Efficacy of, and Preference for, a Modification to Differential Reinforcement Procedures

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EFFICACY OF, AND PREFERENCE FOR, A MODIFICATION TO DIFFERENTIAL REINFORCEMENT PROCEDURES

by

Carissa D. Basile M.S., BCBA

A Dissertation submitted to the Faculty of the Graduate School, Marquette University, in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

Milwaukee, Wisconsin
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ABSTRACT
EFFICACY OF, AND PREFERENCE FOR, A MODIFICATION TO DIFFERENTIAL
REINFORCEMENT PROCEDURES

Carissa D. Basile, M.S., BCBA
Marquette University, 2023

Tic disorders, such as Tourette’s Syndrome, are chronic, childhood-onset neurological conditions that involve sudden, repetitive, and involuntary motor movements and/or vocalizations. Individuals with tics often experience a premonitory urge, which is an aversive sensation that occurs right before a tic that may functionally influence tics. Previous research has suggested reinforced tic suppression can effectively reduce tics. Although effective, it may be useful to better understand the behavioral contingencies that most effectively lead to suppression. The purpose of the current study was to compare standard reinforced tic suppression with reinforced tic suppression that included an option for participant-initiated breaks using an alternating treatments design with four participants with motor and/or vocal tics. The current study also utilized individualized DRO intervals. Results showed that three of four participants saw a reduction in tics in both DRO conditions compared to baseline. Furthermore, DRO did not result in significantly higher urge ratings compared to baseline and DRO with breaks with any of the participants. Finally, preference for the conditions was idiosyncratic, with two participants preferring DRO and two participants preferring DRO-Break.
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Carissa D. Basile, M.S., BCBA

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INTRODUCTION

Tic disorders, such as Tourette’s Syndrome, are chronic, childhood-onset neurological conditions that involve sudden, repetitive, and involuntary motor movements and/or vocalizations (American Psychiatric Association, 2022). Motor tics are movements of the body such as eye blinking, head jerks, and shoulder movements. Motor tics can either be simple, involving a few parts of the body, or complex, involving several parts of the body. Vocal tics are sounds a person makes, such as coughing, grunting, and echolalia. Vocal tics can be either simple, involving just sounds, or complex, involving words (Miltenberger et al., 2011). In addition to tics, many affected individuals report experiencing a premonitory urge, or an aversive sensation that occurs immediately before a tic (Capriotti et al., 2014; Conelea & Woods, 2008; Himle et al., 2007; Kane, 1994; Leckman et al., 1993). The premonitory urge has been described as a feeling of tension, pressure, itching, or discomfort that occurs in various parts of an individual’s body prior to the occurrence of a tic (Bliss, 1980; Bullen & Hemsley, 1983; Evers & Van de Wetering, 1994; Findley, 2001; Miltenberger et al., 2011). The premonitory urge has been reported to diminish when the tic occurs (Bullen & Hemsley, 1983; Evers & Van de Wetering, 1994; Miltenberger et al., 2011), suggesting there is a negative reinforcement contingency between the urge, tic, and subsequent removal of the urge that may at least partially maintain tics.

Tic disorders typically begin between the ages of 5 to 7, but the number, type, and frequency of tics can change over time (Bloch & Leckman, 2009; Freeman et al., 2000; Knight et al., 2012; Piacentini et al., 2010; Scahill et al., 2014). Persistent tic disorders (i.e., tic disorders lasting at least one year) affect about 1.4 million people in the U.S.,
with about 1 in 50 children aged 5-15 having tics. Additionally, males are 3-4 times more likely to express tics (Georgitsi et al., 2016; Scahill et al., 2014; Tinker et al., 2022; Zinner et al., 2000).

Frequently co-occurring with other behavioral and psychiatric problems such as obsessive-compulsive disorder, attention-hyperactivity disorder, and autism spectrum disorder, tics can result in functional impairment, social impairment, and increased stress levels (Bitsko et al., 2014; Conelea & Woods, 2008; Conelea et al., 2011; Piacentini et al., 2010; Scharf et al., 2012). Individuals with tics have a higher likelihood of anxiety and depression, as well as an increased likelihood of being bullied by peers (Bitsko et al., 2014; Charania et al., 2022; Eapen and Črnčec, 2009; Leckman et al., 1998). Those with tics often report a lower quality of life, are perceived less positively compared to their peers, and experience more peer rejection (Packer, 2005; Zinner et al., 2012). Fluctuation in tic frequency, duration, and intensity may also negatively affect an individual’s ability to concentrate in academic settings and may affect task performance and task completion in school. Tics can also result in musculoskeletal or neuropathic pain, tissue damage, or other injuries (Fusco et al., 2006). Combined, these difficulties can negatively affect an individual’s daily life; thus, many seek treatment for their tics.

**Causes of Tics**

The exact cause of tics is unknown, but both neurobiological and environmental factors are involved (Baldermann et al., 2016; Dale, 2017; Georgitsi et al., 2016; Leckman & Cohen, 1999). Genetics play an important factor, as tic disorders are heritable conditions. From a neurological perspective, tics stem from disruptions in movement regulation functions supported by the basal ganglia (Bronfeld & Bar-Gad,
Tics are associated with basal ganglia abnormalities that result in an excess of striatal dopamine (Caligiore et al., 2017; Peterson et al., 2001; Whitehead et al., 2002; Zhang et al., 2009), which affects the thalamo-cortical circuits (Abelson et al., 2005; Caligiore et al., 2017; Eapen et al., 1993; Leisman & Sheldon, 2022). As research on tic disorders has progressed, evidence suggests that tics are likely the result of a complex interplay between aberrant biological processes interacting with environmental factors (Conelea & Woods, 2007; Himle et al., 2007).

Environmental stimuli can result in the exacerbation of, or reduction in, tics (Conelea & Woods, 2008). Antecedent and consequent stimuli are two types of environmental stimuli that impact the expression of tics. Antecedent stimuli occur before tics and alter the momentary probability they will occur. Various researchers have evaluated the impact of antecedent stimuli on tics through self-report measures and experimental studies. O’Connor et al. (2003) evaluated 13 individuals who self-reported antecedent situations that resulted in the occurrence of more tics. Results showed that tics occurred more often in some settings compared to others (e.g., when waiting, transitioning, or engaging in social activities). Similarly, Silva et al. (1995) surveyed 14 individuals with tics and found that tics were reported to increase in certain antecedent conditions, such as when fatigued, alone, in anxiety-producing situations, watching tv, and during family gatherings. These studies provide preliminary evidence that antecedent stimuli impact tics, but given the study design, the causal impact of antecedents on tics could not be established.
Taking a more experimental approach, Watson et al. (2005) evaluated the effects of antecedent stimuli by interviewing two teachers and children to assess antecedent stimuli that affected the children’s tic expression. The interviews suggested that the type of class, setting, and work task affected tics differently for each participant. The authors then experimentally evaluated the impact of these variables on tics by systematically presenting the antecedent stimuli. Stimuli such as seat work, reading, and easy task material resulted in higher rates of tics for the first participant compared to lab work, written assignments, and difficult task material. Antecedent stimuli such as quiet classroom times and downtime between assignments resulted in higher rates of tics for the second participant compared to noisy classroom times and work periods. Malatesta (1990) also systematically evaluated changes in tic frequency when a child with tics was exposed to various environmental antecedent stimuli. Specifically, the author evaluated tic frequencies in the presence of either the child’s mother or father and found that the child’s tics occurred more often in the presence of the child’s father, compared to the child’s mother. In another example, Woods et al. (2001) conducted an experimental analysis investigating the effect of tic-related conversation in two participants with Tourette’s Syndrome. The authors compared the occurrence of tics across two different 5-min conditions. In the control condition, the participant and clinician engaged in conversation unrelated to tics. In the “tic-talk” condition, the clinician discussed tic-related topics such as what the tics looked like and the social consequences of tics. Vocal tics, but not motor tics, occurred more frequently during the “tic-talk” condition compared to the control condition. Combined, these studies along with others, have demonstrated how antecedent environmental stimuli influence tics (Conelea & Woods,
2008; Eapen et al., 2004; Malatesta, 1990; O’Connor et al., 1994; O’Connor et al., 2003; Robertson et al., 2002; Silva et al., 1995; Watson et al., 2005; Woods et al., 2001).

In addition to antecedents, consequences, or stimuli that occur following the occurrence of a tic, can also affect tic expression (Capriotti et al., 2017; Conelea & Woods, 2008; Woods et al., 2008). Researchers have been able to demonstrate control over tics, both in anecdotal and experimental evaluations (Capriotti et al., 2015; Carr et al., 1996; Conelea & Woods, 2008; Packer, 2005; Woods & Himle, 2004).

For example, Packer (2005) surveyed 69 parents of children with tic disorders to identify consequences used to modify their child’s tics at school. Various consequences, such as sending a child out of a room, commenting on the child’s tics, withholding field trips, and reinforcing decreased frequency of tics were reported as affecting their child’s tic frequency.

Experimental studies have also examined the functional relation between tics and various consequences (Carr et al., 1996; Conelea & Woods, 2008; Himle & Woods., 2005; Himle et al., 2008; Himle et al., 2007; Packer, 2005; Roane et al., 2007; Rosen & Wesner, 1998; Scotti et al., 1994; Watson et al., 1998, Woods & Himle., 2004; Woods et al., 2008). Scotti et al. (1994) conducted a functional analysis of the tics of an individual with Tourette’s Syndrome. Tic frequencies were evaluated across 5 conditions: (a) tics resulting in escape from a task, (b) tics resulting in positive attention, (c) tics resulting in social disapproval, (d) when the individual was alone in a room, and (e) when the individual was in a room with an item that was reported to minimize tics. Following repeated exposure to the conditions, the authors found that participant’s tics were highest when followed by escape from a task. Similarly, Carr et al. (1996) conducted a functional
analysis in which (a) tics resulted in escape from tasks, (b) tics resulted in attention, (c) the individual was alone in the room, (d) the individual had access to free play, and (e) the individual had access to high sensory stimulation. Responding was elevated across all conditions, but highest rates of tics were observed when tics were followed by attention and escape from a task. Likewise, in another study, Watson et al. (1998) conducted a functional assessment interview with caregivers and found that tics occurred exclusively during mealtimes with the family. Following the interview, the authors experimentally evaluated the consequences of tics in a functional analysis during mealtimes. Caregiver attention was shown to maintain the participant’s tic. The authors then utilized this information to implement an intervention involving withholding attention contingent on the tic. This resulted in the tic decreasing to zero levels.

Beyond functional analyses, researchers have evaluated other various forms of consequence manipulations that alter tic expression. Woods and Himle (2004) compared a verbal instructions condition to a differential reinforcement of zero behavior (DRO) condition. In the verbal instruction condition, experimenters told participants to do whatever they could to stop tics for the session. In the DRO condition, tokens were provided for every 10 s that passed without the occurrence of a tic. In this condition, participants were told to suppress their tics and that any tokens earned for every 10-s tic-free interval could be exchanged for money. The DRO condition produced a 76.3% decrease in tics from baseline, compared to a 10.3% reduction from the verbal instructions condition. Himle et al. (2008) further evaluated consequence-based interventions by assessing differences in tic frequency during three conditions: baseline where participants were free to tic, DRO where participants earned tokens for successful
tic suppression, and non-contingent reinforcement where tokens were delivered on a fixed-time schedule regardless of successful suppression. Tic frequencies were lower when reinforcement contingencies were in place for the suppression of tics (i.e., DRO) compared to the non-contingent reinforcement condition, suggesting the DRO contingency was important.

In addition to reinforcing consequences, researchers have evaluated the efficacy of punishing consequences on tic expression. Capriotti et al. (2012) compared differences in tic frequency following a baseline, DRO, and punishment condition. The punishment procedure consisted of a response cost system that resulted in token loss contingent on tic occurrence. Tic frequency decreased during both the DRO and punishment conditions compared to baseline, with no reliable differences in tic reduction between DRO and punishment conditions.

