Summer 2018

Assessment and Treatment of Behavior Maintained by Automatic Reinforcement

Nicolette Yatros
nyatros@rollins.edu

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

MASTER OF ARTS IN APPLIED BEHAVIOR ANALYSIS AND CLINICAL SCIENCE

August, 2017
Winter Park, FL

Acknowledgements

First, I would like to genuinely thank my professors for all their guidance and learning opportunities. Sarah Slocum Freeman, Stephanie Kincaid and April Williams, thank you for helping shape me in to the best professional version of myself possible.

Second, I would like to thank my thesis advisor, Sarah Slocum Freeman, for countless hours of mentoring, correcting, and shaping of my verbal behavior. You have helped me in more ways than I can express.

Third, I would like to thank my family and friends who lent me their love and support throughout my entire graduate school experience.

Table of Contents

Abstract

Two to four subjects diagnosed with autism spectrum disorder (ASD) or related disabilities will undergo a functional analysis to ensure hand-clapping is maintained by automatic reinforcement. A secondary analysis (sensory analysis) will be conducted to assess different stimuli that are sensory-stimulating. Finally, a function-based noncontingent reinforcement (NCR) procedure using sensory stimuli will be applied to reduce the target behavior, and the schedule of reinforcement will be thinned. We expect a decrease in hand-clapping when the function-based treatment is implemented. This research will further elucidate 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, Kuhl et al. (1997) found children with ASD might not develop language skills until the age of 5, whereas typically developing children commonly develop these skills around 1 year of age. This lack of appropriate means to communicate could be the reason children engage in problem behavior (Richman, Wacker, & Winborn, 2001). Problem behavior is typically an operant response to access reinforcers in one's environment (Iwata, Dorsey, Slifer, Bauman, & Richman, 1994).

The field of Applied Behavior Analysis (ABA) has been effective in treating behavior disorders among individuals diagnosed with ASD and related disabilities (Peters-Scheffer, 2013). ABA therapists analyze the environment in which problem behavior occurs, exposing an individual to manipulations in antecedents and consequences to evaluate potential triggers for problem behavior (Langthorne & McGill, 2011). For a therapist to implement an effective treatment to either decrease inappropriate behavior (e.g., crying when a friend takes a toy away or tantruming to escape a demand) or increase appropriate alternative behavior (e.g., taking turns or asking for a break), he or she must first conduct an analysis to identify which maintaining variable(s) increases the probability of problem behavior occurring in the future. The gold-standard methodology to identify the function(s) of behavior is the functional analysis (FA; Iwata et al., 1994). An FA identifies the function of a behavior by exposing the individual to a

variety of conditions that could be maintaining the target response and helps therapists develop functional treatments based on the results (Chock, Shlesinger, Struder, & Bird, 2012).

Iwata et al. (1994a) outlined what is considered standard FA methodology. Each condition (aside from the control condition) tests a different potential function of the target behavior (e.g., attention, escape, or automatic). The control condition is used as a baseline to compare the measure of target behavior in the other conditions to. 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 additionally planned stimuli during the "alone" condition. This condition is included to see if the target behavior is maintained by automatic reinforcement. "Unstructured play" is a free-play condition where the subject is allowed to play with toys and receives verbal praise and brief physical contact from the therapist contingent on the absence of the target behavior. This condition serves as a control against which therapists can compare subject responding in the other conditions. In the Iwata et al. study, while each subject engaged in a similar topography of responding (i.e., self-injurious behavior), idiosyncratic functions were found across subjects.

While all FAs do not necessarily test the same variables, often, these analyses will determine a behavior is maintained by social reinforcement in the form of attention from others, denied access to tangible items, or escape from demands, or that a behavior is maintained by automatic reinforcement (Beavers, Iwata, & Lerman, 2013). Behavior maintained by social reinforcement means reinforcement is provided by others, whereas behavior maintained by automatic reinforcement produces its own reinforcement (Risley, 1968). Behavior maintained by

automatic reinforcement is more challenging to treat because it is difficult to identify functional treatments that either compete with or outweigh reinforcement provided by the target behavior itself (Vollmer, Peters, & Slocum, 2015).

