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## THE EFFECTS OF USING A CONDITIONED STIMULUS TO CUE DRO SCHEDULES<sup>†</sup>

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A reversal design was used to examine the effects of a differential reinforcement of other behavior (DRO) procedure and the presence of a stimulus (i.e., a bracelet), conditioned via discrimination training, on reducing socially maintained non-contextual vocalizations in an adolescent girl with autism. Initially, a functional analysis determined that non-contextual vocalizations were maintained by social attention. Then, discrimination training was used to establish the presence of the bracelet as a discriminative stimulus for the absence of vocalizations. Specifically, when the bracelet was on, non-contextual vocalizations were interrupted, and edible reinforcement was provided for the absence of vocalizations. When the bracelet was off, vocalizations were not interrupted and the teacher provided social attention to the participant (i.e., reciprocated conversation with the participant about the topic). During intervention, a DRO procedure was used. The participant was presented with the bracelet, a timer set for a specified interval, and the instruction to work quietly. If vocalizations did not occur for the entire duration of the interval, the bracelet was removed and the learner was given the opportunity to engage in vocalizations. The DRO interval was systematically increased throughout the intervention. Results are discussed in terms of discrimination training as an effective addition to differential reinforcement procedure. Copyright © 2015 John Wiley & Sons, Ltd.

Problem behavior, as any behavior, is emitted in the presence of particular environmental stimuli; as such, these stimuli may be altered to reduce the probability of problem behavior (Luiselli et al., 2008). Recent studies have demonstrated the effectiveness of antecedent interventions, particularly stimulus control procedures, to decrease automatically maintained problem behavior (Brusa & Richman, 2008; Doughty et al., 2007; McKenzie et al., 2008; Rapp et al., 2009). Antecedent interventions are beneficial because these procedures are implemented prior to an occurrence of problem behavior often preventing its occurrence, as opposed to applying

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consequences. When antecedent interventions are successful in preventing problem behavior, the use of more invasive or resource-intensive procedures might be avoided.

Stimulus control procedures are antecedent interventions that use discrimination training to condition a response to occur in the presence of a particular stimulus (e.g., a green card) and not to occur in the absence of that stimulus or the presence of a different stimulus (e.g., a red card). In effect, two stimuli cue two different schedules of reinforcement (e.g., FR1 and extinction), and the participant comes to respond more frequently to the presence of the stimulus associated with reinforcement and less frequently in the presence of the stimulus associated with extinction. Discrimination training has been commonly used to teach new skills but is becoming increasingly popular as an intervention for decreasing maladaptive behavior. It has been suggested that stimulus control procedures may be a more socially valid approach to treating problem behavior considering the overall lack of research on and understanding of punishment procedures (Rapp et al., 2009).

Discrimination training has been used as a part of a treatment package to reduce problem behavior in several recent studies. Haley, Heick and Luiselli (2010) used an antecedent intervention by presenting cue cards to signal to a learner when it was appropriate to engage in stereotypic vocalizations and when it was not. Rapp, Patel, Ghezzi, O'Flaherty and Titterington (2009) used stimulus control procedures with either positive or negative punishment. The experimenters paired a red card with either a verbal reprimand or response cost contingent upon stereotypy. When a green card was presented, there were no consequences implemented for stereotypy. They found that when the red card was present, stereotypy decreased and in the presence of the green card, stereotypy remained at high levels. In 2008, Brusa and Richman used discrimination training to decrease object-related string play in a young boy with autism. They used green and red stimuli that served as the discriminative stimuli for the respective conditions. During the green condition, the learner was provided free access to motor stereotypy and conversely, during the red condition, stereotypy was blocked. The results demonstrated that the learner successfully discriminated between the two conditions and stereotypy decreased in the presence of the red stimuli.