Antecedent- and consequence-based manipulation have been shown to affect the frequencies of tics. Although they can effectively reduce tics when in place, one concern raised is whether the use of consequences to reduce tics results in unwanted changes in tic expression when the contingency is removed. Specifically, it has been suggested that an increase in tic frequency above baseline levels will occur once the DRO contingency is paused or removed (Burd & Kerbenshian, 1987; Marcks et al., 2004). To assess for this purported “rebound effect,” Himle and Woods (2005) evaluated differences in three conditions. Participant tic rates were compared in a baseline condition with no contingencies in place, a DRO condition with tokens provided contingent on the absence of tics, and a post-DRO condition in which baseline contingencies were reinstated. The post-DRO condition was used to evaluate the occurrence of a rebound effect, defined by
the authors as a “post-suppression increase in tic frequency of at least ½ of a standard deviation above baseline levels” (p.1444). The DRO condition resulted in lower tic rates compared to baseline, and there was no evidence of a rebound effect in the post-DRO sessions. Although anecdotal reports suggest tic suppression leads to higher rates of tics when given the opportunity to tic again (Burd & Kerbeshian, 1987; Marcks et al., 2004), the authors demonstrated that no such rebound effect occurred in any of the participants. Other studies have also tested for but failed to find an occurrence of a rebound effect following DRO-induced suppression (Himle & Woods, 2005; Hoogduin et al., 1997; Meidinger et al., 2005; Pray et al., 1986; Verdellen et al., 2007).

**Treatment for Tics**

Due to the detrimental psychosocial impact of tics, researchers have investigated interventions to reduce tics. Two primary forms of intervention have been studied and recommended: medication and behavior therapy.

**Medication.** Alpha 2 agonists and antipsychotic medications (e.g., clonidine guanfacine, risperidone, haloperidol, and pimozide) have been used as a first and second line of treatment to reduce tic severity for many years (Seahill et al., 2006; Slinger, 2010). These medications are effective at decreasing severe or disruptive tics but are not universally effective (Borison et al., 1982; Deckersbach et al., 2006; Robertson, et al., 1990; Seahill et al., 2006; Seahill et al., 2013; Woods et al., 2008) and often result in a variety of adverse side effects such as weight gain, slowed cognition, headaches, restlessness, dystonia, sedation, anxiety, and lethargy (Allison & Casey, 2001; Bruun, 1988; Huys et al., 2012; Martin et al., 2004; Meyer & Koro, 2004; Seahill et al., 2003;
Scahill et al., 2013). Such side effects may result in treatment discontinuation (Deckersbach et al., 2006; Scahill et al., 2006).

*Behavior Therapy.* The second primary class of interventions for tics involves behavior therapy, which teaches individuals to manage their tics by engaging in responses that are incompatible with the tic (e.g., habit reversal) and manipulating environmental contingencies (e.g., antecedents and consequences) that directly affect specific tics (e.g., functional interventions).

Habit Reversal Training (HRT) is a commonly utilized behavioral intervention for tics (Woods et al., 2008) and consists of three components: (a) awareness training, (b) competing response training, and (c) social support (Azrin & Nunn, 1973; Miltenberger et al., 1998; Miltenberger et al., 2011). Awareness training involves having individuals practice identifying each occurrence of the target tic through response description, response detection, and early warning training (Woods & Miltenberger, 1995). Competing response training involves having individuals learn to engage in an incompatible response (i.e., a competing response) when they are about to engage in a tic or when they begin engaging in a tic (Azrin & Nunn, 1973; Piacentini et al., 2010). The final component of HRT, social support, involves having an individual in the patient’s life reinforce correctly doing the competing response and prompting the patient to use the competing response when it is not done correctly (Capriotti & Woods, 2013; Himle et al., 2006; Verdellen et al., 2008). HRT has been demonstrated as effective in reducing tics (Deckersbach et al., 2006; Peterson et al., 1994; Piacentini & Chang, 2005; Wilhelm et al., 2003; Woods & Miltenberger, 1995), but it does not include function-based interventions.
Comprehensive Behavioral Intervention for Tics (CBIT) was designed to enhance HRT by including treatment elements that address functional variables related to tics. CBIT incorporates HRT with both functional intervention and psychoeducation (Piacentini et al., 2010; Pringsheim et al., 2019). Functional intervention involves identifying antecedents and consequences that influence tic expression and then altering these factors in the service of tic reduction (Piacentini et al., 2010). Psychoeducation focuses on reducing the stigma of tics by teaching the individual about tic disorders. In addition to HRT, functional intervention, and psychoeducation, CBIT clinicians deliver reinforcers for compliance behaviors, such as attending sessions and completing homework as treatment compliance has been found to be a strong predictor of tic reduction (Essoe et al., 2021).

Research has demonstrated the efficacy of CBIT (Blount et al., 2014; Chen et al., 2020; Peterson et al., 2022; Piacentini et al., 2010; Wilhelm et al., 2012). For example, Piacentini et al. (2010), conducted a randomized controlled trial with 126 individuals diagnosed with Tourette’s Syndrome or chronic tic disorder. Children in the CBIT group exhibited a 7.6-point decrease in the Yale Global Tic Severity Scale (YGTSS; Leckman et al., 1989) following 10 weeks of treatment, compared to a 3.5-point decrease in the supportive therapy plus education control condition. In addition, 52.5% of children in the CBIT group were rated by a masked independent evaluator as very much improved or much improved on the Clinical Global Impressions-Improvement scale, compared to 18.5% in the control group (Piacentini et al., 2010).

Although CBIT generally is an effective treatment, many patients who receive CBIT do not receive benefit, underscoring the need for further research on enhancing its
efficacy. One component of CBIT that can be modified to potentially increase treatment efficacy focuses on \textit{when} reinforcers are provided. In CBIT, reinforcers are provided contingent on compliance behavior (e.g., attending session, completing homework, etc.), but specific reinforcers beyond occasional praise from the support person are not delivered contingent on either tic reduction or use of the competing response. Although reinforcing general compliance is important (Essoe et al., 2021), these reinforcers are delayed and not contingent on tic reduction. Providing direct reinforcers may result in greater gains, and one way to do this would be to instead provide reinforcers contingent on the absence of tics (e.g., successful tic suppression).

\textbf{Using DRO to Create Tic Suppression}

Laboratory research has shown that directly reinforcing tic suppression leads to a significant decrease in tic frequency (Capriotti et al., 2012; Himle et al., 2008; Woods & Himle, 2004). This approach, known as differential reinforcement of zero behavior (DRO; Conelea & Woods, 2008), consists of differentially reinforcing the absence of a target behavior (Cowdery et al., 1990; Poling & Ryan, 1982). In DRO, reinforcers are provided following a pre-determined interval in which the target response does not occur (Capriotti et al., 2014; Capriotti et al., 2017; Heffernan & Lyons, 2016; Himle et al., 2007; Vollmer et al., 1993). Typically, DRO interventions involve a resetting time schedule, in which the occurrence of a target behavior starts the interval timer again. For example, in a standard DRO contingency, a token may be delivered following a 10-s interval without any occurrence of the target behavior. Following token delivery, the interval resets and the contingency starts again. If the target behavior occurs at any point
within the 10-s interval, the timer restarts, and no tokens are provided until a consecutive 10-s period without the target behavior occurs.

**DRO Efficacy.** Several researchers have evaluated the therapeutic impact of DRO on tics. Wagaman et al. (1995) reduced vocal tics for a 9-year-old male by providing a reinforcer following the absence of throat clearing and coughing tics. DRO resulted in a reduction of tics to near-zero levels compared to baseline. Rosen and Wesner (1973) also evaluated the efficacy of DRO in reducing tics. In the DRO condition, the researchers illuminated a light for every 30-s interval in which zero tics occurred. Following the session, the participant was given a piece of candy each time the light was illuminated, and praise was provided for every instance of tic-incompatible behavior. After successfully reducing tics using DRO, the authors implemented the intervention in the child’s classroom by giving all students candy for each 30-s tic-free interval. This was done to establish the individual’s peers as reinforcers for reducing tic expression. This intervention was faded to include only the delivery of praise, and tics were reduced to zero levels when the DRO intervention was in place.

Due to initial evidence supporting DRO as a therapeutic tool, the procedure began to be used in various experimental studies to further evaluate its efficacy with procedural modifications. Capriotti et al. (2017) compared standard DRO contingencies to a modified contingency in which the number of reinforcers provided following a 10-s tic-free interval increased with each successive 10-s tic-free interval. For example, an individual may have earned one point following the first 10-s tic-free interval, two points following the second 10-s tic-free interval, three points following the third, and so on.
Results showed no differences between the two forms of DRO, and the study replicated previous research demonstrating the efficacy of DRO on tic suppression.

*DRO and the Premonitory Urge.* It is also worth considering the impact of DRO on the premonitory urge. It has been reported that when an individual engages in a tic, the premonitory urge decreases (Leckman et al., 1993; Kwak et al., 2003). As such, the premonitory urge is thought to play an important role in the maintenance of tics. Urge reduction is believed to reinforce tic occurrence through the following contingency: (a) the presence of the premonitory urge, (b) engaging in a tic, and (c) a reduction in urge. In such a case, the individual would be more likely to engage in a tic when the urge is present in the future, creating a functional relation between the urge and tics.

Himle et al. (2007) demonstrated a functional relation between premonitory urges and tics; showing that as tic frequency decreased with the use of DRO contingencies, premonitory urge ratings increased. Furthermore, as the frequency of tics increased, premonitory urge ratings decreased. Such research has lent support to the idea that the tic is negatively reinforced by the removal of the urge. Additionally, some research has demonstrated that as individuals repeatedly experience tic reduction under DRO contingencies, the premonitory urges decrease (Capriotti et al., 2012; Himle et al., 2007). An individual may then report higher premonitory urges during initial suppression conditions but may report decreased urge ratings over repeated exposure to DRO contingencies.

In the presence of a premonitory urge, an individual is presented with a behavioral choice. They may choose to engage in a tic, which will reduce the aversive urge, or they may choose to engage in tic suppression, which is reinforced by a preferred stimulus
(e.g., praise, tokens) or avoidance of an aversive stimulus (e.g., social disapproval from peers). If an individual engages in suppression, the urge may build, resulting in urge reduction becoming more valuable as a reinforcer in the early stages of DRO. During this period, the individual will allocate responding to engaging in the tic (e.g., the response that removes the urge immediately) rather than an incompatible behavior or suppressing the tic. Higher rates of tics early on in a DRO contingency, due to the increased urge strength, may affect the individual’s motivation to initiate or maintain tic suppression behavior. Thus, identifying a means to mitigate increases in urge ratings during periods of suppression may be important and lead to more effective tic suppression over time (Himle et al., 2007).

In support of this notion, Capriotti et al. (2014) compared tic rates and premonitory urge ratings under three conditions: (a) baseline, (b) standard DRO, and (c) DRO with breaks. In the baseline condition, individuals were free to tic during the session, and no contingencies were in place. The standard DRO condition consisted of reinforced tic suppression via token delivery on a resetting 10-s schedule. The DRO with breaks condition consisted of the same contingencies as the standard DRO, except that individuals were provided the opportunity to pause, or take a break from, the DRO contingencies for 10 s. While on a break, the DRO interval timer was paused, providing a 10-s interval in which the participant could tic freely. Following the 10-s break, the DRO contingencies were reinstated. These breaks were included to provide an observable and measurable response to evaluate escape from the premonitory urge and analyze the negative reinforcement contingency between the urge, tic, and subsequent removal of the urge. To assess urge differences in these conditions, participants rated their premonitory
urge every 30 s throughout the study as well as at the beginning and end of each of the breaks.

Because the breaks were introduced as a novel way to measure escape from the premonitory urge and to evaluate the negative reinforcement contingency between urge and tic, the authors evaluated tic frequency data from both the DRO and DRO with breaks conditions together. Results showed that the DRO contingency (in both conditions) was effective at decreasing tics. Additionally, premonitory urge ratings were higher in the DRO contingency (in both conditions combined) compared to baseline. Urge ratings reported in the DRO conditions decreased with repeated exposure to the DRO contingency. Finally, within the DRO with breaks condition, tic rates were higher while on a break (DRO timer paused) compared to when the DRO contingency was active (not on a break).

Although the authors found that the combined DRO conditions reduced tics and increased urge ratings compared to baseline, it is important to compare data for the different DRO conditions (i.e., DRO vs. DRO+Break) separately to determine if tics and urges are differentially impacted under these conditions. Previous research has shown that the standard DRO condition can reduce tic rates compared to baseline (Capriotti et al., 2017; Wagamen et al., 1995; Woods & Himle, 2004). However, it is unclear how DRO with breaks affects responding. For example, tics that occur during the “break” portion of the DRO with breaks condition may be reinforced on a variable schedule, leading to overall higher rates of tics, specifically during the non-break portions (i.e., the DRO contingency). Conversely, breaks from DRO contingencies may lower premonitory urge ratings, which may result in lower rates of tics compared to standard DRO and
baseline conditions. In the context of a concurrent schedule of reinforcement in which tic suppression is reinforced via the reduction of aversive social interactions and engaging in a tic reduces the aversive properties of the urge, the strength of the urge may affect the relative likelihood of ticcing. If the aversive properties of that urge are relatively low, it may decrease the probability of engaging in a tic. For this reason, finding interventions that result in lower urge ratings while continuing to suppress tics is important. Given the possibility that DRO with breaks may either result in increased tic rates based on variable reinforcement or reduced tic rates based on lower premonitory urge ratings, it is important to evaluate differences in tic rates and urges in standard DRO and DRO with break conditions separately.