Review of Literature

Self-injurious behavior maintained by automatic reinforcement presents as several topographies and has been reported to account for 25% of behavioral functions (Hagopian, Rooker, & Zarcone, 2015). Some topographies of SIB are considered extremely dangerous such as head banging, ear pulling, and pica, whereas others are considered less harmful such as hand mouthing (Iwata et al., 1994a). Regardless of the severity level, self-injurious behavior should be treated using a functional intervention (Saini et al., 2016). While the topography of a response does not necessarily indicate the function of the behavior, some examples of behavior that have been shown to be maintained by automatic reinforcement include self-induced emesis (Wunderlich, Vollmer, & Zabala, 2017), pica (Saini et al., 2016), stereotypy (Rapp & Vollmer, 2004), and hand-clapping (Roscoe, Iwata, & Zhoe, 2013). Hand-clapping could be one form of stereotypy, and previous research suggests it has been shown to be maintained by automatic reinforcement (Roscoe et al., 2013). Interventions for problem behavior maintained by automatic reinforcement have included punishment, extinction, differential reinforcement, and noncontingent reinforcement.

Punishment

Punishment has been shown to be an effective treatment for several topographies of behavior maintained by both social (Lerman & Iwata, 1996) and automatic reinforcement (Ahearn, Clark, Gardenier, Chung, & Dube, 2003; Love, Miguel, Fernand, & Labrie, 2012; Wunderlich et al., 2017; Smith, Russo, & Le, 1999). Prior to the development of the FA, many

studies found punishment to be effective (Dorsey, Iwata, Ong, & McSween, 1980; Risley, 1968; Sajwaj, Libet, & Agras, 1974), likely because the function of a target behavior was not identified meaning reinforcement-based procedures might not have been identified or utilized correctly. Risley used electric shock in a laboratory setting to eliminate an individual's disruptive climbing, which was subsequently implemented in the individual's home. Some treatments such as contingent lemon juice have been used to reduce the life-threatening rumination of a six-month-old infant (Sajwaj et al., 1974), whereas others have successfully used water misting to reduce self-injurious behavior (Dorsey et al., 1980). Sajwaj et al. squirted small amounts of lemon juice into an infant's mouth contingent on a precursor behavior of a specific tongue movement. Dorsey et al. used contingent water misting to reduce severe topographies of self-injurious behavior including hand-biting and head-banging. Risley additionally treated self injury and rocking potentially maintained by automatic reinforcement with contingent reprimands; reprimands were effective in reducing the target behavior. However, the function of this behavior cannot be confirmed because the FA had yet to be created. Although punishment treatments such as electric shock, water misting, contingent lemon juice, and contingent reprimands have been shown to be effective, they are not common because of the ethical implications they pose.

More recent punishment interventions such as response interruption and redirection (RIRD; Love et al., 2012) and response blocking (Wunderlich et al., 2017) have been used to reduce problem behavior maintained by automatic reinforcement. Both methods attempt to interrupt a response and either redirect the individual (RIRD) or prevent the behavior from occurring (blocking). RIRD is the presentation of a stimulus (verbal or physical; e.g., a toy with sound) to interrupt a target response and redirect the individual to a different behavior (Love et al., 2012). Love et al. and Ahearn et al. (2003) evaluated the effects of RIRD on vocal stereotypy

presumably maintained by automatic reinforcement in clinical and classroom settings, respectively. In both cases, RIRD was an effective treatment for vocal stereotypy and increased appropriate behavior including manding and student productivity.

Response blocking has been used to reduce the frequency of behavior maintained by automatic reinforcement (Smith et al., 1999; Wunderlich et al., 2017). Wunderlich et al. used response blocking to treat self-induced emesis for one individual. The authors found response blocking as an effective treatment for reducing the frequency with which the individual engaged in the target behavior. Lerman and Iwata (1996) and Smith et al. (1999) implemented response blocking with different levels of integrity and found that response blocking could function as either extinction or punishment depending on the effect of the schedule of blocking. Lerman and Iwata reported response blocking functioned as a punisher for an individual who engaged in hand-mouthing maintained by automatic reinforcement. Following a condition blocking each instance of problem behavior, various levels of blocking did not maintain low levels of the target behavior. This resulted in the authors concluding response blocking functioned as a punisher, as responding only decreased gradually after repeated exposure to response blocking. Smith et al. used response blocking to treat SIB in the form of eye poking maintained by automatic reinforcement. According to the authors, response blocking functioned as an extinction procedure because the target behavior was gradually extinguished rather than immediately. Both Smith et al. and Lerman and Iwata found response blocking can decrease target behavior maintained by automatic reinforcement.

