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Assessment and Treatment of Behavior Maintained by Automatic Reinforcement

A Thesis
By
Nicolette Yatros

Submitted to the Faculty of the Department of Health Professions
at Rollins College in Partial Fulfillment
of the Requirements for the Degree of

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Abstract

Two subjects diagnosed with autism spectrum disorder (ASD) and related disabilities underwent a functional analysis to ensure hand-clapping was maintained by automatic reinforcement. A secondary analysis (sensory analysis) was conducted to assess the effect of different sensory-stimulating items on responding. Finally, a function-based noncontingent reinforcement (NCR) procedure using sensory stimuli was applied to reduce the target behavior, and the schedule of reinforcement was thinned. Results showed a decrease in hand-clapping when the function-based treatment was implemented, and hand-clapping remained at low levels when the schedule of reinforcement was thinned. This research further elucidates how NCR can impact behavior maintained by automatic reinforcement.

Keywords: automatic reinforcement, functional analysis, noncontingent reinforcement, sensory analysis, treatment

Introduction

Autism Spectrum Disorder (ASD) is a prevalent disability that affects nearly 1 in 68 children (Centers for Disease Control and Prevention, 2014). ASD is characterized by deficits in communication, difficulty with social interactions, and stereotypic motor movements (American Psychiatric Association, 2013). As ASD is a behavioral diagnosis, individuals with ASD often present with behavioral excesses and deficits in these three domains. For example, Osterling, Dawson, and Munson (2002) found infants with ASD engage in less social interaction, more repetitive motor motions (i.e., stereotypy), and use gestures rather than vocal behavior (e.g., cooing and babbling) compared to infants who are typically developing. Other research has shown individuals with ASD more commonly exhibit difficulty or delays with language acquisition, production, and comprehension compared to neurotypical peers (Mitchell et al., 2006). Research has shown a common link between individuals with language delays and behavior considered problematic (Carson, Klee, Perry, Muskina, & Donaghy, 1998; Beitchman, Nair, Clegg, Ferguson, & Patel, 1986; Irwin, Carter, Briggs-Gowan, 2002). A lack of appropriate means to communicate could lead to individuals engaging in problematic behavior (e.g., self-injurious behavior; SIB) to access reinforcers in their environment (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994a).

While several therapies have been used to improve behavioral excesses and deficits in individuals with ASD, few are empirically supported. The field of Applied Behavior Analysis (ABA) has been empirically supported in treating behavior disorders among individuals diagnosed with ASD and related disabilities (Foxx, 2008). Additionally, David Satcher, the United States Surgeon General in 1999, endorsed the field of ABA acknowledging over 30 years of research demonstrating effective procedures for increasing appropriate behavior while

decreasing inappropriate behavior. ABA evaluates changes in an individual's behavior caused by operant and respondent conditioning. The field of ABA assesses behavior by manipulating the environment to determine what variables reinforce or punish behavior. Following assessment, therapists change the contingencies for behavior to promote appropriate behavior and decrease inappropriate behavior.

To decrease problem behavior (e.g., aggression or disruption), a behavior analyst must first identify the variables that maintain the behavior. The functional analysis (FA) is the gold-standard method to identify the function(s) of problem behavior by exposing an individual to a variety of conditions in which different consequences are administered contingent on a target response (Iwata et al., 1994a). FA results inform treatment selection, targeting the maintaining variable identified through the FA (Chock, Shlesinger, Struder, & Bird, 2012)

While all FAs do not necessarily test the same variables, often these analyses include the following conditions (Beavers, Iwata, & Lerman, 2013). The "social disapproval" (attention) condition consists of the therapist ignoring the subject and only giving attention contingent on the target behavior. The "academic demand" (demand) condition includes the presentation of task demands, and contingent on the target behavior, the demand is removed and later re-introduced. The subject is alone in the room without any additional stimuli during the "alone" condition. In an "unstructured play" (toy play) condition, the subject is permitted to play with toys and receives verbal praise and brief physical contact from the therapist contingent on the absence of the target behavior. Responding in a control condition (unstructured play) is compared to the level of target behavior in several test conditions.

While behavior maintained by social reinforcement is mediated by another person (e.g., attention, access to items, escape from demand), behavior maintained by automatic

reinforcement suggests the target behavior produces its own reinforcement (Risley, 1968). There are two patterns of responding in an FA that indicate an automatic function. The first is high levels of a target behavior across FA conditions, and the second is higher levels of a target behavior in the alone compared to the other conditions. According to Beavers et al. (2013), behavior maintained by automatic reinforcement accounts for about 16.9% of behavioral functions, a large proportion of the maintaining variable(s) for problem behavior. Although the topography of a behavior does not necessarily indicate the function of that behavior, some topographies of behavior most often shown to be maintained by automatic reinforcement include self-induced emesis (Wunderlich, Vollmer, & Zabala, 2017), pica (Saini et al., 2016), and stereotypic behavior (Rapp & Vollmer, 2004). Hand-clapping is often considered a form of stereotypy (Ahrens, Lerman, Kodak, Worsdell, & Keegan, 2011) and was the focus of the current study.

Treatments that target the maintaining variable of a behavior are called function-based treatments and are often more effective than treatments or stimuli selected arbitrarily (Iwata, Pace, Cowdery, & Miltenberger, 1994b). For example, if a child engages in escape-maintained tantrums when directed to complete an academic demand, a functional treatment might involve not allowing escape (i.e., escape extinction). An arbitrary (or nonfunctional) treatment involves selecting an intervention that does not necessarily target the function of a behavior. Considering the example above, if time-out was selected as an intervention arbitrarily, the child's problem behavior might worsen over time because escape is being delivered contingent on problem behavior. To demonstrate the need for functional treatments, Iwata et al. (1994b) exposed three individuals with behavior maintained by different functions to different procedural forms of extinction (i.e., attention extinction, escape extinction, and sensory extinction). For behavior

maintained by attention, the authors used attention extinction where the therapists would ignore or not provide attention for target behavior. For behavior maintained by escape, the authors used escape extinction during which the therapists would not allow the individual to escape the completion of a task or demand. For behavior maintained by sensory stimulation, the authors used sensory extinction where the therapists would block access to a sensory consequence that maintained the target behavior. The results showed only the functional form of extinction reduced problem behavior. Therefore, to ensure a functional treatment is selected, an FA should be conducted. However, prior to the development of formal analyses of environmental variables maintaining behavior, treatments and stimuli used in treatments were likely arbitrarily selected, or researchers defaulted to punishment procedures that did not require the identification of a functional reinforcer (Pelios, Morren, Tesch, & Axelrod, 1999).

Another reason arbitrarily selected treatments and/or stimuli might be used is if the maintaining variables cannot be identified or if they are difficult to withhold (e.g., high-magnitude SIB maintained by attention might be difficult to ignore; Fischer, Iwata & Mazaleski, 1997). For example, Mazaleski, Iwata, Vollmer, Zarcone, and Smith (1993) found the delivery of music in a DRO effectively decreased SIB maintained by attention. While studies have shown arbitrarily selected treatments or stimuli can work, a problem could arise if greater response effort is required to engage with the arbitrarily selected item (or replacement behavior) compared to engaging in problem behavior (Richman, Wacker, & Winborn, 2001). Additionally, arbitrarily selected treatments/stimuli could cause treatment failure because they do not always offer the same reinforcing properties as the target behavior, leaving the motivating operation for the target behavior in effect. Although this is not exemplified in the above studies, this could be a problem for some individuals, especially if problem behavior is maintained by automatic reinforcement.

Automatic reinforcement does not provide much information about the maintaining variable for problem behavior beyond that the behavior produces its own source of reinforcement (Hagopian, Rooker & Zarcone, 2015). However, by identifying the sensory modality of the reinforcement maintaining the target behavior, a function-based procedure can be implemented. A variety of treatments have previously been shown to decrease problem behavior maintained by automatic reinforcement ranging from SIB to hand flapping. These treatments can be categorized into punishment and extinction, differential reinforcement, and noncontingent reinforcement.