Identifying the efficacy of interventions that may reduce tics while also maintaining low levels of urge ratings is beneficial not just in laboratory research, but clinically as well. For example, if providing opportunities to tic while globally being expected to suppress (e.g., DRO with breaks) results in higher rates of tics and urge ratings compared to a standard DRO condition, then it might suggest that the use of breaks to tic during clinical interventions such as HRT and CBIT should be minimized. If, on the contrary, DRO with breaks results in similar or lower levels of tic rates and urge ratings compared to standard, no-break DRO contingencies, it may suggest that providing breaks to tic during HRT and CBIT may not be detrimental and perhaps preferred by the patient. If both DRO and DRO with breaks are equally effective, one component that should be evaluated is whether participants want to experience breaks from the DRO contingencies. In Capriotti et al. (2014), every participant opted to engage
in some level of escape from the DRO contingencies. This may be indicative of participant preference for this intervention over standard DRO.

*Preference.* Participant preference for various interventions is an important factor to consider. Providing opportunities for participants to make choices regarding the types of interventions they would like to experience can be reinforcing (Catania & Sagvolden, 1980; DeLeon et al., 2009; Drifke et al., 2019; Fisher et al., 1992; Fisher et al., 1997; Hanley & Tiger, 2011). In addition, choice opportunities lead to increased participation, improved performance, decreased problem behavior, and less reported discomfort (Bannerman et al., 1990; Catania & Sagvolden, 1980; Givens et al., 2007; Gureghian et al., 2020; Sidani et al., 2006; Sidani et al., 2009; Tiger et al., 2006).

Given the reinforcing properties and benefits of choice-making opportunities through preference assessments, researchers have incorporated preference assessments for various efficacious interventions (Hanley et al., 1997; Hanley et al., 2005; Slocum & Tiger, 2011). For example, Hanley et al. (1997) evaluated participant preferences for various interventions to decrease problem behavior. The authors examined participant preference for three conditions: functional communication with extinction, non-contingent reinforcement, and extinction alone. The authors used a concurrent chains preference assessment in which participants were given the opportunity to select between three colors that had been previously associated with each of the conditions and then experienced the selected condition. The authors identified which intervention was most preferred by all participants (e.g., functional communication with extinction) that could be used as the intervention to reduce problem behavior.
Providing the opportunity for participants to select preferred interventions also provides a means to assess the social acceptability of the intervention and ensures clients’ right to a therapeutic environment in which they are included in the decision-making process (Schwarts & Baer, 1991; Van Houten et al., 1988). Thus, when multiple modalities of intervention are effective, offering participant choice in treatment selection ensures social validity and may further help with maintaining intervention implementation. Identifying preference among behavioral interventions for tics can provide information on what components are preferred (e.g., breaks vs. no breaks), how preference compares with efficacy, and ultimately lends insight into what components should be included in other behavioral interventions like HRT and CBIT.

Both HRT and CBIT contain components of DRO in which individuals suppress their tics followed by delayed conditioned reinforcers. By identifying the effective and preferred components under experimental conditions (e.g., urge ratings, opportunities to engage in breaks, etc.), we can better understand what may be preferred under conditions of HRT and CBIT and how this may lead to better therapeutic outcomes. Furthermore, it is possible that including an opportunity to take a break from DRO contingencies may be a preferred form of intervention and lead to better outcomes given that preferred interventions can lead to increased participation and higher treatment compliance.

The purpose of this study was to (a) extend the work of Capriotti et al. (2014) by evaluating whether adding a break from DRO contingencies affected tic rates differently than standard DRO conditions, (b) assess differences in premonitory urge ratings across baseline, DRO, and DRO-Break sessions, and (c) evaluate participant preferences for each of these conditions. It was hypothesized that DRO and DRO-Break would both
reduce tics compared to baseline, but that the standard DRO would more effectively reduce tics overall. This was hypothesized because engaging in periodic breaks provides variable reinforcement (i.e., via urge reduction) for engaging in the tic. Additionally, it was hypothesized that premonitory urge ratings would be higher overall in the standard DRO condition, but these urge ratings would decrease over repeated exposure to the DRO contingencies. This was hypothesized because the standard DRO condition allows for habituation to the urge over time. It was also hypothesized that the urge ratings would be lower in the DRO-Break condition, compared to the standard DRO condition, but higher in the DRO-Break condition compared to the baseline condition as previous research has demonstrated free access to ticcing resulted in lower urge ratings (Himle et al., 2007). Finally, it was hypothesized that preference for these conditions would be idiosyncratic across participants.
GENERAL METHODS

Participants and Settings

Four participants were recruited from a local tic disorders specialty outpatient clinic. Nora identified as a 13-year-old Caucasian female. Ivy identified as a 9-year-old Caucasian female. Joy identified as a 10-year-old Caucasian female. And Brett identified as a 12-year-old Caucasian male. Individuals on the clinic’s waitlist were contacted and asked about their interest in participating in a research study before going into treatment. To be included in the study, participants had to have (a) met the diagnostic criteria for Tourette Disorder, Persistent Motor Tic Disorder, or Persistent Vocal Tic Disorder (b) a Yale Global Tic Severity Scale total score ≥ 14 and < 30 (YGTSS; Leckman et al., 1989) (c) engaged in at least one tic per min during an initial 5-min observation (d) been between the ages of 9-17 years old, (e) received a T score > 37 on the vocabulary subtest of the Wechsler Abbreviated Scale of Intelligence (WASI-II), and (f) no recent medication changes or had been on stable medication for at least 3 weeks prior to the start of the study. Participants were excluded if they had (a) an ADHD diagnosis, substance use disorder, or autism spectrum disorder, or (b) scores outside the above-mentioned ranges for the YGTSS and vocabulary subtest of the WASI-II. The study was conducted in a room measuring approximately 3 m x 4 m located in the university-based outpatient tic clinic. During experimental sessions, the participant remained in the experimental room while the experimenter remained in an adjacent room. The experimental room included a computer with an attached video camera that live-streamed and recorded sessions, a table, a chair, a “tic detector,” and condition-associated colored cards. Each session was 5 min in duration, with a 1-2 min break offered following each session.
Initial Screening

Before the experiment began, a trained clinician conducted a 1.5-hour screening assessment for prospective participants. During the initial screening, the experimenter described the purpose of the study and obtained informed consent and assent. Contingent on consent and assent, the experimenter conducted a demographic interview (Appendix D) and administered three initial assessments (i.e., the Yale Global Tic Severity Scale, Wechsler Abbreviated Scale of Intelligence, and Mini International Neuropsychiatric Interview for Children and Adolescents). Additionally, the experimenter conducted an initial observation to assess participant eligibility for the study. During the initial observation, participants were asked to sit alone in a room without interacting with any items for 5 consecutive min. The experimenter observed the frequency of the patient’s tics to ensure participants engaged in at least one tic per min.

The primary experimenter used the information collected during the initial screening session to assess participant eligibility. Eligible participants were invited to continue with the study and scheduled for weekly experimental sessions. Tics identified during the screening assessment were operationally defined and targeted during experimental contingencies. Tics not identified in the screening assessment, but that occurred after the experimental study began, were not targeted (i.e., contingencies were not in place for those tics). However, data were recorded on the frequency of novel tics that occurred throughout the study.

Yale Global Tic Severity Scale (YGTSS; see Appendix A) The Yale Global Tic Severity Scale (YGTSS) is a 15-30 min clinician-administered interview that consists of a symptom checklist, tic severity ratings, and an assessment of tic impairment (Leckman et
The symptom checklist is a list of commonly seen tic topographies. The YGTSS severity rating scale assesses the number, frequency, intensity, interference, and complexity of tics as well as the overall degree of impairment that tics cause in daily life (Leckman et al., 1989). Tic number is evaluated from 0 (no tics) to 5 (multiple discrete tics and greater than two patterns of complex or sequential tics). Frequency is scored from 0 (none) to 5 (always; specific tic behaviors are present virtually all the time, with difficult-to-identify tic-free intervals). Intensity is scored from 0 (absent) to 5 (severe; tics are forceful and exaggerated). Complexity is scored from 0 (if tics are present, they are simple tics) to 5 (severe; lengthy bouts of tics that involve unusual or inappropriate behavior that would be hard to camouflage due to their length). Finally, interference is rated from 0 (none) to 5 (severe; tics often disrupt ongoing actions). Vocal and motor tics are rated separately across these five dimensions, and the scores are summed to provide a tic-severity score ranging from 0 (none) to 50 (severe; high severity). The YGTSS also provides an impairment scale score from 0 (none) to 50 (severe) that focuses on the impact of tics on the individual’s self-perception, self-esteem, relationships, and performance in the community. The higher the score, the more severe disability and distress experienced by the participant.

The YGTSS has good internal consistency, convergent validity, discriminant validity, and interrater reliability (Leckman et al., 1989; McGuire et al., 2018; Storch et al., 2005). The YGTSS was completed by a trained experimenter and used to determine eligibility for participation in the study.

*Mini International Neuropsychiatric Interview for Children and Adolescents (MINI-Kid)* The Mini International Neuropsychiatric Interview for Children and
Adolescents (MINI-Kid) is a brief (~30 min) standardized diagnostic interview completed by both the caregiver and the child that assesses for psychiatric disorders and suicidality in individuals 6 to 17 years old (Sheehan et al., 2010). The MINI-Kid was administered by a trained experimenter during the initial screening and used to evaluate study eligibility (Sheehan et al., 2010).

*Wechsler Abbreviated Scale of Intelligence (WASI-II).* The Wechsler Abbreviated Scale of Intelligence (WASI-II) assesses intellectual functioning for individuals aged 6 to 89 years old (Wechsler, 1999). A trained clinician administered only the vocabulary subtest of the WASI-II, which involves labeling pictures and defining words. The vocabulary subtest was conducted to assess the participant’s overall understanding of words using a standardized assessment. Results of the assessment were used for participant eligibility in the study. Raw scores were converted into T scores utilizing tables in the WASI-II manual. The WASI-II has strong interrater reliability, test-retest reliability, temporal stability, as well as concurrent, content, and construct validity (The Psychological Corporation, 1999).

**METHODS**

**Experimental Design and Procedure**

Following the initial screening, an alternating treatments design was used to evaluate differences between experimental and baseline conditions. Baseline (BL), Differential Reinforcement of Zero Behavior (DRO), and Differential Reinforcement of Zero Behavior with Breaks (DRO-Break) conditions were run as a set in a blocked, randomized order. The order in which each condition was run within a set was randomized, but all condition types were run once before starting the next set. For
example, in each set, the first condition type was randomly selected from the three available condition types (BL, DRO, DRO-Break). After the selected condition was run, the next condition was randomly selected from the remaining two conditions until all three were run. After all three condition types within a set were run, a new set with a randomized order was run. Data were collected for a minimum of three sessions of each condition type and data collection continued until responding was visually analyzed to be of stable level, trend, and variability. If responding remained unstable for 5 sessions of each of the condition types (i.e., variable responding for 5 sessions of each condition across all conditions), the experimental evaluation stopped and the individual’s participation in the study ended.

Each visit consisted of a maximum of three condition sets. The primary experimenter evaluated responding in BL, DRO, and DRO-Break conditions. To assist with participant discrimination across the three conditions and for use in the preference evaluation, specific-colored cards were placed on the table in front of the participant. Each colored card was associated with a specific condition (e.g., white, purple, and orange were associated with BL, DRO, and DRO-Break respectively). For the DRO and DRO-Break conditions, each participant’s DRO interval was individualized and predetermined by evaluating the mean time between any of the participant’s tics in the initial screening observation. Specifically, the duration of each interval between tics was summed and divided by the number of intervals in the 5-min screening observation to find the mean inter-response time that would be used for the interval.
Urge Ratings

During BL, DRO, and DRO-Break, urge ratings were taken every 30 s using an urge thermometer that appeared on a laptop screen on the table in front of the participant. Urge ratings were also collected after each participant-initiated break in DRO-Break sessions. Urges were scored from 0-100 with 0 indicating the individual had no urge to tic and 100 indicating the individual had a strong urge to tic. During the instructions provided before each session, regardless of the condition, the clinician stated,

"Every 30 s, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating of 0-100, with 0 meaning you have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud."