Although punishment procedures have been shown to be effective treatments, the field of ABA is generally moving towards reinforcement-based interventions over punishment procedures with the development of a functional-analysis methodology (Pelios, Morren, Tesch,

& Axelrod, 1999). Other interventions used to reduce target behavior include procedures such as extinction, differential reinforcement, and noncontingent reinforcement.

Extinction

While response blocking has been shown to be an effective treatment in some cases, other extinction interventions have been used and shown to effectively reduce target behavior. Extinction involves the withholding of a reinforcer contingent on a target response that previously provided contact with reinforcement (Iwata, Pace, Cowdrey, and Miltenberger 1994b) and has been used as a functional treatment in different forms (sensory, attention, and escape extinction) (Iwata et al., 1994b; Roscoe, Iwata, & Goh., 1998; Smith et al., 1999). Smith et al. and Roscoe et al. used sensory extinction in the form of response blocking using protective gear. The authors found sensory extinction was effective in reducing the target behavior. Roscoe et al. used continuous access to items such as protective gloves to block an individual from engaging in arm rubbing behavior which was deemed to be self injurious, attempts to remove the protective gear were blocked. The authors stated continuous access to protective equipment could be conceptualized as an extinction procedure because the response no longer produces reinforcement; further no stimulus was added or removed contingent on a response (as would be the case with a punishment procedure).

Iwata et al. (1994b) found different forms of extinction (attention extinction, escape extinction, sensory extinction) to be effective for three subjects in their study. This study shows the importance of individualized functional treatments; the procedure that works for one function will not always work for other functions. Other treatments have been used with or instead of extinction, such as differential reinforcement and noncontingent reinforcement. These could be

functional treatment options for more dangerous or socially significant behavior maintained by automatic reinforcement.

Differential Reinforcement

Differential reinforcement has been implemented successfully to treat problem behavior maintained by automatic reinforcement (Horner & Day, 1991; Patel, Carr, Kim, Robles, & Eastridge, 2000; Toussaint & Tiger, 2012; Vollmer, Roane, Ringdhal, & Marcus, 1999). Horner and Day and Vollmer et al. evaluated differential reinforcement of alternative behavior (DRA) with behavior maintained by automatic reinforcement. Horner and Day evaluated a DRA procedure with 100% integrity. DRA was evaluated by incorporating an alternative response hypothesized to be a competing behavior. The study was conducted to see if providing reinforcement for manding (the alternative response) would result in reduction of the target behavior. The authors were able to teach a socially appropriate alternative response (American Sign Language (ASL) to mand in a full sentence for items); however, DRA with this alternative response was not effective. After modifying the alternative response to one word instead of a full sentence, the treatment was successful. This study shows that functional treatments are necessary in the reduction of target behavior. Additionally, this study shows the importance of the topography of the competing response in a DRA procedure. Vollmer et al. effectively used DRA to reduce the SIB and aggression of three individuals with different identified functions of target behavior. In addition to effectively treating the target behavior, the authors evaluated DRA to see what level of treatment integrity was necessary for the treatment to work. The authors found DRA was only effective when conducted with 100% treatment integrity. This research is an important addition to the literature because it shows that DRA might be ineffective if not implemented with high integrity.

Toussaint and Tiger (2012) and Patel et al. (2000) implemented differential reinforcement of other behavior (DRO) for behavior maintained by automatic reinforcement. Toussaint and Tiger conducted their study with an individual who engaged in covert skin-picking. A variable momentary DRO successfully suppressed the individual's skin-picking. Patel et al. alternated the reinforcement of engaging with one of two identified preferred stimuli within the same response class as the target behavior in a DRO procedure for two individuals who engaged in self injury and stereotypy. Results showed this was an effective treatment for subjects' target behavior.