Review of Literature

Punishment and Extinction Interventions

Punishment has been shown to be an effective treatment for several topographies of problem behavior maintained by automatic reinforcement (Ahearn, Clark, MacDonald, Chung, & Dube, 2007; Lerman & Iwata, 1996; Love, Miguel, Fernand, & LaBrie, 2012; Wunderlich et al., 2017; Smith, Russo, & Le, 1999) or of unknown function (Dorsey, Iwata, Ong & McSween, 1980; Risley, 1968; Sajwaj, Libet & Agras, 1974). Prior to the development of the FA, punishment procedures used contingent delivery of an aversive stimulus to effectively decrease problem behavior. Risley (1968) used contingent electric shock to eliminate one subject's disruptive climbing. This was done both in a laboratory and home setting. Sajwaj et al. (1974) implemented a contingent lemon juice procedure to reduce the life-threatening rumination of a six-month-old infant. The lemon juice was administered by squirting small amounts into the infant's mouth contingent on a precursor behavior of a specific tongue movement. Finally, Dorsey et al. (1980) used contingent water misting to reduce severe topographies of SIB including hand-biting and head-banging. Although these punishment procedures have been effective in the past, they are not commonly implemented because of the ethical problems they

pose such as not allowing subjects the right to a least-restrictive intervention (Behavior Analyst Certification Board Code of Ethics, section 2.0).

Recently, less-intrusive punishment interventions have been used for behavior maintained by automatic reinforcement. These include interventions such as response interruption and redirection (RIRD; Ahearn et al., 2007; Love et al., 2012; Ahrens et al., 2011) and response blocking (Lerman, & Iwata 1996; Wunderlich et al., 2017). Both methods interrupt a response and either redirect the subject (RIRD) or prevent the behavior from occurring (blocking). RIRD is the presentation of a stimulus to interrupt a target response and redirect the subject to engage in a different behavior (Love et al., 2012). For example, vocal stereotypy might be interrupted by asking a question that requires a vocal response.

Ahearn et al. (2007) and Love et al. (2012) evaluated the effects of RIRD on vocal stereotypy in classroom and clinical settings, respectively. Ahearn et al. trained a teacher to issue academic demands contingent on the occurrence of the target behavior until the student complied with three consecutive demands. Love et al. effectively implemented RIRD and reduced stereotypy through interruption. The therapist would call the subject's name and issue a demand that required a vocal response. RIRD has also been used to reduce motor stereotypy maintained by automatic reinforcement (Ahrens et al., 2011). To interrupt motor stereotypy, Ahrens et al. trained the therapist to instruct the subject to engage in different motor movements (e.g., "Pat your belly"). Although RIRD was found to be effective in each of these studies, it might not be the best option for other topographies of behavior such as head-banging. For example, RIRD requires some level of compliance from the subject which might be difficult to prompt while severe behavior is being emitted. Treatments such as response blocking might be a better

treatment option for these behaviors (e.g., pica) because the behavior can be physically harmful to the individual and might require immediate intervention that blocks all attempts.

Response blocking is an intervention used to prevent an individual from contacting the reinforcing consequences of a target behavior. There have been conflicting results about the mechanism responsible for the effectiveness of response blocking; it could function as a positive punishment procedure by delivering an aversive stimulus contingent on a specific behavior (Lerman & Iwata, 1996), or it could function as an extinction procedure by eliminating the response-reinforcer relationship (Smith et al., 1999). One way to determine the mechanism responsible for response blocking is to manipulate treatment integrity. Lerman and Iwata (1996) compared the implementation of response blocking with perfect (100%) and less-than-perfect treatment integrity. The authors suggested that if the procedure functions as extinction, the target behavior will occur at a higher level when response blocking is implemented with less-than-perfect treatment integrity compared to 100% treatment integrity. However, if the procedure functions as punishment, the target behavior will likely remain at low levels even under imperfect treatment-integrity conditions (i.e., an intermittent schedule of punishment). Another way to determine the mechanism responsible for response blocking is to analyze how quickly problem behavior decreases through visual analysis. If blocking functions as extinction, one might expect an increase in responding (i.e., an extinction burst) followed by a gradual decrease in problem behavior. This is consistent with the results seen in Smith et al. (1999). Conversely, if blocking functions as punishment, one would expect rapid decreases in problem behavior. This is consistent with the results seen in Lerman and Iwata.

While punishment procedures have been shown to be effective, the field of behavior analysis is moving toward the use of reinforcement-based procedures (Pelios et al., 1999). Pelios

et al. (1999) found an increase in reinforcement-based treatments over punishment-based interventions from 1981 to 1997 likely due to the development of the FA. Additionally, as stated in the Behavior Analyst Certification Board Code of Ethics (section 2.0), Board Certified Behavior Analysts (BCBA[®]) are to use the least-restrictive procedure, such as extinction, to change a target behavior.

Extinction involves withholding a reinforcer contingent on a target response that previously produced reinforcement (Iwata et al., 1994b) and includes various forms (defined above): attention extinction, sensory extinction and escape extinction. Iwata et al. (1994b) showed withholding access to the maintaining variable (e.g., sensory extinction for target behavior maintained by automatic reinforcement) was effective in reducing the target behavior while another form of extinction (e.g., attention extinction for the same behavior) was not successful. Iwata et al. revealed the need to implement a treatment based on the function of the behavior. Smith et al. (1999) and Roscoe, Iwata and Goh (1998) used sensory extinction in different forms (e.g., response blocking and protective gear) to treat target behavior maintained by automatic reinforcement. Smith et al. used sensory extinction in the form of response blocking to reduce eye poking, whereas Roscoe et al. used protective gloves to prevent a subject from contacting the reinforcement provided by arm rubbing.

Extinction's effectiveness as a treatment is dependent on the functional implementation of the procedure (Iwata et al., 1994b). Other reinforcement-based interventions have been used in conjunction with or in lieu of extinction. These include differential reinforcement where an alternative behavior or the omission of behavior is reinforced as well as noncontingent reinforcement where a stimulus is delivered regardless of the subject's behavior.

Differential Reinforcement Interventions

Differential reinforcement (DR) consists of providing reinforcement for responses within a response class while not providing reinforcement for responses that do not meet criteria (Cooper, Heron & Heward, 2014). This reinforcement-based treatment has been successfully implemented to treat problem behavior maintained by automatic reinforcement (Patel, Carr, Kim, Robles, & Eastridge, 2000; Toussaint & Tiger, 2012). There are several ways to use DR, among the most common are differential reinforcement of alternative behavior (DRA) and differential reinforcement of other behavior (DRO) (Vollmer & Iwata, 1992). DRA involves teaching an alternative response to replace a target behavior, whereas DRO involves providing reinforcement contingent on the absence of a target behavior.

Some studies have tested DRA with behavior maintained by an unknown function (e.g., Horner, 1980) as well as automatic reinforcement (Lindberg, Iwata, & Kahng, 1999). Horner (1980) used a DRA procedure to decrease target behavior such as throwing silverware during meals and to increase appropriate play (e.g., puzzle play). The results show this method was effective in decreasing problem behavior while increasing appropriate behavior. Lindberg et al. (1999) implemented a DRA procedure to increase object manipulation with two subjects who engaged in SIB maintained by automatic reinforcement. Results showed the DRA procedure was effective in decreasing SIB while increasing appropriate object manipulation.

Other studies have used DRO to decrease problem behavior. Some researchers have used DRO to decrease covert problem behavior (i.e., behavior that occurs when no one else is around) monitored via video surveillance (Toussaint & Tiger, 2012; Cowdery, Iwata and Pace, 1990 respectively). Toussaint and Tiger (2012) implemented a variable momentary DRO to reduce covert skin-picking maintained by automatic reinforcement. At the end of the DRO interval, the therapist walked in the room and delivered a token or praise if the subject did not engage in skin-

picking during the interval. The subject was video monitored from another room to measure skin-picking in the absence of the therapist. Cowdery et al. (1990) implemented an escalating DRO schedule observed via video surveillance for a subject who engaged in stereotypic scratching. If the subject did not engage in scratching during the interval, the clinician would give the subject a penny (that could be exchanged for backup reinforcers). If the subject did engage in the target behavior, he was instructed to try again to earn the penny. The escalating schedule of increasing the duration of DRO intervals was an effective treatment.