At each 30-s mark, the urge thermometer appeared on the screen and participants vocally indicated at what level their current urge was. After vocally indicating their urge, the screen returned to black. Before the first session of the study, the primary experimenter practiced participants reporting their urge ratings by providing two opportunities for the participant to state their urge when the thermometer was presented on the screen. Each time the participant stated their urge following the presentation of the thermometer, the experimenter provided feedback on the response (e.g., “Great job providing your urge rating when the thermometer is presented, you will continue to do this even when I am not present).”

Baseline (BL)

During 5-min BL sessions, no consequences followed any occurrence or absence of tics. In other words, no tokens were delivered for tic suppression. The experimenter placed a white-colored card on the table in front of the participant. Participants were told,
“During white sessions, we are going to have you sit for 5 min. During this time, this tic detector will count your tics. You are free to tic as much as you please and nothing will happen whether you tic or don’t tic. Every 30 s, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating of 0-100, with 0 meaning you have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud.”

No instructions to suppress tics were provided (see Appendix B for experimenter scripts) and no tokens were delivered during BL. Before beginning each BL session, participants were asked to repeat the instructions to ensure they attended to the relevant contingencies. Any errors of commission or omission were followed by a correcting prompt and asking them to repeat the instructions until the participant emitted them correctly.

**Differential Reinforcement of Zero Behavior (DRO)**

The Differential Reinforcement of Zero Behavior (DRO) condition assessed tic rates when the absence of tics for a period of X s was followed by token delivery. During these sessions, the experimenter placed a purple-colored card on the table in front of the participant. Participants were told,

“During purple sessions, this tic detector will count your tics when they occur for the next 5 min. It will give you a token for every X s that you go without having a tic. At the end of the study, we will count how many tokens you received, and you will be able to exchange them for prizes. Remember, you will get a token for every X s that you go without having a tic, but if you do tic, the X-s tic clock will start over, and you will not get a token until a full X s without a tic occurs. Every 30 s, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating of 0-100, with 0 meaning you have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud.”

Regardless of the number of tokens earned during the study, all participants earned a gift card worth $10. As in BL, participants were asked to repeat the instructions for the upcoming condition. Any errors of commission or omission were followed by a
correcting prompt and asking them to repeat the instructions until the participant said them correctly. Experimenters monitored participant tics from an adjacent room and delivered tokens according to a resetting interval, meaning a token was delivered immediately after each X-s period in which the participant displayed none of the tics discussed at intake. Contingent on a tic, the X-s timer restarted, and no token was provided until X-s without the occurrence of a tic passed.

*Differential Reinforcement of Zero Behavior with Breaks (DRO-Break)*

The Differential Reinforcement of Zero Behavior with Breaks (DRO-Break) condition assessed tic rates in a similar manner to the DRO condition, but during DRO-Break, participants could pause the DRO resetting timer for 10 s, providing a “free to tic” break that did not result in their DRO interval resetting. The DRO-Break condition was capped at 5 min and did not extend past the 5 min regardless of the number of breaks that were initiated by participants. During DRO-Break sessions, the experimenter placed an orange-colored card on the table in front of the participant. Participants were told,

“During orange sessions, the tic detector will count your tics and give you a token for every X-s that you go without having a tic for the next 5 min. At the end of the study, we will count how many tokens you received, and you will be able to exchange them for prizes. Remember, you will get a token for every X-s that you go without having a tic, but if you do tic, the X-s tic clock will start over, and you will not get a token until X-s without a tic occurs. During these sessions, when the orange card is out, you can pause your tic detector clock for 10 s whenever you want by clicking start on this break timer on the table. When you start this break timer, your X-s tic detector clock will pause, and you can have 10 s where you can tic without it affecting your tic detector clock. In other words, if you start this break timer, you can tic and it won’t start the tic detector clock over. When your 10 s break is over, the timer clock will beep. You may stop the timer by clicking this button and your tic detector clock will continue wherever it left off. Even though you are free to tic when you start your break timer, you cannot earn any tokens when the break timer is on. Throughout the session, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating of 0-100, with 0 meaning you
have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud.”

In the first DRO-Break session, the experimenter practiced starting and stopping the timer with the participant to ensure they could correctly engage in the skill. Regardless of the number of tokens that were earned, all participants earned a gift card for $10 upon completion of the study. As in BL and DRO, participants were asked to repeat the instructions for the upcoming condition. Any errors of commission or omission were followed by a correcting prompt and asking them to repeat the instructions until they were repeated correctly. Experimenter monitored tics from an adjacent room and delivered tokens according to a resetting X-s schedule (i.e., a token was delivered immediately after each X-s period in which the participant displayed none of the tics discussed at intake, unless the participant chose to take a break). DRO-Break conditions were evaluated in two segments. The first looked at tic rates that occurred only during the DRO contingency of DRO-Break (DRO-Break (DRO On)). In other words, any tics that occurred while not on a break. The second looked at tic rates that occurred only while on a break in DRO-Break (DRO-Break (On Break)).

During DRO-Break, urges were taken every 30 s when the DRO contingency was on (i.e., DRO-Break (DRO On); not during participant-initiated breaks). Once a break was initiated, the experimenter paused the DRO interval and urge rating timers, and restarted them once the break was completed. Additionally, urge ratings were recorded at the end of each participant-initiated break (DRO-Break (Break End)). Following each session, urge ratings were converted into means by summing together the urge scores and dividing them by the number of opportunities participants had to provide an urge rating.
These resulting means were analyzed across condition types both as means within the session and across time.

Preference

After completing the DRO experimental evaluation, the experimenter conducted a preference assessment for the different conditions. In the preference evaluation, participants selected which contingency they most preferred by vocally indicating which associated color (i.e., condition) they liked the best. Before inquiring about preference, the experimenter provided the instructions for each condition while laying the colored cards on the table; the experimenter then asked the participant to repeat the instructions for each condition. Any errors of commission or omission would have been followed by a correcting prompt, but no participants engaged in any errors when providing the instructions before the preference evaluation. The experimenter then asked which of the three colored conditions, each previously associated with the BL, DRO, and DRO-Break conditions, the participant preferred most and told the participant they would experience whichever condition they selected. After the selection, the experimenter told the participant they would not actually be experiencing the condition. Participants were told they would experience their selected condition to increase the likelihood that the participants selected a preferred intervention rather than select an intervention based on another variable (e.g., what they expected the experimenter preferred). The experimenter video-recorded participant selection. At the beginning of the preference evaluation, participants were told,

“Now, we want to find out which session type you liked the best and would like to experience next. As a reminder, in the white condition, you will sit for 5 min. During this time, the tic detector will count your tics. You are free to tic as much as you please and nothing will happen whether you tic or don’t tic. In the purple
condition, the tic detector will count your tics when they occur for 5 min. It will
give you a token for every $X$'s that you go without having a tic. If you have a tic,
the timer will restart, and you will not get a token until $X$'s without a tic occurs. In
the orange condition, the tic detector will count your tics and will give you a
token for every $X$'s you go without having a tic for 5 min. If you do tic, the tic
clock will start over, and you will not get a token until $X$'s without a tic occurs.
Here, you can pause your tic detector clock whenever you want by clicking start
on a break timer on the table which will pause your $X$-s tic detector clock and
give you 10 $s$ to tic without it restarting your tic detector clock. Before we begin,
tell me what happens in each condition...Which color intervention did you prefer
the most?"

After the participant made the selection, the experimenter thanked them for sharing
which intervention they preferred and asked them to explain why that condition was
preferred. Following participant responses, the experimenter informed the participant that
they would not actually experience the condition again and that their participation in the
study was complete. Upon completion of the study, participants were provided a $10 gift
card for participating in the study.

**Response Measurement and Interobserver Agreement**

*Token Dispenser (Tic Detector)*

Tokens were delivered through a token machine on the table in front of the
participant. The token machine consisted of a large case that stored tokens, a plunger that
could be manually operated by the experimenter through an adjacent room to release
tokens, a hopper into which tokens were released, and an inoperable camera sitting on top
of the machine. The participants were each told that the machine was a “tic detector” that
monitored and counted tics through motion sensors, even though the device did not do so.
During both DRO conditions, the researcher manually activated the token dispenser
contingent on the participant going $X$'s without a tic. Once activated, a colored token
dispensed from the machine into a hopper in front of the participant. Tokens remained in
the hopper until the end of the session. Participants were told that the tokens could be
summed and exchanged at the end of the study for a prize (see Appendix B for experimenter scripts).

Data Collection

Participants were video recorded during each condition. Data collectors scored the rate of tics during BL, DRO, and DRO-Break conditions by tracking occurrences of the operationally defined vocal or motor tics and dividing that frequency by the duration of the session (see Appendix C for datasheets). In addition, because the DRO-Break condition consisted of two subcomponents (DRO-Break (DRO On) and DRO-Break (On Break)), tic rates were calculated separately for these two subcomponents. In each, the frequency of operationally defined tics was divided by the duration of time spent within that subcomponent of that DRO-Break session (e.g., the rate for tics on DRO-Break (On Break) was calculated by dividing the frequency of tics that occurred only during the DRO-Break (On Break) component of a DRO-Break session by the time they were in the break to result in the rate of tics for DRO-Break (On Break)). To assess the reliability of these measures, a second observer independently collected data using a pencil and paper datasheet on participant behavior for a minimum of 33% of BL, DRO, and DRO-Break conditions (i.e., reliability measures were recorded for at least one out of every three sessions for each condition). The primary and secondary observers reviewed operational definitions before collecting data to ensure an understanding of each tic.

Interobserver agreement (IOA) was calculated using a frequency-within-interval method (Himle et al., 2006; Himle et al., 2007). Each 5-min session was divided into 10-s intervals. Agreement within each interval was calculated by dividing the smaller number of tics by the larger number of tics and multiplying by 100%. The resulting scores were
then averaged across the entire 5-min session to identify the agreement score. Urge rating agreement scores were calculated by dividing the number of urge ratings both observers agreed on by the number of urge ratings collected within a session and multiplied by 100%. Observers’ records of participant preferences were compared and scored on whether an agreement or nonagreement on participant selections occurred. Nora’s mean IOA in the DRO evaluation was 98.21% (range, 96.42% to 100%) for BL, 100% for DRO, and 100% for DRO-Break. IOA for each of Nora’s urge ratings in BL, DRO, and DRO-Break conditions was 100%. Additionally, IOA for Nora’s preference selection was 100%. Ivy’s mean IOA in the DRO evaluation was 94.97% (range, 89.65% to 97.68%) for BL, 100% for DRO, and 97.13% (range, 91.38% to 100%) for DRO-Break. IOA for each of Ivy’s urge ratings in BL, DRO, and DRO-Break conditions was 100%. Additionally, IOA for Ivy’s preference selection was 100%. Joy’s mean IOA in the DRO evaluation was 88.68% (range, 83.32% to 94.03%) for BL, 87.12% (range, 81.03% to 91.05%) for DRO, and 88.74% (range, 82.11% to 93.10%) for DRO-Break. IOA for each of Joy’s urge ratings in BL, DRO, and DRO-Break conditions was 100%. Additionally, IOA for Joy’s preference selection was 100%. Brett’s mean IOA in the DRO evaluation was 87.49% (range, 82.11% to 92.86%) for BL, 97.59% (range, 96.43% to 98.74%) for DRO, and 98.20% (range, 96.39% to 100%) for DRO-Break. IOA for each of Brett’s urge ratings in BL, DRO, and DRO-Break conditions was 100%. Additionally, IOA for Brett’s preference selection was 100%.