O'Connor et al. (2011) extended the results of Brusa and Richman (2008) by evaluating the continued effects of two stimuli conditioned via discrimination training on decreasing both motor and vocal stereotypy related to books displayed by an 11-year-old boy with autism. During discrimination training, a green card was paired with free access to stereotypy while a red card was paired with the blocking and redirection of stereotypy. Following this, the experimenters used a changing criterion design to assess the effects of these two stimuli on increasing the latency to engage in stereotypy. The reinforcement criterion for latency to engage in stereotypy in the presence of the red card was systematically increased. It was also demonstrated that the green card functioned as a conditioned reinforcer by applying it contingently

upon the absence of stereotypy within the changing-criterion design. The duration of access to stereotypy was also systematically decreased. The results demonstrated that the stimuli conditioned via discrimination training can be useful cues with DRO procedures.

Differential reinforcement of other behavior (DRO) is an intervention used successfully to reduce problem behavior such as self-injury and motor stereotypy (Beare, Severson, & Brandt, 2004), stereotypic vocalizations (Rozenblat, Brown, Brown, Reeve, & Reeve, 2009), and verbal perseverations (Rehfeldt & Chambers, 2003). Arguably, DRO procedures require the participant to make complex discriminations. That is, when a DRO is in effect, reinforcement is provided if problem behavior does not occur within a specific period of time and will not be provided if problem behavior occurs within that same interval. Thus, the participant must discriminate when and when not to engage in problem behavior based on the passage of time. Given the complexity of this discrimination, it might be advantageous to first establish control of the problem behavior by an arbitrary stimulus conditioned via discrimination training and then use this stimulus to cue the availability of reinforcement within a DRO schedule. Particularly when problem behavior occurs at high rates and is under the control of many environmental stimuli, it might be advantageous to use a visual stimulus that has previously been conditioned to signal the occurrence of two separate schedules of reinforcement operating within the DRO.

The current research used discrimination training prior to implementing a DRO to decrease non-contextual vocalizations in an adolescent girl with autism who displayed perseverative vocalizations about very specific topics (e.g., airlines, karate, roller coasters). Specifically, we wanted to see if the stimuli that acquired control over occurrences and non-occurrences of vocalizations during discrimination training could be used to signal the reinforcement schedules operating within a DRO. While previous research using stimulus control procedures has focused mainly on automatically maintained stereotypic behavior or the use of DRO procedures alone, we were interested in the combined effects of discrimination training and DRO procedures on reducing non-contextual vocalizations that were maintained by teacher attention. The procedures used for discrimination training were derived from Brusa and Richman (2008) and O'Connor et al. (2011).

## METHOD

### Participant and Setting

The participant was a 13-year-old female who attended a behaviorally based school for children with autism. Her Picture Peabody Vocabulary Test age equivalent

score was 6 years and 2 months at the time of the study, and general adaptive functioning, as determined by the Vineland Adaptive Behavior Scales was low with a mild deficit. This was consistent across all domains including communication, daily living, and socialization. The participant engaged in high rates of non-contextual vocalizations that centered on perseverative topics. For instance, she would talk about going to museums, airplanes, and video games among other things during instructional programming and at other inappropriate times. As part of her education program, the participant was engaged in a variety of skill acquisition programs targeting appropriate social interaction. She was learning to initiate and engage in scripted conversation about preferred activities and topics under the appropriate conditions, to introduce herself to unknown people, and to state verbal phrases in the appropriate context (e.g., to ask for assistance when needed). The study took place in a classroom at the participant's school. The classroom contained five desks, chairs, and shelving holding instructional materials and leisure items. All sessions were conducted by classroom teachers with 3–5 years of experience with the clinical application of Applied Behavior Analysis.

## Materials

During discrimination training, a red bracelet made of 100% silicone rubber was used, as well as edibles identified by teacher survey as preferred, and a vibrating pager to signal to the teacher when to provide reinforcement. During the DRO procedure, the bracelet was used as well as a *Radio Shack*® timer mounted on a small clipboard to signal the time intervals of the DRO. During both discrimination training and the DRO procedure, the participant's regular educational materials were used.