DRO has also been used to decrease overt SIB (Patel et al., 2000; Repp and Deitz, 1974). Patel et al. (2000) assessed sensory stimuli to identify the modality of sensory reinforcement that maintained rapid tongue movements and SIB for two subjects. They implemented a DRO procedure in which the authors delivered stimuli identified to be highly preferred and within the same sensory class as the target behavior (e.g., vibrating toothbrush for rapid tongue movements and vibrating head massager for SIB). The items were delivered contingent on the nonoccurrence of target behavior. Repp and Deitz (1974) implemented a DRO procedure with four subjects who engaged in different topographies of SIB maintained by unknown functions. During the implementation of the DRO, if the subject did not engage in the target behavior, he or she was given a reinforcer (e.g., candy, tokens, or toys); however, if the subject did engage in target behavior, a time-out or verbal reprimand was issued. Across all the above applications of DRO, target behavior was effectively decreased.

While DR was effective in the previous cases, other studies have found DR to be an ineffective method to reduce problem behavior (e.g., Harris & Wolchick, 1979). Harris and Wolchik (1979) conducted a study with three experiments in which the authors implemented DRO with four subjects who engaged in self-stimulation (i.e., clapping hands, repetitive hand

motions, etc.). In Experiment 1, the DRO consisted of providing social reinforcement (e.g., “good sitting”) and a gentle stroke on the subjects’ arms or hands after every other academic task if subjects had not engaged in the target behavior. The same procedure was used in Experiment 2; however, physical touch was not used. In Experiment 3, sessions took place during play activities where subjects were socially reinforced for appropriate play every 20 s. If subjects did not engage in target behavior for 5 s after the 20 s interval, they would receive food. The results showed DRO was not an effective method in reducing target behavior and in fact only had minimal impact on two of four subjects’ behavior.

DR might not be effective if items identified through preference assessments are not of equal or greater reinforcing value as reinforcement provided by the target behavior (Toussaint & Tiger, 2012). Further, identifying items of equal or greater value for behavior maintained by automatic reinforcement is difficult (Vollmer, Peters, & Slocum, 2015). In addition to not always being effective, DR might be more difficult for therapists to implement than other methods for treating behavior maintained by automatic reinforcement (Patel et al., 2000). In cases such as this, other treatments such as NCR should be considered because, in this treatment, functional reinforcers are delivered regardless of the occurrence of target behavior such that individuals contact the functional reinforcer for problem behavior without a contingency. This allows the individual to become satiated on the reinforcer (i.e., reduces the motivating operation to engage in the target behavior to access the reinforcer). NCR could be more beneficial to individuals with low discriminative abilities (in which case DRO would probably not be successful), as well as those who engage in high frequency target behavior such that a DRO might not allow subjects to contact new contingencies to earn the reinforcement. NCR might also be easier for caregivers to implement.

Noncontingent Reinforcement Interventions

Noncontingent reinforcement (NCR) is a procedure in which access to a reinforcer is provided on a fixed-time or variable-time schedule not contingent on an individual's behavior. NCR is used to satiate the individual with respect to the functional reinforcer (i.e., it acts as an abolishing operation, AO) and has produced variable treatment effects for behavior maintained by automatic reinforcement (Phillips, Iannaccone, Rooker, & Hagopian, 2017; Saini et al., 2016). Providing access to arbitrary stimuli (environmental enrichment; Horner, 1980), providing access to highly preferred stimuli (Phillips et al., 2017; Lindberg, Iwata, Roscoe, Wordsell & Hanley, 2003), and providing access to stimuli that provide a similar stimulation as the target behavior (matched stimuli; Rapp, 2006) involve the presentation of stimuli independent of responding, and therefore can be conceptualized as variations of NCR. These procedures are often implemented with extinction. For example, matched stimuli might be provided noncontingently while the target behavior is blocked.

Environmental enrichment involves placing a variety of stimuli with potential reinforcing qualities in an environment (Vollmer et al., 1994). While it has been shown to be effective when implemented independently (Vollmer et al., 1994), it has also been shown to produce better results when combined with other treatments (Horner, 1980). Vollmer et al. (1994) tested the effectiveness of environmental enrichment on the reduction of SIB such as head banging, face hitting, and hand mouthing maintained by automatic reinforcement. The authors found environmental enrichment was an effective treatment when implemented alone. Horner (1980) used environmental enrichment to treat the problem behavior (of unknown function) of subjects in an institutional ward. Horner compared the use of environmental enrichment alone to a combination with DRA. Results showed a greater change in target behavior when subjects were

exposed to the combined treatment of environmental enrichment with DRA than when exposed to environmental enrichment alone. While environmental enrichment has been effective in the above-mentioned cases, there is not overwhelming support that enrichment reliably reduces behavior maintained by automatic reinforcement. This might be because environmental enrichment uses arbitrarily selected stimuli instead of items that have been identified to be preferred or within the same sensory class as the maintaining variable.

Another method of NCR involves presenting items determined to be highly preferred via preference assessments. Phillips et al. (2017) analyzed treatment effects for subjects diagnosed with various developmental disabilities who engaged in severe problem behavior maintained by automatic reinforcement. Results showed NCR with highly preferred items was effective in treating problem behavior; however, the authors determined other treatment components were necessary to decrease problem behavior to socially acceptable levels for 5 of the 9 subjects. Lindberg et al. (2003) evaluated the effects of NCR with highly preferred items for individuals who engaged in SIB maintained by automatic reinforcement. The authors allowed access to highly preferred items during NCR conditions. The results showed that when noncontingent access to highly preferred stimuli was used, SIB decreased. Lindberg et al. also assessed the use of NCR with constant access to one highly preferred item compared to sessions where a variety of preferred stimuli were available for two of the three subjects. The condition with a variety of stimuli was more effective in maintaining reduced levels of SIB than the condition with one highly preferred item. These findings suggest NCR with preferred stimuli can be an effective treatment but providing a variety of stimuli might be necessary. It is possible an item presumed to provide similar stimulation to the target behavior, or a matched stimulus, would be more effective than selecting an item solely based on preference. Similar to the argument presented

earlier, the use of matched stimuli might be conceptualized as a function-based intervention rather than an arbitrarily selected one that does not directly address behavioral function.

NCR in the form of matched stimuli includes items identified to meet the same sensory function as the target behavior; matched stimuli has been found to effectively reduce behavior maintained by automatic reinforcement (Piazza et al., 2000; Rapp, 2006; Rincover, Cook, Peoples, & Packard, 1979). Piazza et al. (2000) tested the effect of both functionally matched and arbitrarily selected stimuli. For example, a subject was exposed to an edible as a functionally matched stimulus and a toy car as an arbitrarily selected stimulus for hand mouthing. Functionally matched stimuli were largely more effective in reducing behavior maintained by automatic reinforcement compared to arbitrarily selected stimuli. These stimuli were presumably more effective because they provided the same sensory stimulation or modality that maintained the target behavior. Rapp (2006) also used matched stimuli to treat the stereotypic behavior of one subject who was given noncontingent access to a stimulus that likely provided the same sensory stimulation as the target response. However, one of the critiques of this study was that a preference assessment was conducted to identify items that were preferred and *possibly* produced similar sensory reinforcement as the target behavior instead of conducting a formal analysis of sensory consequences in which the different modes of sensory reinforcement were assessed.