In addition to dependent measures, an independent data collector scored measures of experimenter procedural integrity during a minimum of 33% of BL, DRO, and DRO-Break conditions for each participant (i.e., treatment integrity was recorded for at least
one out of every three sessions for each condition). The secondary trained experimenter recorded independent variable implementation (see Appendix C for the treatment integrity datasheet). These measures included general session integrity and accurate reinforcer delivery, such as (a) the experimenter correctly providing contingency instructions (b) error-correction contingent on the participant incorrectly describing the contingencies, (c) the experimenter correctly presenting the contingency-specific color discriminative stimulus, (d) experimenter presenting a token during DRO and DRO-Break contingencies following X-s tic-free-interval within 2 s (or no tokens delivered during BL), and (f) DRO interval paused when participants initiated a break in DRO-Break conditions. Treatment integrity data were calculated by dividing the number of steps implemented correctly by the experimenter by the total number of possible steps and multiplying by 100% to result in a treatment integrity percentage. During Nora’s sessions, the experimenter scored 100%, 100%, and 100% for BL, DRO, and DRO-Break respectively. Additionally, the experimenter scored 100% on the implementation of the preference evaluation. During Ivy’s sessions, the experimenter scored 100%, 100%, and 100% for BL, DRO, and DRO-Break respectively. The experimenter also scored 100% on the implementation of the preference evaluation. During Joy’s sessions, the experimenter averaged 100%, 100%, and 100% for BL, DRO, and DRO-Break respectively, and 100% in the preference evaluation. Finally, during Brett’s sessions, the primary experimenter averaged 100% in BL, 100% in DRO, and 97% in DRO-Break, as well as 100% during the preference evaluation. Thus, across conditions and participants, the experimenter had high integrity throughout the study, resulting in high confidence that the independent variable was implemented as intended.
RESULTS

Nora

*Initial Screening.* Nora received a T score of 57 on the WASI-II, indicating an average IQ estimate. Nora engaged in 10 distinct tics during the initial observation, including head jerk, screaming, whistling, punching, hitting, shoulder movement, crouching, kicking, hand clenching, and barking tics. On the YGTSS, Nora received a total tic score of 29 and an impairment score of 25. In an initial 5-min observation, Nora engaged in a rate of 6 tics per min. The average inter-response time calculated between each of her identified tics was 11 s. After beginning the study, two novel tics were observed. As per study procedures, these tics were counted, but not included in independent or dependent variable calculations. Nora engaged in an eye-twitching tic and a shoulder movement tic. Four eye-twitching tics and two shoulder movement tics were observed throughout the study. DRO contingencies were not in place for these novel tics.

*Experimental Evaluation.* Figure 1 displays the results of Nora’s experimental evaluation. Tic rates per min are depicted in the top panel. It was hypothesized that DRO and DRO-Break would reduce tics compared to BL and that DRO would reduce tics more effectively than DRO-Break. Nora was observed having tics in only one session, BL. Nora reported that her tics had gotten significantly better shortly after beginning the study. A waxing and waning of tics is a common characteristic of tic disorders, so this is not unheard of. Nora’s participation in the study ended as a result of an absence of tics. The frequency of breaks across sessions is denoted in Figure 2. Nora did not take any breaks during DRO-Break sessions.
Figure 1 (bottom panel) displays Nora’s urge ratings across sessions. It was hypothesized that the premonitory urge would be highest in DRO, followed by DRO-Break, and then BL. Nora only provided an urge rating above 0 three times throughout the study (in two DRO-Break sessions and one DRO session). The highest urge ratings were in DRO, followed by DRO-Break, and then BL. Due to the minimal urge ratings above 0, there is not enough evidence to determine if this hypothesis is supported. Additionally, it was hypothesized premonitory urges would decrease over repeated exposure to the DRO contingency. There is not enough evidence from Nora’s data to determine if this hypothesis is supported as well. Finally, in support of the hypothesis that preference for conditions would be idiosyncratic, Nora indicated a preference for DRO (see Table 1).
Figure 1

Nora’s BL, DRO, and DRO-Break Efficacy Evaluation

Note: BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, and DRO-Break (DRO On) = Differential Reinforcement of Zero Behavior with Breaks while the DRO contingency was active (i.e., while not on a break). The top panel depicts tic rates per min and the bottom panel depicts average urge ratings across sessions. Apart from urge ratings provided during sessions 2, 3, and 12, all other data points denote an urge rating of 0. Nora did not engage in any breaks; thus, no urge ratings were recorded for DRO Break (Break End).
Figure 2

Nora's Frequency of Breaks During DRO-Break

![Graph showing Nora's frequency of breaks during DRO-break sessions. Each session shows a 0 frequency of breaks.](image-url)
### Table 1

**Preference Assessment Results**

<table>
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Ivy

*Initial Screening.* Ivy received a T score of 60 on the WASI-II, indicating an average IQ estimate. On the YGTSS, Ivy received a total tic score of 14 and an impairment score of 20. Ivy engaged in 4 tics, including a head jerk, shoulder movement, finger tapping, and knuckle cracking tic. Ivy’s finger tapping and knuckle cracking tics consisted of multiple consecutive finger tapping or knuckle cracking movements; each new instance of a tic was defined by a 2-s offset from the previous finger tapping or knuckle cracking tic. In the initial 5-min observation, Ivy engaged in a rate of 2.6 tics per min. The mean inter-response time calculated between each of her identified tics was 11 s. After beginning the study, no additional tics outside of those mentioned above were observed.
Experimental Evaluation. Figure 3 displays Ivy’s results from the experimental evaluation. Tic rates, depicted in the top panel, were lower in DRO and DRO-Break (DRO On) compared to BL, supporting the hypothesis that DRO and DRO-Break would more effectively reduce tics compared to BL. There was significant variability in Ivy’s BL responding, with the first two data points showing elevated tic rates relevant to latter data points. There was considerably less variability in DRO and DRO-Break (DRO On) conditions, with only one data point of each overlapping with a data point in BL. Nevertheless, there was continued separation between BL and DRO conditions, even during latter sessions. These results suggest that the DRO contingency was more effective than BL at reducing tics.

Visual analysis of DRO and DRO-Break (DRO On) conditions indicates significant overlap between the conditions, revealing no clear separation between DRO and DRO-Break (DRO On). These results contradict the hypothesis that DRO would reduce tics to a greater extent than DRO-Break. To evaluate how breaks in DRO-Break affected tic rates throughout the entire DRO-Break session, rather than just during DRO-Break (DRO On), tic rates were calculated by summing tics from both on and off of breaks (Figure 5, top panel). Overlap of DRO and DRO-Break data points indicated no major differences in tic rates between DRO and DRO-Break. Additionally, the average frequency of tics within each condition was calculated (Figure 6, top panel). Ivy engaged in an average of 4.6 tics in BL sessions, 1.3 tics in DRO sessions, .67 tics in DRO-Break (DRO On) sessions (while the DRO contingency was active), and 1.67 tics in DRO-Break (On Break) sessions (while on a participant-initiated break). Ivy’s frequency of breaks across each DRO-Break session is denoted in Figure 4. Ivy initiated an average of
1.6 breaks in each DRO-Break session, alternating between initiating 1-2 breaks in each DRO-Break session.

Figure 3 (bottom panel) displays Ivy’s urge ratings across sessions. It was hypothesized that the premonitory urge would be highest in DRO followed by DRO-Break and then BL. No significant differences in premonitory urge ratings across conditions were observed. Ivy reported an average urge of 15.90 in BL, 21.17 in DRO, 18.41 in DRO-Break (DRO On), and 10.83 at the end of the breaks in DRO-Break (see Figure 6, bottom panel). Thus, there are minimal differences in urge ratings across conditions. As such, Ivy’s urge ratings do not support the hypothesis that urge ratings would be highest in DRO followed by DRO-Break and BL. It was hypothesized that urge ratings in DRO would decrease over time with repeated exposure to the DRO contingency when compared to the other conditions. Over the course of the study, Ivy’s urge ratings decreased in DRO as well as in BL and DRO-Break conditions. Finally, in support of the hypothesis that participant preferences would be idiosyncratic, Ivy indicated a preference for DRO (see Table 1).
Figure 3

Ivy’s BL, DRO, and DRO-Break Efficacy Evaluation

Note: BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, DRO-Break = Differential Reinforcement of Zero Behavior with Breaks, DRO-Break (DRO On) = while the DRO contingency was active (i.e., not on a break) in DRO-Break, DRO-Break (On Break) = while on a break in DRO-Break, and DRO-Break (Break End) = urge ratings collected at the end of participant-initiated breaks. The top panel displays tics per min while the bottom panel displays average urges.
Figure 4

Ivy's Frequency of Breaks During DRO-Break
Figure 5

Ivy, Joy, and Brett Data Sets with DRO-Break Combined

Note: BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, and DRO-Break (Combined) = DRO-Break (DRO On) and DRO-Break (On Break) combined. Tic rate calculated as rate per min.
Figure 6

Participant Average Tics and Urge Ratings Across Conditions

Note: Each data path represents a participant. BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, DRO-Break = Differential Reinforcement of Zero Behavior with Breaks, DRO-Break (DRO On) = DRO contingency active (i.e., while not on a break) in DRO-Break, DRO-Break (On Break) = on a break in DRO-Break, and DRO-Break (Break End) = urge ratings collected at the end of participant-initiated breaks. Missing DRO-Break (Break End) data points indicate no break was taken.

Joy

Initial Screening. Joy received a T score of 57 on the WASI-II, indicating an average IQ estimate. On the YGTSS, Joy received a total tic score of 23 and an impairment score of 20. Joy engaged in 7 tics, including a throat clearing, sniffing in, blinking, nose scrunching, mouth widening, coughing, and copropraxia (inappropriate
gesture) tic. In an initial observation, Joy engaged in a rate of 7.4 tics per min. The average inter-response time calculated between each of her identified tics was 8 s. After beginning the study, no additional tics outside of those mentioned above were observed.

**Experimental Evaluation.** Figure 7 displays Joy’s results from the experimental evaluation. Tic rates, depicted in the top panel, were highest in BL compared to DRO and DRO-Break (DRO On). These results support the hypothesis that DRO and DRO-Break would reduce tics more than BL. There was high variability observed in BL; nevertheless, apart from one data point, there was continued separation between BL and both DRO conditions. These results suggest that both DRO contingencies reduced tics relative to BL. There was also considerable variability observed in DRO, with elevated responding in the first DRO session that dropped and remained stable after the second DRO session. Although there are points in which DRO-Break (DRO On) tic rates are lower than DRO tic rates, there is significant overlap between DRO and DRO-Break (DRO On) conditions. These results contradict the hypothesis that DRO would reduce tics to a greater extent than DRO-Break (DRO On).

To evaluate how breaks affected tic rates throughout the entire DRO-Break session, rather than just during DRO-Break (DRO On), total tics from on and off of breaks were summed (Figure 5, middle panel). With the exception of the first DRO data point, similar levels of responding in DRO and DRO-Break (Combined) were observed. Finally, to further evaluate how responding differed across these conditions, experimenters evaluated the average frequency of tics within each condition. Figure 6, (top panel) displays Joy’s average tic frequency within each condition. Joy engaged in an average of 44.5 tics in BL sessions, an average of 13.5 tics in DRO, an average of 5.25
tics in DRO-Break (DRO On), and an average of 2 tics in DRO-Break (On Break). Joy’s frequency of breaks across each DRO-Break session is denoted in Figure 8. Joy initiated an average of .75 breaks in each DRO-Break session. As shown in the top panel of Figure 7, and further depicted in Figure 6 (top panel), Joy engaged in slightly lower rates of tics in DRO-Break (DRO On) compared to DRO, contradicting the hypothesis that DRO would reduce tics to a greater extent than DRO-Break.

Figure 7 (bottom panel) displays Joy’s average urge ratings across sessions. It was hypothesized that the premonitory urge would be highest in DRO followed by DRO-Break and then BL. As depicted in Figure 7 (bottom panel), and further evidenced in Figure 6 (bottom panel), Joy’s urge ratings were highest in BL overall followed by DRO-Break, with no significant differences in urge ratings in DRO compared to BL and DRO-Break, contradicting this hypothesis. To further analyze these data, experimenters averaged urge ratings within each condition (Figure 6, bottom panel). Joy reported an average urge of 44.55 in BL, 36.73 in DRO, 27.51 in the DRO-Break (DRO On), and an average urge of 20 in DRO-Break (Break End). It was also hypothesized that urge ratings in DRO would decrease over repeated exposure to the DRO contingency. Over the course of the study, Joy’s urge ratings did not decrease over time, contradicting this hypothesis.

Finally, in support of the hypothesis that participant preference would be idiosyncratic, Joy indicated a preference for the DRO-Break condition (see Table 1).
**Figure 7**

*Joy’s BL, DRO, and DRO-Break Efficacy Evaluation*

Note: BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, DRO-Break = Differential Reinforcement of Zero Behavior with Breaks, DRO-Break (DRO On) = while the DRO contingency was active (i.e., not on a break) in DRO-Break, DRO-Break (On Break) = tic rates while on a break in DRO-Break, and DRO-Break (Break End) = urge ratings collected at the end of participant-initiated breaks. Missing DRO-Break (Break End) data points indicate no break was taken. The top panel depicts tics per min and the bottom panel depicts average urge ratings.
Brett

*Initial Screening.* Brett received a T score of 57 on the WASI-II, indicating an average IQ estimate. On the YGTSS, Brett received a total tic score of 22 and an impairment score of 30. Brett engaged in two tics, a head and swallowing tic. Due to the experimenter being unable to observe the swallowing tic, it was excluded from the study. In the initial observation, Brett engaged in a rate of 2 tics per min. The average inter-response time calculated between each of his identified tics was 23 s. After beginning the study, no additional tics outside of those mentioned above were observed.