## Dependent Variable and Measurement

Non-contextual vocalizations were defined as words or phrases that were not relevant to the immediate context and were related to specific topics such as rollercoasters, airplanes, bowling, karate, ninjas, and Halloween. Vocalizations were scored during both discrimination training and the DRO conditions. During each 10-min discrimination training session, we used a 20-s partial-interval recording system to measure the occurrence of vocalizations. Data were summarized as the percentage of intervals with vocalizations. During baseline and DRO conditions, we measured the frequency of vocalizations across the school day, which ran from 9:15–2:30. For both measures, repeated statements (e.g., 'roller coaster, roller coaster roller coaster') were scored as one occurrence of vocalizations. To be scored as a separate occurrence, 2 s of quiet was required between vocalizations.

## Independent Variable

Discrimination training and a DRO were the two independent variables in this study. Discrimination training was used to teach the participant to not engage in vocalizations when the bracelet was on and to engage in vocalizations when the bracelet was off. Once the bracelet was conditioned during discrimination training, it was used along with a DRO to systematically increase the duration of the absence of vocalizations throughout the school day.

## Design

A multi-element design was used to evaluate the effects of discrimination training on establishing the bracelet as a discriminative stimulus for reinforcement for the absence of vocalizations. A reversal design was used to evaluate the combined effects of the bracelet and DRO on reducing vocalizations throughout the school day.

## Procedure

### *Functional Analysis*

A classroom-based functional analysis was conducted using procedures similar to Iwata et al. (1994) to determine the function of the vocalizations.

Because non-contextual vocalizations occurred in the highest percentage of intervals during the attention condition (represented by the open triangle in Figure 1), it was determined that the behavior was maintained by social positive reinforcement in the form of conversational engagement with a teacher regarding a specific topic.

### *Discrimination Training*

An initial baseline was conducted to determine the percentage of intervals with vocalizations when the bracelet was on and when the bracelet was off prior to the use of discrimination training. The purpose of discrimination training was to establish the presence of the bracelet as a discriminative stimulus for reinforcement for the absence of vocalizations and to establish the removal of the bracelet as a discriminative stimulus for reinforcement for engagement in vocalizations. Discrimination training took place in the participant's classroom during 10 min sessions, approximately two or three days per week. Sessions were counterbalanced so that sessions began with a bracelet-on condition and bracelet-off condition equally. The duration of the bracelet-on condition was 7 min and the duration of the bracelet-off condition was 3 min. The duration of the bracelet-off condition was less than the bracelet-on

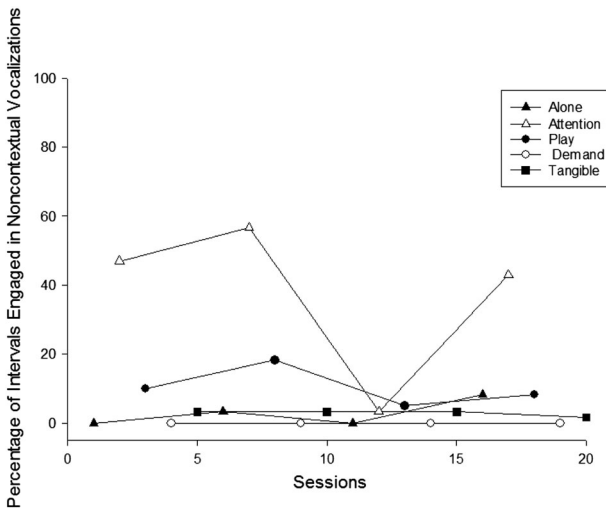


Figure 1. Functional analysis data across 20 sessions. Data indicate that the function is attention.

condition during discrimination training because we did not want the participant to engage in vocalizations for long periods of time. Doing so could result in an increase in the intensity of the vocalizations (e.g., volume) and in the occurrence of additional problem behavior such as hang wringing, body tensing, and rapid breathing. Additionally, we wanted the relative durations of the two conditions of discrimination training to reflect the relative durations of these conditions that would occur during the DRO intervention to be used across the school day (i.e., periods of bracelet-on where she was required to work quietly would be longer than periods of bracelet-off where vocalizations were not interrupted).