Rincover et al. (1979) assessed modalities of sensory reinforcement of self-stimulatory behavior. The authors implemented a sensory extinction procedure where different sensory consequences were eliminated (e.g., for a subject who engaged in finger-flapping hypothesized to be maintained by visual stimulation, a blindfold was used). Once the sensory modality was confirmed, items that produced similar sensory stimulation as the target behavior were presented noncontingently in a reversal design. The results showed noncontingent access to matched items

was effective in reducing target behavior even in follow-up sessions 13 months later. Rincover et al. adds to the literature by showing that identifying the mode in which sensory reinforcement is maintained can be used to produce a functional treatment for behavior maintained by automatic reinforcement.

Schedule Thinning

Many studies have evaluated different forms of schedule thinning with NCR procedures to decrease problem behavior maintained by social reinforcement (Hagopian, Crockett, Stone, DeLeon, & Bowman, 2000; Hagopian, Toole, Long, Bowman, & Lieving, 2004; Kahng, Iwata, DeLeon, & Wallace, 2000). Schedule thinning was effective in the above cases; however, few studies have been conducted with subjects whose behavior is maintained by automatic reinforcement (e.g., Ward & Higbee, 2008; Carr, Dozier, Patel, Adams, & Martin, 2002).

Kahng et al. (2000) compared two methods of schedule thinning for three subjects who engaged in SIB maintained by positive reinforcement in the form of access to tangible items. The authors compared a fixed-time versus an adjusted interresponse time (IRT) schedule of reinforcement at initial implementation as well as throughout the thinning process. IRT schedules were determined individually based on the time between instances of SIB in baseline. Both forms of schedule thinning maintained low levels of SIB. Other research has compared schedule thinning of NCR alone and NCR with DR and extinction in a reversal design (Hagopian et al., 2000). Results showed both were effective in reducing target behavior maintained by different variables. However, as the schedule of NCR alone was thinned, the target behavior increased. When the NCR schedule was thinned with DR and extinction, thinning was more effective. Although their NCR thinning procedure was ineffective when NCR was implemented

alone, the authors only conducted this part of the evaluation with one subject; therefore, schedule thinning with NCR alone requires further analysis.

Hagopian et al. (2004) compared the effects of a dense-to-lean and a fixed-lean schedule of NCR with one subject who engaged in severe problem behavior maintained by access to a variety of stimuli. With the former, reinforcement was initially delivered on dense schedules of reinforcement followed by leaner schedules. With the latter, reinforcement was delivered on a lean schedule from the outset of schedule thinning. The procedures were similarly effective, and the fixed-lean schedule produced faster results compared to the dense-to-lean thinning procedure for two of the three subjects.

Other studies have evaluated the use of NCR using a multiple schedule of reinforcement (Hagopian, Bruzek, Bowman, & Jennett, 2007; Slocum, Grauerholz-Fisher, Peters, & Vollmer, 2018; Rapp, 2006). Hagopian et al. (2007) conducted a study using a multiple schedule of reinforcement with two components for two subjects who engaged in SIB with inconclusive FA results. Because problem behavior was reported to occur when there was an interruption of an ongoing activity, the authors implemented signal cards to reduce levels of problem behavior when free play was interrupted. Two cards were introduced; one card signaled the subject could engage in uninterrupted play, and the other card signaled play would be interrupted with a demand, and compliance would lead to reinforcement. The duration of the first card (uninterrupted play) remained at 1 min throughout all sessions and alternated with the latter card (interrupted play) as the duration of interruptions increased (i.e., 10 s, 30 s, 1 min, 1.5 min, and so on). Results showed this was an effective treatment for both subjects.

Slocum et al. (2018) began treatment by providing signaled continuous access to the functional reinforcer throughout the entire session for three subjects who engaged in aggression

maintained by social-positive reinforcement. To thin the schedule, the authors slowly increased the time in which the functional reinforcer was unavailable (i.e., signaled extinction was in place for 10 s of the session, then 30 s, 60 s, and so on). Over time, the researchers thinned the NCR schedule such that subjects had access to the functional reinforcer for half of the session and were exposed to extinction for the other half while maintaining low levels of aggression across subjects.

While many studies have evaluated NCR with socially mediated behavior, few studies have assessed schedule thinning with NCR as treatment for behavior maintained by automatic reinforcement (e.g., Ward, & Higbee, 2008; Carr et al., 2002). Ward and Higbee (2008) implemented NCR schedule thinning with one subject who engaged in tub-standing. The initial schedule of reinforcement was FT 2 min. At the end of the 2 min interval, the child was given free access to a preferred bath toy for 30 s. The schedule of reinforcement was then thinned to FT 3 min. The authors were successful in thinning the schedule of reinforcement for a subject with target behavior maintained by automatic reinforcement. Carr et al. (2002) used an NCR procedure with one individual to decrease object mouthing maintained by automatic reinforcement. The authors found NCR was not an effective procedure when implemented independently and therefore the researchers included other treatment components such as response blocking. Every 10 s, the subject would have access to a matched stimulus for the next 30 s. The authors successfully thinned the schedule of reinforcement to delivering a matched stimulus for 30 s every 300 s (FT 300 s). Although NCR was not effective independently, it was successful when response blocking was introduced. One reason NCR might not have been effective independently is that the items were selected via a preference assessment as opposed to being selected based on the sensory modality maintaining the target behavior (e.g., taste, texture,

temperature). Schedule thinning was successful for both studies using NCR procedures with behavior maintained by automatic reinforcement; however, more research is needed in this area.

Statement of the Problem

Previous research has shown behavior maintained by automatic reinforcement is prevalent across clinical and classroom settings (Beavers et al., 2013). Many behavior-analytic interventions have been found to be effective at reducing behavior maintained by automatic reinforcement, including punishment using aversive stimulation (e.g., Risley, 1968), RIRD (e.g., Ahearn et al., 2007), response blocking (e.g., Smith et al., 1999), extinction (e.g., Roscoe et al., 1998), differential reinforcement (e.g., Toussaint & Tiger, 2012), environmental enrichment (e.g., Vollmer et al., 1994), access to preferred items (e.g., Phillips et al., 2017), and matched stimuli (e.g., Rapp, 2006). That said, there are still gaps in the literature on reinforcement-based treatments, like NCR, based on a sensory analysis (Rincover et al., 1979) to reduce behavior maintained by automatic reinforcement.

First, Rincover et al. (1979) examined various topographies of behavior maintained by automatic reinforcement and found each topography was maintained by different sensory variables. The current study examined the same topography of behavior (i.e., both subjects engaged in hand-clapping) to see if different individuals engage in the same behavior for different reasons. Second, Rincover et al. assessed only the modality of sensory reinforcement hypothesized to maintain the target behavior for each subject during the assessment of sensory reinforcement. For example, for behavior hypothesized to be maintained by visual stimulation, lights in the room were turned off. The current study employed an analysis of various potential modalities of sensory reinforcement (i.e., for behavior hypothesized to be maintained by tactile stimulation, we also assessed visual and auditory stimulation). Third, Rincover et al. did not

included schedule thinning. This is a limitation because it is not feasible to implement continuous treatment without thinning and/or fading the matched stimulus. In the current study, we thinned the schedule of reinforcement to socially appropriate levels. Fourth, Rincover et al. did not evaluate both a) stimuli that might possess reinforcing properties such that their presentation might act as noncontingent reinforcement and b) stimuli that prevent contact with the reinforcing consequence of engaging in the target behavior such that their presentation might act as sensory extinction. In the current study, our analysis of sensory reinforcement included stimuli that were predicted to have *either* noncontingent reinforcement *or* extinguishing qualities.

The purpose of this study was to first conduct an FA to determine hand-clapping was maintained by automatic reinforcement and subsequently to determine the source of automatic reinforcement or sensory stimulation maintaining hand-clapping. We selected hand-clapping for several reasons. First, it is a behavior that can appeal to a variety of sensory modalities (e.g., it could be maintained by visual, tactile, or auditory stimulation) while some behaviors such as pica would likely not be maintained by visual or auditory reinforcement. Additionally, NCR with matched stimuli can be implemented to treat hand-clapping without the use of response blocking, which might be ethically necessary if another topography such as SIB was included. Further, this study required two separate assessments (an FA and a sensory analysis) prior to the implementation of treatment, which required treatment to be withheld longer than typical. Again, this might not have been ethically appropriate for severe behavior. Following successful treatment of hand-clapping using noncontingent access to matched stimuli, the NCR schedule was thinned using multiple-schedule procedures similar to Slocum et al. (2018).