*Experimental Evaluation.* Figure 9 displays Brett’s results from the experimental evaluation. Tic rates per min, depicted in the top panel, were highest in BL compared to DRO and DRO-Break (DRO On), supporting the hypothesis that DRO and DRO-Break (DRO On) would reduce tics relative to BL. There was high variability seen throughout BL, nevertheless, with the exception of one data point, there was continued separation.
between BL and both DRO conditions. These results suggest that both DRO contingencies are more effective at reducing tics than BL. There was considerably less variability in DRO and DRO-Break (DRO On) conditions. There is significant overlap in DRO and DRO-Break (DRO On) data paths suggesting there isn’t clear separation between DRO and DRO-Break (DRO On). These results contradict the hypothesis that DRO would reduce tics to a greater extent than DRO-Break.

To evaluate how breaks affected tic rates throughout the entire DRO-Break session, rather than just during DRO-Break (DRO On), total tics from on and off of breaks were summed together when calculating rate per min (Figure 5, bottom panel). Similar levels of responding in DRO and DRO-Break (Combined) were observed. Finally, to further evaluate how responding differed across these conditions, experimenters evaluated the average frequency of tics within the conditions. Figure 6 (top panel) displays Brett’s average tic frequency within each condition. Brett engaged in an average of 19.33 tics in BL, 7.5 tics in DRO, 5.33 tics in DRO-Break (DRO On), and 2.5 tics in DRO-Break (On Break). Brett’s frequency of breaks across each DRO-Break session is denoted in Figure 10. Brett initiated one break in each DRO-Break session.

Figure 9 (bottom panel) displays Brett’s urge ratings across sessions. It was hypothesized that urge ratings would be highest in DRO followed by DRO-Break and then BL. Brett’s urge ratings were fairly undifferentiated with no large differences in ratings across conditions. To further analyze urge data, experimenters averaged urge ratings within each condition (see Figure 6). Brett reported an average urge of 50.50 in BL, 52.79 in DRO, 57.38 in DRO-Break (DRO On), and 52.33 in DRO-Break (Break End). Although these differences are minimal, these results contradict the hypothesis that
DRO would result in higher urge ratings followed by DRO-Break and BL. It was also hypothesized that urge ratings would decrease over repeated exposure to the DRO contingency; but this was not observed in Brett’s data, as urge ratings remained relatively stable across sessions (Figure 9, bottom panel). Finally, in support of the hypothesis that participant preferences for conditions would be idiosyncratic, Brett indicated a preference for DRO-Break (see Table 1).
Figure 9

Brett’s BL, DRO, and DRO-Break Efficacy Evaluation

Note: BL = Baseline, DRO = Differential Reinforcement of Zero Behavior, DRO-Break = Differential Reinforcement of Zero behavior with breaks, DRO-Break (DRO On) = while the DRO contingency was active (i.e., not on a break) in DRO-Break, DRO-Break (On Break) = on a break in DRO-Break, and DRO-Break (Break End) = urge ratings collected at the end of a participant-initiated break. The top panel depicts tic rate per min and the bottom panel depicts average urge rating.
Figure 10

*Brett’s Frequency of Breaks During DRO-Break*

![Graph showing Brett's Frequency of Breaks during DRO-Break sessions. The x-axis represents DRO-Break sessions from 1 to 6, and the y-axis represents the frequency of breaks from 0 to 3. The graph shows that the frequency of breaks remains constant across all sessions.](image-url)
DISCUSSION

Previous research has shown the efficacy of DRO contingencies in reducing tics. This study sought to replicate and extend previous research in three ways. First, the study investigated whether incorporating an option for participant-initiated breaks differentially impacted tic suppression. Second, the current study assessed the differences in premonitory urge ratings across BL, DRO, and DRO-Break conditions. Finally, the study evaluated participant preferences for each of these conditions.

**Efficacy of DRO vs. DRO-Break**

It was hypothesized that DRO and DRO-Break (DRO On) would both reduce tics relative to BL. In support of this hypothesis, all four participants engaged in fewer tics during DRO and DRO-Break (DRO On) conditions compared to BL. Thus, reinforced tic suppression effectively reduces tics, replicating previous research (Capriotti et al., 2017; Rosen & Wesner, 1973; Wagaman et al., 1995). It was further hypothesized that DRO would be more effective at suppressing tics compared to DRO-Break (DRO On).

Contrary to this hypothesis, both DRO and DRO-Break (DRO On) were similarly effective at reducing tics. These data are surprising given the variable reinforcement of tics while participants tic during breaks in DRO-Break sessions. In addition to evaluating how breaks affected tics when the DRO contingency was active in DRO-Break sessions (i.e., DRO-Break (DRO On)), it was also of interest to evaluate how breaks affected tic rates throughout the entire DRO-Break session (i.e., tics from both on and off participant-initiated breaks; Figure 5). Nevertheless, when these data were summed together, still no differences emerged. Thus, when looking at tic rates from DRO-Break (DRO On) as well
as aggregated tic rates from DRO-Break (Combined), both DRO and DRO-Break conditions were similarly effective at reducing tics.

These results have implications for clinical practice. Noting the similar efficacy of DRO and DRO-Break is important as it may suggest HRT and CBIT can retain effectiveness if an individual has a lapse in tic suppression (i.e., an individual opts to occasionally engage in a tic rather than suppression) throughout therapy. Future research should evaluate the use of participant-initiated breaks in HRT and CBIT training packages to provide additional evidence for this notion.

**Use of Breaks in DRO-Break**

As noted previously, it is important to consider variable reinforcement when evaluating DRO-Break. When a premonitory urge is present, engaging in a tic results in a decrease in the aversive properties of the urge. This negative reinforcement contingency increases the likelihood that a tic will occur again in the presence of that urge. Thus, the use of participant-initiated breaks should provide opportunities for the continued negative reinforcement of tics. Interestingly, the breaks did not result in significantly higher tic rates during DRO-Break (DRO On) compared to DRO and BL across the current participants.

Participant-initiated breaks in DRO-Break are likely the result of an urge building to a point in which the value of the negative reinforcer (i.e., urge removal) becomes greater than the reinforcer for continued suppression (i.e., tokens). Three out of the four participants initiated at least one break during DRO-Break sessions. One participant initiated zero breaks throughout the study (Nora), one participant initiated between one to two breaks in each DRO-Break session (Ivy), and two participants initiated a maximum
of one break in each DRO-Break session (Joy and Brett). It is possible Joy and Brett believed they could only take one break in each DRO-Break session (i.e., they believed they could not use the break multiple times within a single session). Although the DRO-Break instructions stated participants could “pause your tic detector clock for 10 s whenever you want…,” it is possible participants interpreted this as they could use it once whenever they wanted. Additional evidence in support of this hypothesis came from Brett’s reasoning for preferring the DRO-Break condition, stating “I like how you can use the timer for 10 s and tic as much as you want. Once you use it, you go the entire time without ticcing, it’s kind of like a game to not tic after.” Future research should evaluate the effect on tic rates when single and multiple break opportunities are available. Additionally, the duration of the 10-s break in this study was selected arbitrarily, and future research can compare tic rates with varied break times (e.g., 5 s, 15 s, 20 s).

In addition to Brett only taking one break within each DRO-Break session, an interesting response pattern emerged. Within DRO-Break sessions, Brett either engaged in similar or more tics while the DRO contingency was on compared to when it was off (i.e., more tics occurred in DRO-Break (DRO On) compared to DRO-Break (On Break)). Many tics that occurred while the contingency was on, happened as soon as, or shortly after, a token was delivered. This pattern resembled a fixed interval scallop. In a ‘post reinforcement pause’ period, Brett engaged in tics, rather than tic suppression responses, and then returned to the tic suppression response. Given the possibility Brett believed he could use a maximum of one break in each session, he may have learned that by engaging in a tic as soon as a token was delivered, he maximized his ability to still earn tokens. Brett’s DRO resetting interval was 23 s, and thus, engaging in a tic as soon as a token
was delivered only resulted in 1-3 s extra time, rather than ticcing at the end of a 23-s interval which would result in 20-23 s extra time. This pattern was not observed with other participants in the study.

**Impact of DRO-Break on Premonitory Urges**

It was hypothesized that premonitory urge ratings would be highest in DRO, followed by DRO-Break, and lowest in BL. This was not observed in these participants as Nora provided zero-level urges throughout most of the study, no significant differences in urge ratings were observed with Ivy and Brett, and Joy had higher urge ratings in BL compared to DRO-Break. Interestingly, Joy’s results contradict previous research stating urge ratings are lowest in BL conditions and highest in tic suppression conditions (Himle et al. 2007; Kwak et al., 2003; Leckman et al., 1993). Thus, the negative reinforcement contingency of an urge followed by a tic resulting in the removal of, or reduction in urge was not observed in these participants.

The lack of replication from previous research on urge ratings may be due to a few reasons. First, it is possible that the participants did not fully understand the premonitory urge before beginning the study. Although each participant practiced identifying their urges at the beginning of the study, it is possible the description and practice were not sufficient. Furthermore, it is possible the numbers provided by participants did not correspond with the urges themselves. For example, it is possible that a rating of 50 may have been a participant’s perceived rating of the likelihood they would tic at that moment rather than the rating of the aversive sensation that occurs before tics. Additional time spent discussing and practicing premonitory urge ratings may have resolved this issue. Second, it is possible that participants had urges for many of their tics
throughout each of the conditions. For example, an individual may engage in a head jerk tic, reducing the urge for that specific tic, however, an urge for a sniffing tic may still be present at a similar rating. Thus, general urge ratings may have been consistent throughout each condition for this reason. As possible evidence of that matter, Brett never reported an urge rating below 30, even after immediately engaging in a tic. It is also possible that differences in urge ratings across conditions and sessions were not observed because the 5-min session duration was not long enough to observe these patterns within these participants. Finally, it is possible that participants engaged in some level of suppression in every condition, even in BL, resulting in similar urge ratings. As done in previous research, instructions were provided before each session explaining each condition. One component was that the tic detector counted the number of tics participants would do. It is possible that this instruction was enough to warrant some level of suppression in each condition, resulting in moderate urge ratings across BL, DRO, and DRO-Break (e.g., Brett’s urge ratings).

It was also hypothesized that urge ratings in DRO would decrease with repeated exposure to the DRO contingency. With continued exposure to reinforced tic suppression in DRO, it is likely participants would habituate to the urge. If habituated to the urge, the value of the reinforcer (i.e., removal of the urge), would decrease and ultimately reduce the likelihood of a tic occurring. If initiating breaks and subsequently engaging in tics during DRO-Break sessions, participants would be unable to habituate to the urge. Nevertheless, the results of the current study suggest that DRO with and without breaks did not differentially affect urge ratings across time for these participants. Ivy’s urge ratings in DRO decreased over time, but at similar levels in BL and DRO-Break. Joy and
Brett’s urge ratings did not significantly decrease with continued exposure to DRO. Thus, continued exposure to DRO did not affect urge ratings substantially. One reason for this may be that Ivy, Joy, and Brett each had DRO sessions in which they continued to engage in some level of tics (even minimally). Because of this, they likely never fully habituated to the urge. Despite the lack of habituation to urges, both DRO and DRO-Break were still effective at reducing tics. Future research should evaluate if urge habituation in DRO may be a predictor of whom participant-initiated breaks may be beneficial or detrimental to in the efficacy of treatment (i.e., does the use of breaks in tic suppression differentially affect individuals who do not habituate to their urge over time compared to individuals that do).

