulus. The participant was seated at a desk with the red stimulus and was given a book. No instructions, additional prompts, or reinforcers were provided as they were during discrimination training. The researcher left the participant alone in the room but observed through a one-way mirror. Once the experimenter's timer reached the predetermined duration, if Diego did not engage in stereotypy, he was granted access to the green condition for the remainder of the 5-min session. If the participant engaged in stereotypy prior to the preset criterion, the session was terminated, and he was returned to his classroom for usual programming and was not granted access to the green condition.

Intervention began with session 11. The criterion for reinforcement (i.e., presentation of the green stimulus and access to stereotypy) during each subphase of the intervention was as follows: sessions 11–13 was 30s; sessions 14–16 was 40s; sessions 17–22 was 1 min; sessions 23–28 was 1 min 30s; session 29 was 2 min; sessions 30–32 was 3 min; sessions 33–35 was 3 min 30s; sessions 36 and 37 was 3 min; session 38 was 3 min 30s; sessions 39–45 was 4 min 15s. At session 42, fading of the red and green stimuli began. For session 42, the stimuli were faded to a single poster board on the desk. For session 43, the stimuli were faded further to a 10 × 10 cm colored card.

Generalization

Generalization was assessed across two different settings during sessions 44 and 45. During session 44, the red and green conditions were conducted in the participant's classroom. He was seated at a table and presented with the red stimulus and a book. After meeting criterion of 4 min 15s latency to engage in stereotypy, the participant was presented with the green stimulus for the remainder of the session (45s). During session 45, the red condition was conducted at a public library, and the green condition was conducted in the experimenter's car outside the library. The participant was instructed to pick a book and was seated at a table and presented with the red stimulus. After meeting criterion of 4 min 15s latency to engage in stereotypy, the participant was brought to the experimenter's car and presented with the green stimulus for the remainder of the session (45s).

RESULTS

Figures 1 and 2 display the results of this study. Figure 1 displays the percentage of 10-s intervals that Diego engaged in stereotypy during discrimination training. Closed circles represent the red condition and open circles represent the green condition. Each phase represents a different setting and/or reinforcement schedule.

At the beginning of phase 1, Diego did not demonstrate discrimination between the red stimulus and the green stimulus. During session 1, he engaged in stereotypy during 54% of the intervals in the red condition and 67% of the intervals in the green condition. However, by the third session, Diego's behavior indicated a clear discrimination between the two stimuli (i.e., he did not engage in any stereotypy in the red condition and engaged in stereotypy in 100% of the intervals in the green condition). This difference in behavior between conditions continued across all phases of discrimination training. By the final session (session 9), Diego did not engage in stereotypy in the red condition and engaged in stereotypy for 83% of the intervals in the green condition.

Figure 2 represents the latency (min) to engage in stereotypy during baseline and intervention sessions. The dotted horizontal lines indicate the preset criterion for each subphase within the changing criterion design. During baseline, the mean latency to engage in stereotypy was 15.7s. During intervention, the latency to engage in stereotypy matched the set criterion for the subphase for all but four sessions. In order to demonstrate control by reinforcement contingencies, the length of time at each

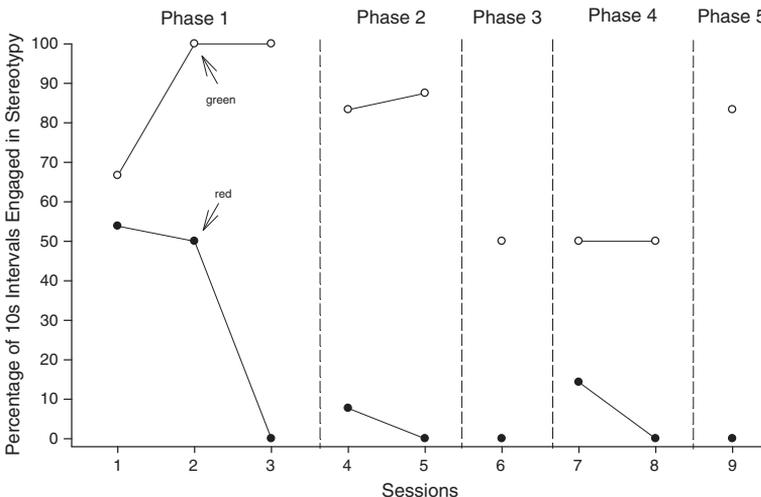


Figure 1. Percentage of 10-s intervals that Diego engaged in stereotypy during the five phases of discrimination training.

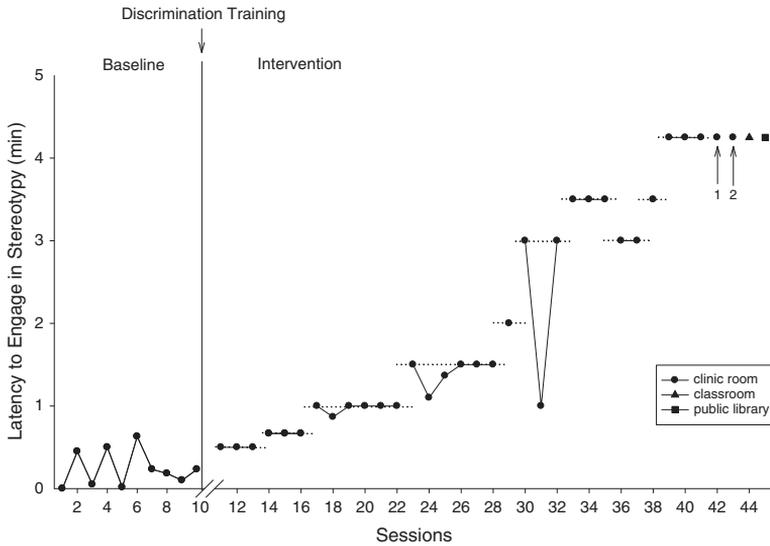


Figure 2. Latency (min) to engage in stereotypy during baseline and intervention sessions. The following numbers correspond to the arrows on the graph and indicate the following fading steps: 1=session 42, stimulus faded to a single poster board on desk. 2=session 43, stimulus faded to 10×10 cm colored card.