Method

Subjects, Setting, and Materials

We recruited two subjects attending Rollins College practicum clinics for applied behavior analysis (ABA) therapy for this study. We obtained consent from guardians, and we only included subjects whose behavior plans did not address the target behavior. Sam was a 9-year-old boy diagnosed with ASD and Fragile X. Micah was a 15-year-old boy diagnosed with ASD, obsessive compulsive disorder, and epilepsy. Both subjects engaged in inappropriate hand-clapping (defined below). Hand-clapping might seem harmless; however, it can be a hindrance to academic achievement as well as a disruptive to peers. This behavior had also caused damage to Micah's wrist in the past.

We conducted sessions in therapy rooms at the subjects' clinics. Sam's session room was 2.44 m by 2.89 m, and Micah's session room was 4.57 m by 6.10 m. Each room contained a table, two chairs, and stimuli needed for various conditions. Materials for the FA included academic demand materials and leisure items in some conditions described in more detail below. Materials for the sensory analysis consisted of a video of another person clapping recorded on an iPad, a hand-clapping audio recording on an iPad, sound-proof headphones, gloves, and a vibrating hand massager. Treatment included one or more items from the sensory analysis. Due to reactivity to recording devices, Sam's sessions were not recorded. For Micah, we recorded all sessions on an iPad.

Response Measurement, Interobserver Agreement, and Treatment Integrity

We defined the target behavior, hand-clapping, as the subject opening his hands with a distance of 2 in or more followed by closing the hands. Additionally, for Micah, hand-clapping included tapping his thighs, stomach, and feet with open palms from 2 in or more. We measured this behavior using rate (responses per min). Two observers independently scored responses across 50% of Sam's and 50% of Micah's sessions to obtain interobserver agreement (IOA). We

calculated IOA using a 10-s exact interval-by-interval method. For each interval, if both observers scored the same number of instances of target behavior (e.g., one observer scored 9 and the other scored 9), that interval was considered an agreement. If the two observers scored a different number of instances of target behavior (e.g., one observer scored 9 and the other scored 10), that interval was considered a disagreement. We divided the total number of agreements by the total number of intervals and multiplied by 100 to obtain a percentage for each session. For Sam, IOA was 96% (range, 83% to 100%), and for Micah, IOA was 95% (range, 80% to 100%).

We collected treatment integrity data throughout 50% of treatment sessions for Sam and 50% of treatment sessions for Micah using a 6-point checklist. A data collector scored “Yes” or “No” for each item in Appendix A. If an item was not appropriate for a session, the data collector scored “n/a,” and we altered the denominator accordingly (e.g., one item states the correct schedule thinning procedure was used, but not all sessions used a thinning schedule). We added up the number of “Yes’s”, divided by 6, and multiplied by 100 to obtain a percentage. For Sam, treatment integrity was 97% (range, 80% to 100%), and for Micah, treatment integrity was 96% (range, 80% to 100%).

Procedure

We used an alternating treatments design for the FA and sensory analysis; we used a reversal design to evaluate treatment. Sessions were 5 min across all phases. Attempts to engage in hand-clapping had no programmed consequences (i.e., response blocking was not used). We analyzed data using visual analysis of the rate of responding across conditions.

Phase I: Functional Analysis (FA). We began by conducting an FA of hand-clapping based on procedures described by Iwata et al. (1994a) with some modifications. We included demand, attention, play and no-interaction conditions. The *demand* condition consisted of the

therapist presenting academic demands to the subject continuously using a least-to-most prompting sequence. We selected demands based on current clinical targets for each subject. For Sam the demand was to match pictures of house hold items, and for Micah, the demand was to clean up task materials. If the subject engaged in hand-clapping, the therapist responded with “ok, you don’t have to,” and removed the demand for 30 s before representing the demand.

In the *attention* condition, the subject had continuous access to a moderately preferred leisure item identified through a free operant preference assessment (FOPA; Roane, Vollmer, Ringdahl, & Marcus, 1998). The therapist told the subject, “I have work to catch up on; you sit here until I’m finished.” If the subject engaged in hand-clapping, the therapist interjected a brief reprimand (e.g., “stop that”). The *play* condition consisted of the subject having continuous access to attention from the therapist as well as access to a highly preferred item identified through the FOPA mentioned above. This condition served as our control. Finally, the *no-interaction* condition consisted of the subject and therapist in a room without any toys or demands. The therapist did not interact with the subject. To further confirm the behavior was maintained by automatic reinforcement, we included an extended no-interaction phase similar to Querim et al., (2013) at the completion of the alternating treatments FA.

Phase II: Sensory Analysis. In our sensory analysis, we assessed a subset of potential sources of sensory reinforcement. We included 6 items total: video, audio recording, sound-proof headphones, gloves, vibrating hand massager, and lights off. We included two items for each sensory modality; one item possessed modality-specific reinforcing qualities (e.g., audio recording of hand-clapping), and the other item possessed potential extinction qualities or prevented the subject from contacting reinforcement (e.g., sound-proof headphones to prevent sound produced by hand-clapping). Before beginning Phase II, we conducted forced exposure to

all stimuli to reduce the likelihood the suppression of hand-clapping would be due to novelty rather than competing sensory stimulation (Rincover et al., 1979). We exposed both subjects to each item three times for 1 min in a random order. Subsequently, we began the sensory analysis to analyze potential sensory modalities associated with the target behavior. We alternated the presentation of each item in an alternating treatments design to see which condition resulted in the lowest level of hand-clapping.

The *no-interaction* condition was identical to the no-interaction condition of the FA. This condition served as our baseline against which we compared the level of hand-clapping in other conditions. Across all test conditions, unless otherwise noted, sessions were identical to the no-interaction condition. To test if visual stimulation was the source of automatic reinforcement for hand-clapping, we conducted a *lights-off* and a *video* condition. In the lights-off condition, lights were turned off for the duration of the session. Darkness acted as sensory extinction for hand-clapping maintained by visual stimulation. The *video* condition included a video of someone hand-clapping without sound. This condition resembled a matched stimulus treatment in that a video of clapping might have provided similar reinforcement if visual stimulation was the variable maintaining hand-clapping. To test for auditory stimulation, we introduced a pair of *sound-proof headphones* and an *audio recording* condition. The sound-proof headphones condition involved the subject wearing sound-proof headphones. If hand-clapping was maintained by auditory stimulation, this condition resembled a sensory extinction procedure. In the audio recording condition, we played the sound of clapping throughout the session; this resembled a matched stimulus procedure if auditory stimulation was the reinforcer for hand-clapping.

To test for tactile sensory stimulation, we introduced a *glove* and *vibrating massager* condition. For the glove condition, the subject wore shock-absorbent gloves to eliminate any tactile reinforcement that might have been provided by hand-clapping. Again, this could have resembled sensory extinction if tactile stimulation was the maintaining reinforcer for hand-clapping. Alternatively, a vibrating massager was tested as a matched stimulus procedure where the subject had access to a vibrating massager for the duration of the session.

Across conditions, attempts to interrupt the sensory stimulus were blocked (e.g., attempts to remove gloves, turn lights back on, etc. were all blocked). In addition, across sessions we prompted subjects to interact with items using a least-to-most prompting hierarchy to engage with the item every 5 s if he stopped doing so. The therapist initially used a verbal prompt such as “Play with the hand massager.” If the subject did not engage with the stimulus after 5 s, the therapist used a gestural prompt pointing towards the stimulus. If the subject did not engage with the stimulus again after 5 s, the therapist used a physical prompt. The condition that produced lowest levels of hand-clapping was the condition selected to be used in the treatment phase. If multiple conditions in Phase II produce low levels of hand-clapping, we allowed the caregivers to select which intervention they would prefer.