During each 7-min-bracelet-on condition, the teacher placed the bracelet on the participant's right wrist and stated the rule, 'Your bracelet is on. Please work quietly. No silly talk.' The participant was instructed to engage in work tasks at a desk. Upon the occurrence of vocalizations, the teacher stated, 'You have your bracelet on. Please work quietly.' Edible reinforcement for working quietly was provided on a variable-interval (VI) 20-s schedule signaled to the teacher by a hidden vibrating pager. The schedule was eventually thinned to a VI 3-min schedule.

During each 3-min-bracelet-off condition, all work materials were removed from the participant's desk. The bracelet was either removed if a bracelet-on condition preceded it, or the teacher pointed to the participant's arm if the bracelet-off condition was the first condition of the session. Then the teacher stated the rule, 'Your bracelet is off. Let's talk about the things you like.' Upon the occurrence of vocalizations, the teacher engaged in conversation with the participant about the topic for the remainder

of the session and continued to score the occurrence of vocalizations for each subsequent interval. Criterion for mastery in each reinforcement phase of discrimination training was the following: the percentage of intervals with vocalizations when the bracelet was off was at least 80% for at least two sessions and the percentage of intervals with vocalizations when the bracelet was on was 20% or less for at least two sessions.

### *Baseline*

Baseline data were collected in the classroom during typical classroom routines to determine the frequency of non-contextual vocalizations across the entire school day (i.e., 9:15–2:30). During baseline, the bracelet was not present. Upon the occurrence of vocalizations, the teacher used redirection procedures that were typically used with all students in the classroom (e.g., if vocalizations occurred during a math lesson, the teacher used verbal instructions and gestures to direct the participant back to the task).

### *Differential Reinforcement of Other Behavior*

Following baseline, and once the participant demonstrated mastery during discrimination training (described earlier), intervention with the DRO began in the classroom across the entire school day. At the start of the school day, the bracelet was placed on participant's right wrist and the rule was stated, 'Your bracelet is on. Please work quietly. No silly talk.' The DRO interval was set for the designated amount of time. Initially, the DRO interval was 7 min and was systematically increased to 30 min over the course of the study. If non-contextual vocalizations did not occur during the interval, the bracelet was removed at the end of the interval and the teacher provided praise (e.g., 'Good working quietly') and the reinforcer. The reinforcer included the teacher engaging in a conversation with the participant for 2 min about the topic of the participant's choice. Upon the occurrence of vocalizations within the interval, the teacher stated the rule, 'You have your bracelet on. Please work quietly' and the timer was stopped and reset for the full interval.

### *Inter-observer Agreement*

Inter-observer agreement data were collected on percentage of intervals with non-contextual vocalizations for 33% of sessions during discrimination training at 100% accuracy. Inter-observer agreement data were collected on frequency of non-



contextual vocalizations for 16% of sessions during baseline and the DRO condition at 100% accuracy. Data were calculated by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. It should be noted that the implementation of the treatment procedure by the teacher during the DRO condition could also signal to the observer that the target response has occurred and thus inflate inter-observer agreement scores.

### *Treatment Integrity*

Treatment integrity data were 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 were collected for 22% of discrimination training sessions and 16% of baseline and DRO sessions at a mean score of 100% accuracy.

## **RESULTS**

Figure 2 displays the results of discrimination training. The initial baseline during discrimination training showed that non-contextual vocalizations occurred during a similar percentage of intervals when the bracelet was either on or off. There was no differentiation. When discrimination training began and edible reinforcement was delivered on a VI 20-s schedule, the participant engaged in non-contextual vocalizations at a higher percentage of intervals while the bracelet was off compared with when the bracelet was on. This trend continued even as the schedule of reinforcement was thinned from 20 to 40 s to 1 min and finally to 3 min.