criterion was systematically varied, differences in magnitude changes between criteria were systematically varied, and a return to a former criterion was implemented. For example, during sessions 36 and 37, the criterion for reinforcement was changed to reflect the criterion of earlier previous subphase (i.e., 3 min criterion from subphase 6). During this return to a former criterion, the latency to engage in stereotypy was 3 min.

Latency to engage in stereotypy according to the set criterion maintained during the fading of the red and green stimuli as well as during generalization sessions. During session 42, the stimuli were faded to the single poster boards; during session 43, the stimuli were further faded to 10×10 cm red and green cards. Session 44 was a generalization probe that occurred in the participant's classroom, and session 45 was conducted at the public library. The latency to engage in stereotypy for each of these sessions was 4 min 15 s.

DISCUSSION

Consistent with Brusa and Richman (2008), the results of this study indicate that discrimination training is a useful intervention for reducing stereotypy. The findings expanded those of Brusa and Richman (2008) by evaluating the discriminative

properties of the red and green stimuli within a changing criterion design. Specifically, we demonstrated that the red and green stimuli alone continued to demonstrate differential control throughout the intervention condition even though programmed consequences were no longer paired with their presentation (e.g., response blocking and reinforcement were not used when the red card was present); whereas, Brusa and Richman (2008) stated that it was unclear whether it was the card or the verbal redirection and statement of contingencies that exerted control over responding.

Additionally, we demonstrated that following discrimination training, the green stimulus functioned as a conditioned reinforcer by applying it contingently upon the absence of stereotypy within the changing-criterion design. That is, access to motor and vocal stereotypy in the green condition served as the reinforcer for the absence of motor and vocal stereotypy in the red condition during the intervention phase. It is possible that the history of edible reinforcement and social praise during discrimination training contributed to the success in the red condition during intervention. However, if that were the case, we would have expected to see an extinction effect during intervention once the edibles and social praise were removed. This did not occur, strengthening the argument that contingent access to stereotypy reinforced its absence.

Finally, generalized responding from the clinic room to the participant's classroom and the library demonstrated even greater control by the red and green stimuli. It is unknown if these stimuli would continue to exert control over behavior in other environments that are less similar to the school environment, such as the home environment, and in the presence of parents, siblings, and relatives. Future work in this area might attempt to promote generalization across environments by varying the settings in which discrimination training occurs and establish control by more complex stimulus combinations.

A procedural aspect of this study may be highlighted as a limitation or may raise questions regarding the conclusions discussed earlier. Specifically, during intervention sessions, if the participant did not meet the latency criterion for a phase within the changing-criterion design (i.e., engaged in motor or vocal stereotypy during the red condition), the session was terminated. It is possible that the termination of sessions prior to the participant accessing the green condition (i.e., access to stereotypy) functioned as a negative punisher, as it was similar to a response cost procedure, thus decreasing the likelihood of engaging in motor stereotypy in red conditions. However, it is unlikely that negative punishment was in effect because no session was terminated prior to the eighth session, and a total of only four out of 35 sessions were terminated. Nonetheless, future research may examine procedures that avoid contingent termination of sessions.

An additional limitation is with respect to measurement. Although *appropriate behavior* was defined for the purposes of reinforcing an appropriate response during the red condition of discrimination training, it was not directly measured during

discrimination training. In fact, discrimination of the red and green stimuli was evaluated by measuring the occurrence and non occurrence of stereotypy. Thus, we do not have a measure of the occurrence of appropriate behavior in the red condition or its absence in the green condition. Similarly, during intervention, the latency to engage in stereotypy served as the measure of appropriate behavior as opposed to a direct measure of appropriate behavior itself. Future studies may use these additional measures to analyze increases in appropriate behavior in the presence of inhibitory stimuli.

Despite these limitations, this study adds to the growing body of literature indicating that automatically reinforced behavior can be addressed via discrimination training and stimulus control procedures. Additionally, the use of stimuli that allow uninterrupted access to the problem behavior as reinforcement for its absence has far reaching applicability for automatically maintained responses that often fail to show improvement using preferred items and activities as potential reinforcers during differential reinforcement interventions. Further, stimulus control procedures can lead to socially valid outcomes as was the case for Diego who was able to refrain from stereotypy while looking at books in his classroom and at a public library. Final response latencies of 4min might seem low to some, however, they arguably represent a socially meaningful change considering Diego was unable to even visit the library or access books as reinforcers in his classroom prior to the study because of the immediate onset of stereotypy that occurred in the presence of books. Thus, the final response latency of over 4min could be considered meaningful relative to the initial response latency. Longer latencies would undoubtedly be more socially relevant with respect to increasing the amount of time that Diego spends in community settings.

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