Phase III: Treatment. After the sensory analysis, we implemented an extended treatment for each subject within a reversal design. We used data from the no-interaction condition of Phase II as our initial baseline. For Sam and Micah, the vibrating hand massager was used for treatment.

To add to our experimental control, we added a procedure from Iwata et al. (1994b). In their study, in addition to evaluating the form of extinction matched to the function of behavior, such as ignoring for problem behavior maintained by attention, they also added another form of

extinction across some portion of baseline and treatment phases, such as sensory extinction (a helmet). This showed the unmatched form of treatment did not change subjects' behavior in baseline or treatment, and only the form of treatment found to be effective in the assessment reduced problem behavior. In the current study, for a portion of baseline and treatment phases, we added one of the treatments shown to be ineffective in the sensory analysis.

After treatment effects of the hand massager were confirmed using an ABAB design, schedule thinning was conducted using methods similar to Slocum et al. (2018). We included a card with a white side and a red side to signal continuous reinforcement was or was not available, respectively, in a multiple schedule. We started treatment with signaled continuous access to the stimulus identified in the sensory analysis. We then gradually increased the time in which the individual was exposed to the signaled unavailability of the stimulus, beginning with 10 s of unavailability, 30 s, 60 s, 120 s, 120 s + 60 s, and 120 s + 60 s + 60 s. In the last two phases of schedule thinning, two and then three separate removals of the stimulus occurred within the session. To thin the schedule of reinforcement, we increase the unavailability of the stimulus based on the subjects' target behavior remaining at or below 80% of baseline levels for Sam and 53% of baseline levels for Micah for two consecutive sessions. (Micah's reduction was 53% rather than 80% due to a calculation error.) We decreased the unavailability of the stimulus based on subjects' hand-clapping occurring at rates higher than the reduction criterion for a single session. We ended schedule thinning when hand-clapping was low, and the stimulus was available for 1 min and unavailable for 4 min (i.e., 120 + 60 + 60 s) for 7 consecutive sessions.

Results

Figure 1 displays Phase I or the FA for both subjects. Sam's responding is depicted in the top panel, and Micah's responding is depicted in the bottom panel. In the initial assessment,

hand-clapping occurred at high rates across all conditions for Sam ($M = 5.6$) and Micah ($M = 25.4$). Responding persisted in an extended no interaction phase ($M = 6.0$ for Sam and $M = 38.8$ for Micah).

Figure 2 displays Phase II or the analysis of sensory reinforcement for both subjects. For Sam, the lowest level of hand-clapping occurred when he had access to the hand massager ($M = 1.7$) and the video ($M = 1.7$). Sam had the highest level of hand-clapping in the no-interaction condition ($M = 3.4$). For Micah, the lowest level of hand-clapping occurred when he had access to the hand massager ($M = 0.5$). Micah had the highest level of hand-clapping in the glove condition ($M = 38.9$).

Phase III or treatment data are presented in the top panel of Figure 3 for Sam and the bottom panel of Figure 3 for Micah. Again, baseline is the no-interaction condition of the sensory analysis re-plotted. We selected the hand massager as the treatment for Sam's hand-clapping based on parent preference for Sam. For Sam, we introduced noncontingent access to the hand massager resulting in low levels of hand-clapping ($M = 0.3$). After a reversal to the no-interaction baseline, we re-captured treatment effects ($M = 0.2$) and began schedule thinning at Session 26. In addition, at Session 10, we added the arbitrary stimulus, audio recording of hand-clapping, and kept that stimulus in place through Session 23. At the completion of schedule thinning, when Sam had access to the matched stimulus for only 1 min of the 5 min sessions, his rate of hand-clapping remained low for 7 consecutive sessions ($M = 0.6$). We selected the hand massager as the treatment for Micah's hand-clapping because it produced the lowest level of hand-clapping in the sensory analysis. For Micah, we introduced noncontingent access to the hand massager resulting in the lowest levels of hand-clapping ($M = 2.2$). After a reversal to the no-interaction baseline, we recaptured treatment effects ($M = 5.5$) and began schedule thinning at

Session 23. In addition, at Session 8, we added the audio recording of hand-clapping, or arbitrary treatment, and kept that stimulus in place through Session 20. At the completion of schedule thinning, when Sam had access to the matched stimulus for only 1 min of the 5 min sessions, his rate of hand-clapping remained low for 7 consecutive sessions ($M = 29.6$).

Discussion

The current study further investigated behavior maintained by automatic reinforcement using a modified version of Rincover et al.'s (1979) sensory analysis. After confirming hand-clapping was maintained by automatic reinforcement for both subjects, we conducted a sensory analysis to identify the specific sensory modality reinforcing the target behavior. For both subjects, tactile stimulation was the source of sensory stimulation. The sensory analysis identified a matched stimulus whose presence reduced hand-clapping. Finally, we systematically thinned the schedule of reinforcement by increasing the amount of time in which the item was unavailable.

The current study adds to the literature on the treatment of behavior maintained by automatic reinforcement in several ways. First, although most studies use an FA to determine the function of behavior (Iwata et al., 1994a; Hanley et al., 2003), few studies explore which modality of sensory reinforcement maintains the behavior (e.g., tactile, visual, auditory; Rincover et al., 1979). Identification of the modality of sensory reinforcement maintaining target behavior is necessary to truly evaluate a “functional” treatment in behavior maintained by automatic reinforcement. Second, the current study was the first to combine matched-stimulus interventions that act as abolishing operations (or provide the source of reinforcement for free) and those that act as extinction (or prevent access to reinforcement) within one sensory analysis. Third, although research on thinning NCR schedules has been conducted with problem behavior

maintained by social reinforcement (e.g., Hagopian et al., 2000; Slocum et al., 2018), there has been minimal research applying schedule thinning to NCR interventions for problem behavior maintained by automatic reinforcement. Schedule thinning is an important component because matched stimuli might not always be available, especially if the procedure is implemented for extended periods of time.

Several studies mentioned above have offered solutions to reduce target behavior maintained by automatic reinforcement but require a high degree of response effort for therapists or parents. For example, RIRD requires the therapist to redirect the subject every time he or she engages in the target behavior (Ahrens et al., 2011), and response blocking has been shown to be an ineffective treatment unless it is implemented with perfect treatment integrity (Wunderlich et al., 2017). Parents cannot likely block every instance of a target behavior. However, NCR can be highly effective with minimal response effort for therapists or parents. The therapist only needs to provide the stimulus and prompt the subject to interact with it. Prompts consisted of verbal instructions to “play with the massager/toy,” a gesture toward the stimulus, or a light physical prompt if the subject did not respond to the initial prompt. We recorded the frequency of prompting across sessions for both subjects. For Sam, prompting was used on average 1 time per session. For Micah, prompting was used on average 2 times per session. This was sufficient to reduce hand-clapping without the need for response blocking. Quite often, behavior maintained by automatic reinforcement requires the inclusion of interventions that prevent the subject from contacting the reinforcement a target behavior produces (e.g., response blocking; Lerman and Iwata, 1996). While the current study addresses a method of treatment that can be used for covert or overt behavior, additional research is needed on treatments such as the one in the current study

that do not require the use of response blocking, as this can be intensive to implement and is not possible when an individual is alone in an environment.

The subjects shared a basic definition of hand-clapping, but Micah had additional topographies of hand-clapping beyond Sam's definition. Micah's secondary definition (tapping his thighs, stomach, and feet with open palms from two inches or more) meant he could interact with the stimulus *and* engage in hand-clapping simultaneously. The shared definition (opening hands with a distance of 2 in or more followed by closing the hands) did not allow for manipulation of the stimulus and hand-clapping to co-occur. This is simply a bi-product of a matched-stimulus intervention; however, it is worth noting.

To show the importance of selecting a functional stimulus, we also included an arbitrarily selected stimulus available noncontingently in conjunction with the functional item through part of the initial treatment phase, return to baseline, and a portion of the final treatment phase similar to Iwata et al. (1994b). The arbitrarily selected item had no effect on the level of hand-clapping for either subject. This is significant because it shows the arbitrarily selected items are not always reliable forms of treatment and therefore researchers and therapists should push to use function-based treatments.