In the current study, researchers evaluated urge ratings every 30 s and at the end of each participant-initiated break. Although these data allowed for a better understanding of participant urges throughout sessions, they did not allow for analysis of urge ratings before and after tics. Thus, the current data do not provide information on whether or not urges reliably decreased following a tic. For example, a participant may provide an urge of 50 and a few seconds later engage in a tic. They may then provide another urge rating of 53 shortly after. What is unclear is how that urge progressed from a rating of 50 leading up to the tic, and how the urge progressed following the tic leading up to the second urge rating of 53. Future research can evaluate the efficacy of having participants more frequently provide their urge rating, as doing so may provide a better understanding of how urges progress within each of these conditions (e.g., how quickly do they increase or decrease in intensity before and after a tic).
Preference

Because both DRO and DRO-Break conditions were similarly effective with these participants, identifying which condition participants preferred was an important next step. It was hypothesized that preference for BL, DRO, and DRO-Break conditions would be idiosyncratic across participants. Two participants preferred DRO, two participants preferred DRO-Break, and zero participants preferred BL (see Table 1). A consistent preference for tic suppression conditions over BL is not surprising given that all participants in this study were on a waitlist for a university-based clinic specializing in interventions to reduce tics. Nora indicated a preference for DRO because of the “challenge.” Ivy indicated a preference for both DRO and DRO-Break, but stated if she had to choose one, she would pick DRO because the colored card associated with the condition was her favorite color, because the condition offered “structure,” and because she liked to “have things under control.” Joy indicated a preference for DRO-Break because the break gave a “refresh.” Finally, Brett indicated a preference for DRO-Break because it allowed him to “tic as much you want” while on the break and it was “kind of like a game.” Correspondence between preference and most effective intervention (lowest average tics) was observed in two of the four participants (Joy and Brett). Nora’s preference also corresponded with performance, but it is important to note that she did not engage in any tics in either DRO or DRO-Break.

In the current study, the evaluation of preference for BL, DRO, and DRO-Break conditions was done through a single presentation. This decision was made as a one-trial preference evaluation mimicked clinical practice within the university-based tic clinic. To address the possibility that participants did not understand the contingencies associated
with each colored card, the experimenter first presented the colored cards and re-stated each condition’s instructions. Then, the experimenter asked the participant to repeat the instructions for each condition. If any errors of commission or omission were made, the experimenter would provide a correcting prompt and repeat the before-mentioned steps until the participant stated the instructions correctly. This did not occur as all participants correctly presented the instructions for each condition. Once the participant made a selection, the experimenter asked the participant to explain why they selected that specific condition. Participant responses matched condition contingencies (e.g., “I like a challenge” for DRO and “You can tic for 10 s so you can get a refresh and get more tokens…so you can hold your tics in longer” for DRO-Break). To further evaluate preference for BL, DRO, and DRO-Break conditions, future researchers should conduct a repeated measures preference evaluation to assess the stability of preference selections for these conditions over time.

**Individualized DRO Interval**

In addition to testing the aforementioned hypotheses, this study extended previous research by utilizing an individualized resetting DRO interval for each participant rather than a uniform 10-s interval. To determine the individualized DRO interval, the experimenter recorded a 5-min observation and calculated the average participant inter-response time by identifying the average time between each tic within the 5-min observation.

Utilizing an individualized DRO interval may offer benefits compared to a uniform 10-s DRO interval for several reasons. For individuals who engage in high rates of tics, a 10-s DRO schedule may be too challenging to maintain suppression. Successful
suppression may be seen more efficiently with individualized DRO intervals that are progressively increased over time. Future research can evaluate the use of individualized DRO intervals that are progressively increased as successful tic suppression is observed. Conversely, individuals who engage in low rates of tics may benefit from longer DRO intervals (e.g., 1 min). Longer DRO intervals provide access to less reinforcement, which may reduce satiation to reinforcers. For example, Brett’s individualized interval was set at 23 s based on his initial observation screening. If using a standard 10-s interval, he could have potentially received double the reinforcers within a session. Reduction in reinforcer delivery may be important to consider with edible reinforcers, as providing access to larger quantities of food may be undesirable. Future research can compare individualized, inter-response time-based DRO intervals with uniform DRO 10-s intervals to evaluate the efficacy and benefits of utilizing individualized DRO intervals.

It is worth noting that a single 5-min observation session, as done in this study, may not provide an accurate representation of the participant’s tics. For example, in Nora’s 5-min observation, she engaged in 30 tics. In the experimental study, however, she engaged in only 20 tics across 75 min. It is possible that recording the 5-min observation at the end of the initial screening assessment led to an inaccurate representation of tics. In Nora’s case, it is possible that discussing her tics in detail throughout the screening increased the frequency of tics in the observation, as previous research has shown that talking about tics may increase the presentation of tics (Woods et al., 2001). Future research should address this limitation by taking repeated measures of participant inter-response times across multiple days to determine a more accurate DRO interval that is best suited for each participant.
In summary, this study extended previous research evaluating the efficacy of DRO contingencies on tic suppression by including the option of a participant-initiated break within a DRO contingency. In general, both DRO and DRO-Break contingencies were similarly effective as both reduced tic rates compared to BL in three out of four participants. Ivy, Joy, and Brett had, on average, fewer tics in DRO-Break (DRO On) conditions compared to DRO, but there was significant overlap across these conditions. Additionally, the results of the current study lend evidence to the continued success of participants who periodically engage in a tic to remove an aversive urge while working through suppression tactics in other behavioral interventions such as HRT and CBIT. Finally, as preference was idiosyncratic across participants, researchers should continue to find ways to identify and incorporate preferred and effective interventions.


# YG TSS
Yale Global Tic Severity Scale

Rater: __________

## YGTSS SUMMARY – COMPLETE AFTER ADMINISTRATION

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<td>Motor</td>
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<tr>
<td>Vocal</td>
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<td>Total</td>
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</tbody>
</table>

**IMPAIRMENT**

## MOTOR TIC SYMPTOM CHECKLIST (Check motor tics present during past week.)

- **Simple Motor Tics** (Rapid, Darting, "Meaningless"):
  - Eye blinking
  - Eye movements
  - Nose movements
  - Mouth movements
  - Facial grimace
  - Head jerks/movements
  - Shoulder shrugs
  - Arm movements
  - Hand movements
  - Abdominal tensing
• Leg, foot, or toe movements
• Other (describe):

• Other (describe):

• Complex Motor Tics (Slower, "Purposeful"):
  • Eye movements
  • Mouth movements
  • Facial movements or expressions
  • Head gestures or movements
  • Shoulder movements
  • Arm movements
  • Hand movements
  • Writing tics
  • Dystonic postures
  • Bending or gyrating
  • Rotating
  • Leg or foot or toe movements
  • Blocking
  • Tic related compulsive behaviors (touching, tapping, grooming, evening-up)
  • Copropraxia
  • Self-abusive behavior
  • Paroxysms of tics (displays), duration ___ seconds
  • Disinhibited behavior (describe):*
  • Other (describe):

PHONIC TIC SYMPTOM CHECKLIST  (Check phonic tics present over the past week.)

• Simple Phonic Symptoms (Fast, "Meaningless" Sounds):
  • Sounds, noises (circle: coughing, throat clearing, sniffing, or animal or bird noises)
  • Other (list):

• Complex Phonic Symptoms (Language: Words, Phrases, Statements):
  • Syllables (list)

  • Words (list)
- Coprolalia (list)
- Echolalia
- Palalalia
- Blocking
- Speech atypicalities (describe)
- Disinhibited speech (describe)*

* Do not include disinhibitions in ratings of tic behaviors

### NUMBER

<table>
<thead>
<tr>
<th>Motor</th>
<th>Phonic</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Single tic</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Multiple discrete tics (2-5)</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Multiple discrete tics (&gt;5)</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Multiple discrete tics plus at least one orchestrated pattern of multiple simultaneous or sequential tics where it is difficult to distinguish discrete tics</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Multiple discrete tics plus several (&gt;2) orchestrated paroxysms of multiple simultaneous or sequential tics that where it is difficult to distinguish discrete tics</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

### FREQUENCY

<table>
<thead>
<tr>
<th>Motor</th>
<th>Phonic</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RARELY</td>
<td>Specific tic behaviors have been present during previous week. These behaviors occur infrequently, often not on a daily basis. If bouts of tics occur, they are brief and uncommon.</td>
<td>0</td>
</tr>
<tr>
<td>OCCASIONALLY</td>
<td>Specific tic behaviors are usually present on a daily basis, but there are long tic-free intervals during the day. Bouts of tics may occur on occasion and are not sustained for more than a few minutes at a time.</td>
<td>0</td>
</tr>
<tr>
<td>FREQUENTLY</td>
<td>Specific tic behaviors are present on a daily basis. Tic free intervals as long as 3 hours are not uncommon. Bouts of tics occur regularly but may be limited to a single setting.</td>
<td>0</td>
</tr>
<tr>
<td>ALMOST ALWAYS</td>
<td>Specific tic behaviors are present virtually every waking hour of every day, and periods of sustained tic behaviors occur regularly. Bouts of tics are common and are not limited to a single setting.</td>
<td>0</td>
</tr>
<tr>
<td>ALWAYS</td>
<td>Specific tic behaviors are present virtually all the time. Tic free intervals are difficult to identify and do not last more than 5 to 10 minutes at most.</td>
<td>0</td>
</tr>
</tbody>
</table>
### INTENSITY

<table>
<thead>
<tr>
<th></th>
<th>Motor</th>
<th>Phonic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ABSENT</strong></td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td><strong>MINIMAL INTENSITY</strong></td>
<td>Tic' not visible or audible (based solely on patient's private experience) or tics are less forceful than comparable voluntary actions and are typically not noticed because of their intensity.</td>
<td>o</td>
</tr>
<tr>
<td><strong>MILD INTENSITY</strong></td>
<td>Tic' are not more forceful than comparable voluntary actions or utterances and are typically not noticed because of their intensity.</td>
<td>o</td>
</tr>
<tr>
<td><strong>MODERATE INTENSITY</strong></td>
<td>Tic' are more forceful than comparable voluntary actions but are not outside the range of normal expression for comparable voluntary actions or utterances. They may call attention to the individual because of their forceful character.</td>
<td>o</td>
</tr>
<tr>
<td><strong>MARKED INTENSITY</strong></td>
<td>Tic' are more forceful than comparable voluntary actions or utterances and typically have an &quot;exaggerated&quot; character. Such tics frequently call attention to the individual because of their forceful and exaggerated character.</td>
<td>o</td>
</tr>
<tr>
<td><strong>SEVERE INTENSITY</strong></td>
<td>Tic' are extremely forceful and exaggerated in expression. These tics call attention to the individual and may result in risk of physical injury (accidental, provoked, or self-inflicted) because of their forceful expression.</td>
<td>o</td>
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</table>

### COMPLEXITY

<table>
<thead>
<tr>
<th></th>
<th>Motor</th>
<th>Phonic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NONE</strong></td>
<td>Tic' are not clearly &quot;simple&quot; (sudden, brief, purposeless) in character.</td>
<td>o</td>
</tr>
<tr>
<td><strong>BORDERLINE</strong></td>
<td>Some tics are not clearly &quot;simple&quot; in character.</td>
<td>o</td>
</tr>
<tr>
<td><strong>MILD</strong></td>
<td>Some tics are clearly &quot;complex&quot; (purposive in appearance) and mimic brief &quot;automatic&quot; behaviors, such as grooming, syllables, or brief meaningful utterances such as &quot;ah huh,&quot; &quot;hi&quot; that could be readily camouflaged.</td>
<td>o</td>
</tr>
<tr>
<td><strong>MODERATE</strong></td>
<td>Some tics are more &quot;complex&quot; (more purposive and sustained in appearance) and may occur in orchestrated bouts that would be difficult to camouflage but could be rationalized or &quot;explained&quot; as normal behavior or speech (picking, tapping, saying &quot;you bet&quot; or &quot;honey&quot;, brief echolalia).</td>
<td>o</td>
</tr>
<tr>
<td><strong>MARKED</strong></td>
<td>Some tics are very &quot;complex&quot; in character and tend to occur in sustained orchestrated bouts that would be difficult to camouflage and could not be easily rationalized as normal behavior or speech because of their duration and/or their unusual, inappropriate, bizarre or obscene character (a lengthy facial contortion, touching genitals, echolalia, speech atypicalities, longer bouts of saying &quot;what do you mean&quot; repeatedly, or saying &quot;fu&quot; or &quot;sh&quot;).</td>
<td>o</td>
</tr>
<tr>
<td><strong>SEVERE</strong></td>
<td>Some tics involve lengthy bouts of orchestrated behavior or speech that would be impossible to camouflage or successfully rationalize as normal because of their duration and/or extremely unusual, inappropriate, bizarre or obscene character (lengthy displays or utterances often involving copropraxia, self-abusive behavior, or coprolalia).</td>
<td>o</td>
</tr>
</tbody>
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### INTERFERENCE