While differential reinforcement has been shown to be an effective treatment for decreasing problem behavior (e.g., Toussaint & Tiger, 2012, Patel et al., 2000), DRA and DRO can be difficult to implement for behavior maintained by automatic reinforcement, especially when the function cannot be identified such as with Horner and Day, or when the procedure has the possibility of not being implemented with 100% treatment integrity (Vollmer et al., 199). In these cases, other treatments such as noncontingent reinforcement should be considered.

Noncontingent Reinforcement

Noncontingent reinforcement (NCR) has produced variable treatment effects on behavior maintained by automatic reinforcement (Phillips, Iannaccone, Rooker, & Hagopian, 2017; Roscoe et al., 1998; Saini et al., 2016). Environmental enrichment (Vollmer, Marcus, & LeBlanc, 1994), noncontingent reinforcement with preferred items (Phillips et al., 2017), and matched stimuli (Rapp, 2006) all involve the presentation of stimuli "for free" rather than contingent on responding, and are therefore variations of NCR procedures.

Environmental enrichment is a treatment method that refers to baiting the environment with potentially enriching stimuli and has mixed results regarding its effectiveness (Horner, 1980; Vollmer et al., 1994). Horner used environmental enrichment to treat the problem behavior

(of unknown function) of individuals in an institutional ward. The author compared environmental enrichment with differential reinforcement to a baseline condition using noncontingent reinforcement alone. Results showed there was no change in appropriate or maladaptive behavior when exposed to enriched environment. Contradictory to these results, Vollmer et al. tested environmental enrichment in an analogue setting. The authors used this intervention to treat self injury and hand mouthing maintained by different functions. The results show environmental enrichment was an effective treatment.

Favell, McGimsey, and Schell (1982) provided toys to individuals who engaged in SIB when alone. Although providing toys decreased self injury, the individuals did not appropriately use the toys. For example, one individual who engaged in hand-mouthing began mouthing the toy provided instead of engaging in the target behavior. Access to a potentially more socially-appropriate item to mouth, such as a teething toy, could replace hand-mouthing; however, the toy would subsequently need to be faded out of the individual's environment for social-validity reasons such as social acceptance. Environmental enrichment has been effective in some of the above-mentioned cases; however, there is not overwhelming support that it is an effective treatment for behavior maintained by automatic reinforcement. This might be because environmental enrichment uses arbitrary stimuli instead of items that have been determined to be highly preferred.

Another method of NCR involves presenting tangible items that were identified as being highly preferred via a preference assessment. Phillips et al. (2017) analyzed treatment effects for 27 individuals diagnosed with various developmental disabilities who engaged in severe problem behavior. Results showed NCR with highly preferred items was effective in treating problem behavior maintained by social reinforcement in 14 out of 15 individuals. However, the authors

determined the use of other treatment components in addition to NCR were necessary to decrease problem behavior to socially acceptable levels in 12 out of 27 cases. It is possible an item presumed to provide a competing stimulation as the target behavior, or a matched stimulus, might be more effective than selecting an item solely based on preference.

Matched stimuli are those identified to meet the same sensory function as a target behavior (Patel et al., 2000; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Rapp, 2006; Rincover, Cook, Peoples, & Packard, 1979). Piazza et al. tested the effect of both functionally matched and arbitrarily selected stimuli to reduce hand mouthing. For example, an individual was exposed to an edible as a functionally matched stimulus and a toy car as an arbitrarily selected stimulus. Functionally matched stimuli were more effective in reducing behavior maintained by automatic reinforcement compared to arbitrary items. These stimuli were presumably more effective because they provided the sensory stimulation maintaining behavior, or provided automatic reinforcement not contingent on the individuals engaging in problem behavior. Rapp also used matched stimuli to treat the stereotypic behavior of one individual. The subject was given noncontingent access to a stimulus that likely provided the same sensory stimulation as the target response, reducing problem behavior maintained by automatic reinforcement. Rincover et al. went a step further and conducted a sensory analysis to determine which sensory variable maintained behavior. For example, the authors used headphones to see if a target behavior presumably maintained by auditory stimulation would extinguish. Results showed the individual engaged with the item that produced the same sensory function as the target response. This study adds greatly to the literature because it shows that a sensory analysis and functional treatments are empirically supported options for behavior maintained by automatic reinforcement.