Figure 3 shows the frequency of vocalizations during baseline and DRO conditions within the reversal design. Solid horizontal lines represent the mean frequency for each condition. During baseline, the mean frequency of non-contextual vocalizations per day was 22. This decreased to 7 once the DRO and bracelet were introduced. Once baseline conditions were reinstated, the mean frequency of vocalizations increased to 11. When the intervention was reintroduced, the mean frequency of vocalizations dropped to 5. The DRO interval was systematically increased from 7 to 30 min throughout sessions 53 through 148, indicated by the break on the *x*-axis. These data can be obtained from the fourth author. During the final 30-min phase of the DRO, the mean frequency of vocalizations per day was less than 1.



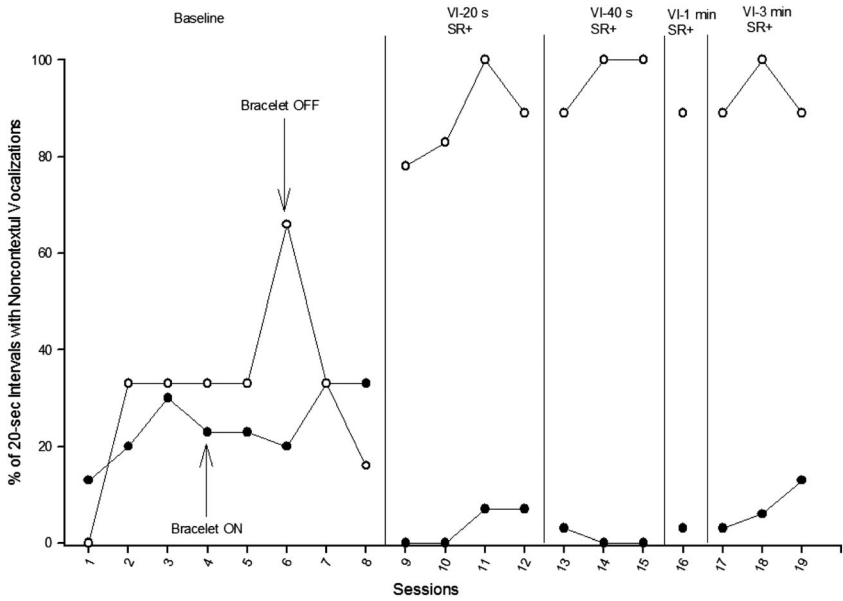


Figure 2. The percentage of 20-s intervals with non-contextual vocalizations during discrimination training. The phase change labels refer to the fading of the variable-interval (VI) schedules during the bracelet-on condition only.

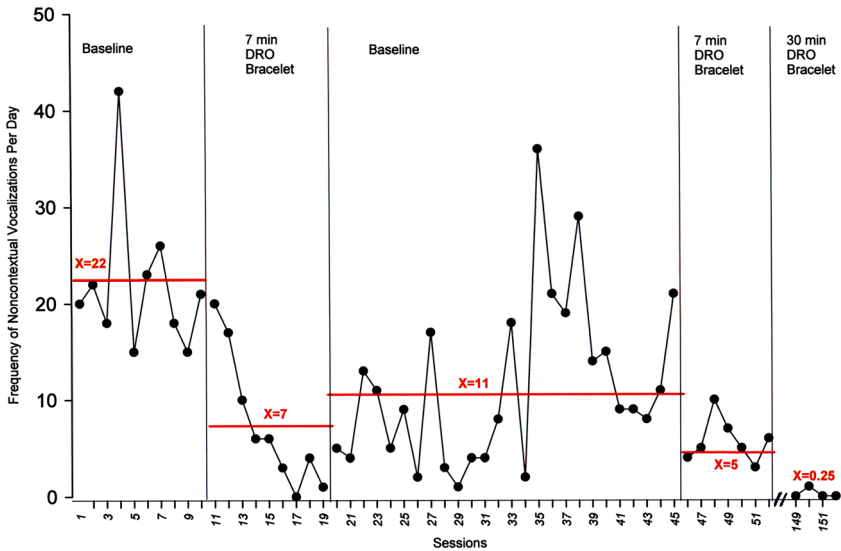


Figure 3. The frequency of non-contextual vocalizations during baseline and differential reinforcement of other behavior (DRO) conditions within the reversal design. Solid horizontal lines represent the mean frequency for each condition.