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
<th>Motor</th>
<th>Phonic</th>
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</thead>
<tbody>
<tr>
<td>NONE</td>
<td>When tics are present, they do not interrupt the flow of behavior or speech.</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MINIMAL</td>
<td>When tics are present, they occasionally interrupt the flow of behavior or speech.</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>MILD</td>
<td>When tics are present, they frequently interrupt the flow of behavior or speech.</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>MODERATE</td>
<td>When tics are present, they frequently interrupt the flow of behavior or speech, and they occasionally disrupt intended action or communication.</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>MARKED</td>
<td>When tics are present, they frequently interrupt the flow of behavior or speech, and they occasionally disrupt intended action or communication.</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>SEVERE</td>
<td>When tics are present, they frequently disrupt intended action or communication.</td>
<td>0</td>
<td>5</td>
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</table>

### IMPAIRMENT (Continuous Scale)

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>NONE</td>
<td>Tics associated with subtle difficulties in self-esteem, family life, social acceptance, or school or job functioning (infrequent upset or concern about tics vis a vis the future, periodic, slight increase in family tensions because of tics, friends or acquaintances may occasionally notice or comment about tics in an upsetting way).</td>
</tr>
<tr>
<td>MINIMAL</td>
<td>Tics associated with minor difficulties in self-esteem, family life, social acceptance, or school or job functioning.</td>
</tr>
<tr>
<td>MILD</td>
<td>Tics associated with some clear problems in self-esteem family life, social acceptance, or school or job functioning (episodes of dysphoria, periodic distress and upheaval in the family, frequent teasing by peers or episodic social avoidance, periodic interference in school or job performance because of tics).</td>
</tr>
<tr>
<td>MODERATE</td>
<td>Tics associated with some clear problems in self-esteem family life, social acceptance, or school or job functioning (episodes of dysphoria, periodic distress and upheaval in the family, frequent teasing by peers or episodic social avoidance, periodic interference in school or job performance because of tics).</td>
</tr>
<tr>
<td>MARKED</td>
<td>Tics associated with major difficulties in self-esteem, family life, social acceptance, or school or job functioning.</td>
</tr>
<tr>
<td>SEVERE</td>
<td>Tics associated with extreme difficulties in self-esteem, family life, social acceptance, or school or job functioning (severe depression with suicidal ideation, disruption of the family (separation/divorce, residential placement), disruption of social tics - severely restricted life because of social stigma and social avoidance, removal from school or loss of job).</td>
</tr>
</tbody>
</table>
APPENDIX B

Scripts

At the first experimental session:
“This is our tic detector. It monitors and counts your tics through motion
sensors. During some sessions, the tic detector will just count how much you tic.
During other sessions, it will give you tokens. We will talk more about these
before each session.”

Baseline:
“During white sessions, the tic detector will count your tics for the next 5 min.
You are free to tic as much as you please and nothing will happen whether you
tic or don’t tic. Every 30 sec, a rating scale will pop up on the computer and you
will be asked to rate your urge at that moment. A thermometer will appear on the
screen with a rating 0-100, with 0 meaning you have no urge to tic and 100
meaning you have a high urge to tic. Every time this appears on the screen,
please tell us your urge rating out loud.”

DRO:
“During purple sessions, this tic detector will count your tics when they occur
for the next 5 min. It will give you a token for every X s that you go without
having a tic. At the end of the study, we will count how many tokens you
received, and you will be able to exchange them for prizes. Remember, you will
get a token for every X s that you go without having a tic, but if you do tic, the X-
s tic clock will start over, and you will not get a token until a full X s without a
tic occurs. Every 30 s, a rating scale will pop up on the computer and you will be
asked to rate your urge at that moment. A thermometer will appear on the screen
with a rating 0-100, with 0 meaning you have no urge to tic and 100 meaning
you have a high urge to tic. Every time this appears on the screen, please tell us
your urge rating out loud.”

DRO-Break:
“During orange sessions, the tic detector will count your tics and give you a
token for every X s that you go without having a tic for the next 5 min. At the end
of the study, we will count how many tokens you received, and you will be able to
exchange them for prizes. Remember, you will get a token for every X s that you
go without having a tic, but if you do tic, the X-s tic clock will start over, and you
will not get a token until X s without a tic occurs. During these sessions, when
the orange card is out, you can pause your tic detector clock for 10 s whenever
you want by clicking start on this break timer on the table. When you start this
break timer, your X-s tic detector clock will pause, and you can have 10 s where
you can tic without it affecting your tic detector clock. In other words, if you start this break timer, you can tic and it won’t start the tic detector clock over. When your 10 s break is over, the timer clock will beep. You may stop the timer by clicking this button and your tic detector clock will continue wherever it left off. Even though you are free to tic when you start your break timer, you cannot earn any tokens when the break timer is on. Throughout the session, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating of 0-100, with 0 meaning you have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud.”

**Follow instruction:**

“Now that we’ve gone through what will happen in this condition, I want you to tell me. Please repeat back what this condition looks like.”

**Contingent on errors of commission or omission:**

“You said ____ (error of commission)/You forgot to mention that in this one ____ (error of omission). Remember in this condition.... (BL, DRO, DRO-Break instructions repeated). Let’s try again. Tell me about this condition.”

**Follow instruction repeating/ Error correction:**

“That’s right. Now I am going to step out of the room. You will hear a bell and that will start the session. At the end of the session, you will hear another bell. That will be the end of the session. I will come back into the room in between sessions.”

**Urge Ratings:**

“Every 30 s, a rating scale will pop up on the computer and you will be asked to rate your urge at that moment. A thermometer will appear on the screen with a rating 0-100, with 0 meaning you have no urge to tic and 100 meaning you have a high urge to tic. Every time this appears on the screen, please tell us your urge rating out loud.”

**Preference:**

“Now, we want to find out which session type you liked the best that you want to experience. As a reminder, in the white condition, you will sit for 5 min. During this time, the tic detector will count your tics. You are free to tic as much as you please and nothing will happen whether you tic or don’t tic. In the purple condition, the tic detector will count your tics when they occur for 5 min. It will give you a token for every X s that you go without having a tic. If you have a tic, the clock will restart, and you will not get a token until X s without a tic occurs. In
the orange condition, the tic detector will count your tics and will give you a token for every $X$ s that you go without having a tic for 5 min. If you do tic, the tic clock will start over, and you will not get a token until $X$ s without a tic occurs. Here, you can pause your tic detector clock for 10 s whenever you want by clicking start on a time-out timer on the table which will pause your $X$-s tic detector clock and give you 10 s to tic without it restarting your tic clock. Before we begin, tell me what happens in each condition...Which color intervention did you prefer the most?"

**At the end of the study:**

"That is the end of the study! Thank you for participating. At the beginning of the study, I told you that the more tokens you earn, the bigger the prize you will receive. However, the amount of the gift card was set before the study began. The reason why we said that was to see if that influenced you to stop your tics. You did a great job, and I am going to give you a $10 gift card for your participation! I also told you that the tic detector counted your tics, but I actually was having it dispense tokens when you didn't engage in a tic. This was to help make sure my involvement didn't affect your tics. Do you have any questions?"
### APPENDIX C

**Datasheets**

**Primary/Reliability Datasheet**

Client: DC Initials: Primary/ Reli (Circle) Session # Condition:

**Tic Frequency:**

Directions: Tally mark within each interval the number of tics that occur. After the session is over, count the total tic frequency and denote it in the “Total Tics” box.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
<th>Tally Tics</th>
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<th>Tally Tics</th>
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</tbody>
</table>

**Tic Rate:** Calculate the rate by dividing the frequency of tics by the duration of time spent in that portion of the session (e.g., 300 seconds for a full 5-min session, 290 in DRO-Break with one break, etc.).
### Primary/Reliability Datasheet (Continued)

#### Urge Rating:

Directions: Following each vocally stated urge rating, write the data in the corresponding urge box. During DRO-Break conditions, indicate whether the urge was given during the DRO-Break (DRO on) portion by circling “DRO-On” or DRO-Break (Break End) by circling “DRO-Off.”

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
</tr>
<tr>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
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<tr>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
<td>DRO-ON DRO-OFF</td>
</tr>
</tbody>
</table>

#### Preference:

Directions: Mark an “X” under the corresponding selected intervention during the preference evaluation.

<table>
<thead>
<tr>
<th>BL</th>
<th>DRO</th>
<th>DRO-Break</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please note the “WHY” below:
## Treatment Integrity

**Participant:**

**Data Collector:**

**Date:**

**Condition:**

**Session#:**

*Directions: Indicate general session integrity by marking yes, no, or not applicable (N/A) for each corresponding integrity check.*

<table>
<thead>
<tr>
<th>General Session Integrity</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>The experimenter read the correct condition instructions to the participant.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter had participant repeat instructions back to them.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter corrected errors of commission or omission.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter had the participant repeat instructions contingent on any error of commission or omission.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter presented the correct color card in front of the participant.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter did not provide tokens during baseline.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter delivered tokens for tic suppression in DRO conditions.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The experimenter paused the timer during break periods during DRO-Break.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total:**
### Treatment Integrity (Continued)

*Directions:* Indicate whether the experimenter correctly delivered reinforcers for a tic-free interval. If the experimenter did not deliver a reinforcer for a tic-free interval appropriately, indicate whether it was an error of omission or commission (see below).

#### Reinforcer Delivery Integrity

<table>
<thead>
<tr>
<th>Correct delivery of reinforcement:</th>
<th>Incorrect delivery of reinforcement:</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>The experimenter provided a token at the end of a X-s tic-free interval within 2 s</td>
<td>Error of omission (O): The experimenter did not provide a token following X-s tic-free interval within 2 s.</td>
</tr>
<tr>
<td>Error of commission (C): The experimenter provided a token when tics occurred.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>+</th>
<th>-</th>
<th>-</th>
<th>+</th>
<th>-</th>
<th>+</th>
<th>-</th>
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<tbody>
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</table>
Preference Treatment Integrity Datasheet

<table>
<thead>
<tr>
<th>Participant:</th>
<th>Data Collector:</th>
<th>Condition:</th>
<th>Session#:</th>
<th>Date:</th>
</tr>
</thead>
</table>

Directions: Indicate general session integrity by marking yes, no, or not applicable (N/A) for each corresponding integrity check.

<table>
<thead>
<tr>
<th>General Session Integrity</th>
<th>Yes</th>
<th>No</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>The experimenter laid out each colored card on the table in front of the participant.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter stated the instructions of each condition.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter asked the participants to repeat the instructions of each condition.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The experimenter corrected errors of commission or omission.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter had the participant repeat instructions contingent on an error of commission or omission.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The experimenter asked which condition type the participant liked best.</td>
<td></td>
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</tr>
<tr>
<td>The experimenter asked why the participant preferred that condition.</td>
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</tr>
<tr>
<td>The experimenter informed the participant they would not actually experience the condition.</td>
<td></td>
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</tr>
</tbody>
</table>

**Total:**
APPENDIX D

Demographic Form

Tic Suppression Evaluation Demographic Form

Participant Code: ___________. Date ____________

1. Child’s Age: ___________

2. Child’s Gender: ___________
   1 = Male
   2 = Female
   3 = Non-binary/third gender
   4 = Prefer not to say

3. Child’s Race: ___________
   1 = White
   2 = Black or African American
   3 = Asian
   4 = American Indian/Alaskan Native
   5 = Native Hawaiian or Other Pacific Islander
   6 = Other Race (Specify) _______________________
   7 = Mixed (Specify) ________________________

4. Is your child currently taking any medications? □ NONE

<table>
<thead>
<tr>
<th>Name of Medication</th>
<th>Current Dosage</th>
<th>Date Started</th>
<th>Date Since Last Dosage Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

5. In the past 6 weeks, has your child stopped taking any medications not listed above?
   □ YES  □ NO
6. Do you plan to begin any psychotropic medication or to change the dosage of any current psychotropic medication prior to or during your possible involvement in this study?

☐ YES   ☐ NO

7. Has your child been diagnosed with any of the following?

- For each “no” ask, “Do you have any concerns your child might be experiencing symptoms of (name of problem)?”

<table>
<thead>
<tr>
<th>Problem</th>
<th>Diagnosed?</th>
<th>Concerned?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obsessive Compulsive Disorder</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>ADHD</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Major Depressive Disorder</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Anxiety Disorder (GAD, social anxiety, etc.)</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Severe Aggression</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Autism Spectrum Disorder</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Oppositional Defiant Disorder</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Conduct Disorder</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Alcohol or substance abuse or dependence</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>Mania</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>A Psychotic Disorder (Schizophrenia, Delusional Disorder, etc.)</td>
<td>Y</td>
<td>N</td>
</tr>
</tbody>
</table>