Other studies have compared NCR with matched items to other treatments. Roscoe et al. (1998) found NCR was faster than sensory extinction in reducing SIB for three individuals diagnosed with intellectual disabilities. Another comparison study evaluated NCR and response blocking alone as well as in combination (Saini et al., 2016). Contrary to Piazza et al. (2000), Saini et al. found these two methods were not successful independently; however, NCR and response blocking in combination were effective in reducing problem behavior maintained by automatic reinforcement.

The NCR procedure is used by manipulating or the establishing operations that are in effect when an individual engages in a target behavior. This procedure

Schedule Thinning

To assist in the transition from the implementation of a stimulus that produces the same sensory reinforcement, schedule thinning will be a key component in this treatment package to ensure we can reduce the target behavior. Many studies have evaluated different forms of schedule thinning with NCR procedures to decrease problem behavior maintained by social reinforcement (Hagopain, Crockett, Stone, DeLeon, & Bowman, 2000; Hagopian, Toole, Long, Bowman, & Lieving, 2004; Kahng, Iwata, DeLeon, & Wallace, 2000; Slocum, Grauerholz-Fisher, Peters, & Vollmer, in press). Schedule thinning was effective in the above cases; however, these studies have not been conducted with individuals whose behavior is maintained by automatic reinforcement.

Kahng et al. (2000) compared two methods for programming and thinning schedules of reinforcement for three individuals who engaged in SIB maintained by positive reinforcement (access to tangible items). The authors compared a fixed-time schedule of reinforcement versus an adjusted interresponse time (IRT) schedule, based on a baseline IRT, at initial implementation

as well as throughout the thinning process. IRT schedules were determined individually based on the time that lapsed 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 differential reinforcement and extinction in a reversal design (Hagopian et al., 2000). Results showed both were effective in reducing target behavior maintained by various variables; however, as the schedule of NCR alone was thinned, the target behavior increased. When the NCR schedule was thinned alongside differential reinforcement and extinction, thinning was more effective. Although their NCR thinning procedure was effective with additional components, 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 individual who engaged in severe problem behavior maintained by access to a variety of stimuli. With the former, reinforcement was delivered on dense schedules of reinforcement at first. Subsequently, progressively leaner schedules were used. With the latter, the reinforcement was delivered on a lean schedule from the outset of schedule thinning. The fixed-lean schedule produced faster results compared to the dense-to-lean thinning procedure for two of the three individuals.

Slocum et al. (in press) began treatment by providing continuous access to the functional reinforcer for three individuals who engaged in aggressive behavior. Subsequently, the schedule was gradually thinned by increasing the time in which the functional reinforcer was unavailable (i.e., extinction). Over time, they thinned the NCR schedule to subjects having access to the functional reinforcer for half of the session and exposure to extinction for the other half while maintaining low levels of aggression across subjects.

Statement of the Problem

Previous research has shown behavior maintained by automatic reinforcement to be prevalent across clinical and classroom settings (Hagopian et al., 2015). Many behavior-analytic interventions have been found to be effective at reducing behavior maintained by automatic reinforcement, including punishment (e.g., Iwata et al., 1994b), response blocking (e.g., Saini et al., 2016), environmental enrichment (e.g., Vollmer et al., 1994), differential reinforcement (e.g., Horner et al., 1991), and NCR (e.g., Phillips et al., 2017). That said, there are still several gaps in the literature.