There were several limitations to the current study. First, we did not include generalization probes to assess our treatment effects in different environments and with parents acting as behavior-change agents. Additionally, there were anecdotal reports from family and staff members that lower levels of hand-clapping would occur for up to 30 min after treatment sessions; however, we have no experimental evidence of this. Future research should measure treatment effects during and following formal experimental sessions. Second, we did not conduct any terminal probes of the schedule thinning procedure as we thinned the schedule of

reinforcement. In Slocum et al. (2018), one of the three subjects was exposed to terminal-schedule probes to see if the schedule needed to be thinned at each step or if responding would remain low when reinforcement was unavailable for the duration of the terminal goal. They found probes made the evaluation longer for that subject and all steps of schedule thinning were necessary. Therefore, we chose to simply thin the schedule of reinforcement using the same procedure Slocum et al. used for the other two subjects. Future research might include terminal-schedule probes to see if time could be saved by skipping steps in the schedule-thinning procedure.

Third, the current study required two assessments, delaying treatment. This procedure might not be a practical option for behaviors that require immediate reduction. Future researchers should evaluate methods to abbreviate the sensory analysis. This could be done by including only hypothesized sensory modalities similar to Rincover et al. (1979). For example, pica is most likely not maintained by visual stimulation, conditions which could be eliminated.

Fourth, we had no control over the subjects' schedules or medication changes. For example, after the FA, Sam had a seizure and was absent from the clinic for a week. When he returned, he was not on his regular therapy schedule and was taken out of therapy sessions early for follow up doctor appointments. Additionally, Sam was sent home on several occasions because he was experiencing symptoms of the new and more powerful medications he was prescribed. Further, medication was a concern for both Sam and Micah. When Sam returned to therapy after his seizure, he was prescribed a much higher dosage of seizure medication as well as the addition of a mood stabilizer. We often had several days between sessions because of these issues, and we do not know how Sam would have responded had his medication not been increased just after the FA and prior to beginning the sensory analysis. Medication changes were

also an obstacle for Micah. After returning to the treatment phase of the intervention, we later learned that his seizure medication was increased to a maximum dose, and Cannabidiol was added to his medication routine (see Session 17 on the bottom panel of Figure 3). We were made aware of this at a later time, or we would have run out our second baseline phase to assess if the medication had an effect on his hand-clapping prior to reinstating treatment.

The current study successfully reduced the level of hand-clapping for two subjects using a matched-stimulus intervention. This study extended the findings of Rincover et al. (1979) by assessing several forms of sensory stimulation and implementing a schedule thinning procedure to improve the treatment's feasibility (Slocum et al., 2018). This study also assessed the use of an arbitrarily selected stimulus similar to Iwata et al. (1994b) and found similar results showing that arbitrarily selected stimuli had no effect on the level of hand-clapping. This matched-stimulus NCR intervention might be applied to clinical settings in which an effective, yet simple, treatment is needed to reduce the level of problem behavior maintained by automatic reinforcement.

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Figure 1. Results for Sam's (top panel) and Micah's (bottom panel) functional analyses.

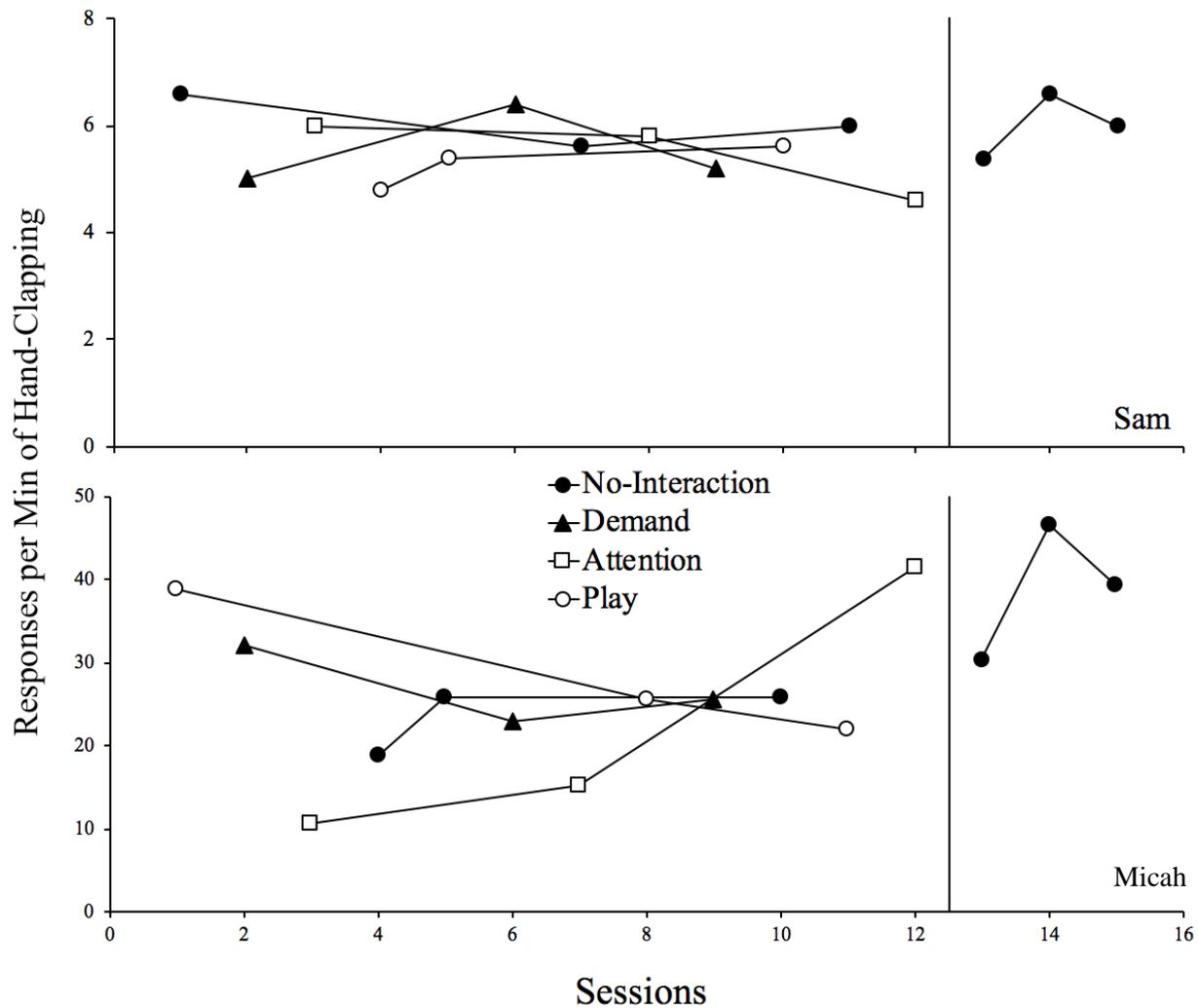


Figure 2. Results for Sam's (top panel) and Micah's (bottom panel) sensory analyses.