## DISCUSSION

Results are consistent with past research indicating that problem behavior can be brought under the control of environmental stimuli (i.e., the presence and absence of a bracelet) using discrimination training (Brusa & Richman, 2008). Specifically, we demonstrated that discrimination training using edible reinforcement was effective in teaching the participant to not engage in vocalizations when the bracelet was on. Alternatively, we demonstrated that by not redirecting vocalizations and by engaging in conversation with the participant about the topic, the participant learned to engage in vocalizations when the bracelet was either not present or removed.

Additionally, results indicated that the DRO was effective at reducing vocalizations below baseline levels. Similar to O'Connor et al., (2011), we found that the stimuli that acquired control over occurrences and non-occurrences of vocalizations during discrimination training could be used to signal the reinforcement schedules operating within a DRO. Moreover, these same stimuli could be applied contingently for the absence of vocalizations as reinforcement for meeting the requirements of the DRO schedule. Due to the fact that we used access to vocalizations with a conversation partner as the reinforcer for the absence of vocalizations during the DRO condition, our results also support past research that has used reinforcers that match the functional properties of the problem behavior (Taylor et al., 2005).

This study expands prior research by demonstrating the effectiveness of these procedures at reducing problem behavior that is not automatically maintained, rather that is maintained by social consequences. Additional research is required to determine if these results could be replicated with other socially maintained responses and responses maintained by escape or access to tangible items. Additionally, stimulus control procedures combined with differential reinforcement provide an alternative to invasive and/or resource-intense procedures such as response interruption and redirection (Ahearn et al., 2007; Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011; Casella, Sidener, Sidener, & Progar, 2011) that require the contingent presentation of demands for vocalizations.

There are some limitations that warrant discussion. First, we did not compare the use of a DRO with and without the bracelet conditioned during discrimination training. Therefore, we do not know if a DRO with the bracelet is more effective than a DRO without a bracelet. Future research might compare the effectiveness of DRO schedules with and without the use of additional stimuli conditioned to cue the DRO schedule to determine if there is indeed a facilitative effect of these stimuli. Second, we removed work materials from the participant's desk during the bracelet-off condition of discrimination training. Although this was done to enhance the discrimination between conditions, it might be argued that doing so could confound the results of discrimination training because we did not remove work materials during

the bracelet on condition. Third, data indicated a slight increase in trend in the bracelet-on condition during the final phase of discrimination training. However, given the degree of separation of the data paths for the bracelet on and off conditions, we were still confident that the bracelet had tight control over the absence of vocalizations. Fourth, we did not attempt to measure generalization to environments other than school. At the time this manuscript was submitted for publication, these procedures were only being utilized at school. Future research should assess the combined effectiveness of discrimination training and DRO in other environments.

Although we chose to use a bracelet because it was less likely to be stigmatizing than teachers holding up colored cards, we did not experimentally evaluate procedures for fading the bracelet. Future studies may want to assess procedures for fading the discriminative stimuli. Finally, some might argue that engaging with the participant about these perseverative topics out of context (as we did when she earned access to the reinforcer) is not socially appropriate over the long term. It is important to note that the nature of the reinforcer changed to be more socially acceptable. Although we do not have any formal measure of this, we shaped the vocalizations into conversation starters. Also, the participant is prompted to engage with related materials such as books, magazines, and the computer while making these initiations when she earns access to it as a reinforcer. For example, when the timer rings on the DRO and vocalizations did not occur during the interval, the participant removes the bracelet, gets a magazine or book with pictures matching the vocalization topic, and initiates a conversation about that topic. In summary, the current study adds to a growing body of research supporting the use of stimulus control procedures to reduce problem behavior and provides a platform for future evaluations of the use of combined procedures.

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