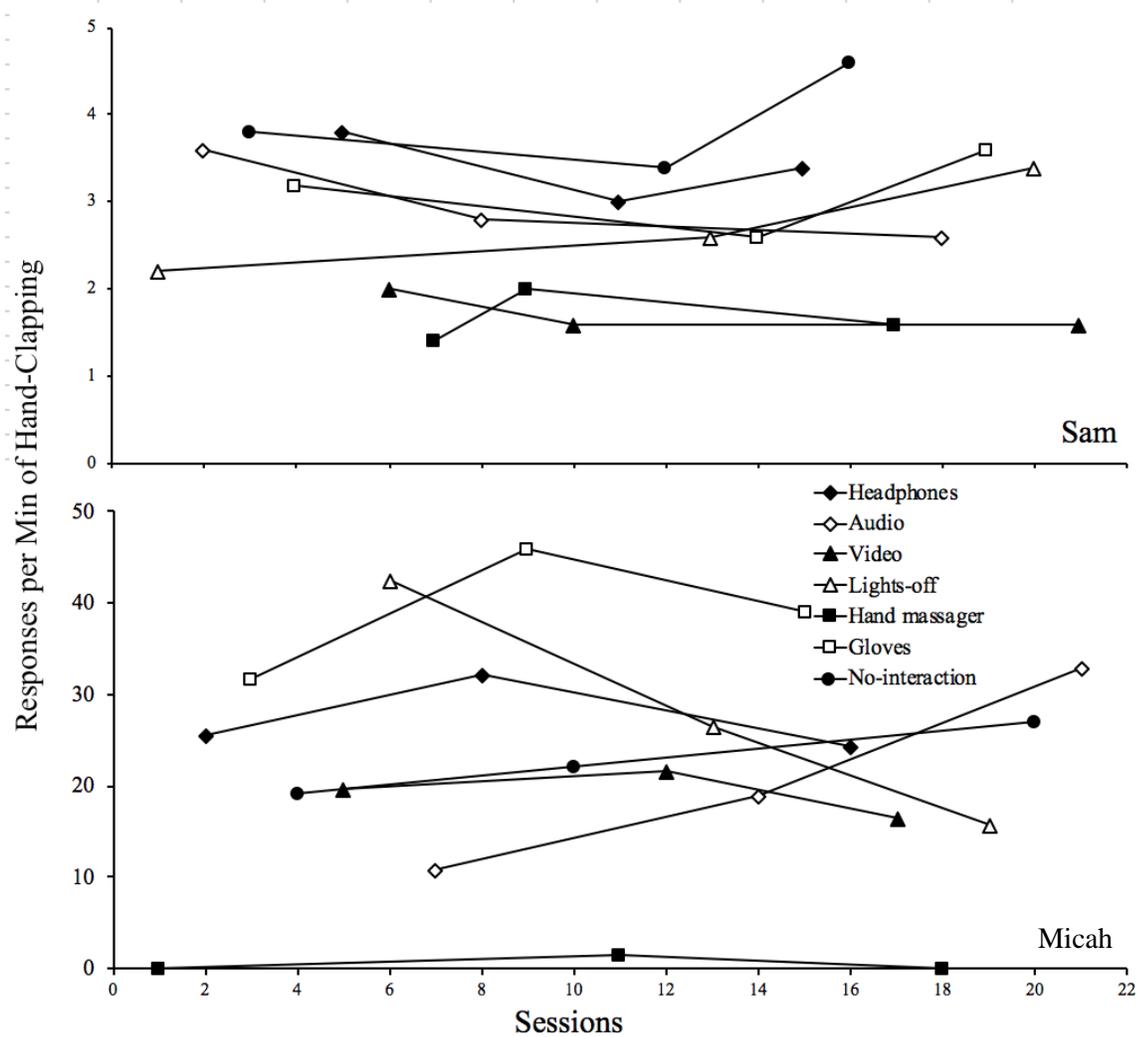
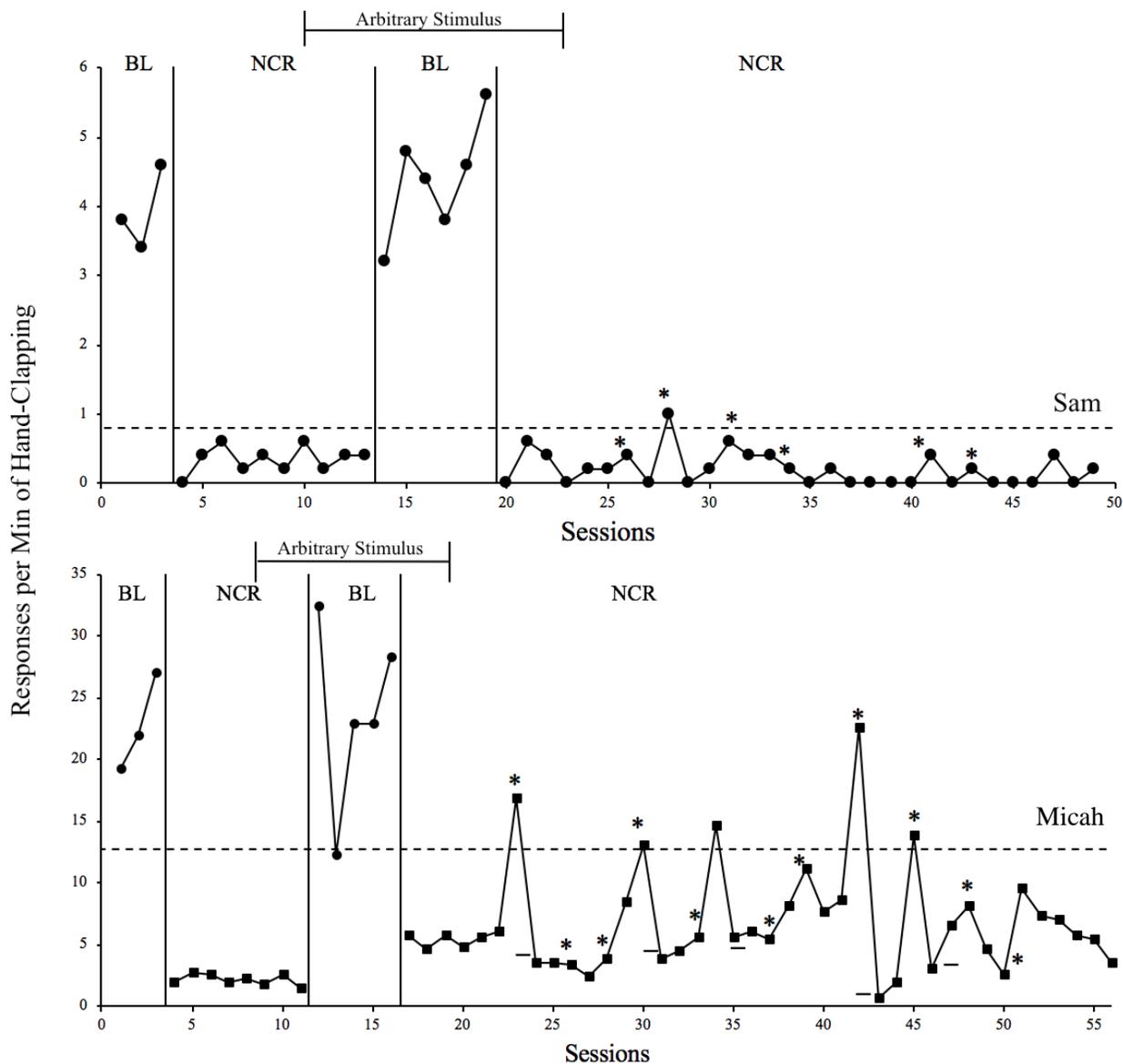


Figure 3. Results for Sam's (top panel) and Micah's (bottom panel) treatment and schedule thinning (bottom panel). The asterisk indicates where schedule thinning occurred while the minus sign indicates where the thinning was moved back to the last successful schedule.



Appendix A. Treatment integrity data sheet. Observers scored the performance of the therapist by selecting “Yes,” “No,” or “N/A”

Treatment Integrity Score Sheet	SESSION:	SESSION:	SESSION:	SESSION:	SESSION:
Therapist presented the correct stimulus.	YES NO				
Therapist prompted the subject to engage with the stimulus as needed.	YES NO N/A				
Therapist allowed noncontingent access to the stimulus for the duration of the session (or portion of the session in which the stimulus should have been available).	YES NO N/A				
Therapist conducted a full-length session (5min).	YES NO				
Therapist allowed the subject to engage in hand-clapping (he or she did not use response blocking).	YES NO				
Therapist used the correct duration of access to item. (i.e., 0 s, 30 s, 60 s, 120 s, 120 + 60 s, 120 + 60 + 60 s).	YES NO N/A				