First, there are many studies that use the FA methodology as a step in the process of determining the function of a behavior to find a functional treatment (Iwata et al., 1994a; Hanley et al., 2003). However, there is little research on the use of an FA methodology to assess the sensory aspect of a treatment for individuals with automatically maintained problem behavior (e.g., Rincover et al., 1979). Second, no studies have compared matched stimulus interventions that act as extinction procedures (i.e., those that eliminate the individual's ability to access reinforcement) and those that act as motivating operation procedures (i.e., those that provide the same source of automatic reinforcement freely but also allow the individual to continue to contact reinforcement by engaging in the target behavior) within one analysis. Finally, although research on thinning NCR schedules has been conducted with problem behavior maintained by social reinforcement (e.g., Hagopian et al., 2000), there is minimal research applying schedule thinning to NCR interventions for problem behavior maintained by automatic reinforcement.

Therefore, the purpose of this study is to first conduct an FA to determine hand-clapping is maintained by automatic reinforcement and subsequently to determine the source of automatic reinforcement or sensory stimulation maintaining hand-clapping. This study will use a sensory

analysis similar to Rincover et al. (1979) to isolate the source of automatic reinforcement. Following successful treatment of hand-clapping using noncontingent access to matched items, the NCR schedule will be thinned using procedures similar to Slocum et al. (in press).

Method

Subjects, Setting, and Materials

Two to four subjects attending Rollins College practicum clinics for applied behavior analytic (ABA) therapy will be recruited for this study. Consent from a guardian will be obtained, and only subjects whose behavior plans do not address the target behavior will be included. Subjects will range from 3 to 18 years of age and engage in inappropriate hand-clapping. Inappropriate hand-clapping will be considered engaging in hand-clapping when it is not a socially appropriate time (e.g., applauding). Hand-clapping is a seemingly harmless behavior; however, it has been reported in school and clinical settings to be a hindrance to academic achievement as well as a disruption to peers for both individuals likely to participate in the study. Subjects will have a diagnosis of ASD or related disability.

This study will be conducted in therapy rooms at the subjects' clinics. These rooms will contain a table, chairs, and stimuli needed for various conditions of the FA and sensory analysis. Across all conditions, an electronic device for data collection and a video camera will be present. Materials for the FA will include academic demands and play items. Materials for the sensory analysis will consist of sound-proof headphones, hand-clapping audio recordings, gloves, a video of another person clapping, and a vibrating-hand massager.

Response Measurement and Interobserver Agreement

The target behavior will be hand-clapping defined as the subject opening his or her own hands with a distance of 2 in or more followed by closing the hands. This behavior will be

measured using a rate (responses per min). All sessions will be video recorded for future data collection and analysis. Two observers will independently score responses across 30% or more of sessions to obtain interobserver agreement (IOA). IOA will be calculated using a 10-s exact interval-by-interval method. For each interval, if the number each observer scores is the same, it will be considered an agreement (e.g., if one observer scores 9 and the other scores 9), even if both observers score zero responding. Disagreements will be defined as observers not scoring the same number of occurrences within the 10-s interval (e.g., if one observer scores 9 and the other scores 10). The number of agreements will be divided by agreements and disagreements; this will be multiplied by 100 to obtain a percentage for each session. Data will be considered reliable if IOA across independent observers is 80% or higher.

Procedure

Sessions will be 5 min across FA, sensory analysis, and treatment phases. Both the FA and sensory analysis will be conducted using a multielement design; treatment will be evaluated using a reversal. No programmed consequences will be in place for hand-clapping across all phases (i.e., response blocking or extinction will not be in place).

Phase I: Functional Analysis. We will begin by conducting an FA of hand-clapping based on procedures described by Iwata et al. (1994a) with some modifications. We will include no-interaction, demand, attention, and play conditions. The *no-interaction* condition will consist of the subject and therapist in a room without any toys or demands. The therapist will not interact with the subject. If the rate of target behavior is higher in this condition compared to control, we will conclude hand-clapping is maintained by automatic reinforcement. The *demand* condition will consist of the therapist presenting academic demands to the subject (e.g., tracing or tying his or her shoe) continuously using a least-to-most prompting sequence. Demands will be selected

based on current clinical targets for each subject. If the subject engages in the target behavior, the therapist will respond with “ok, you don’t have to,” and remove the demand for 30 s. If hand-clapping occurs at a higher rate in this condition than the others, we will conclude hand-clapping is maintained by escape from demands.

The *attention* condition will consist of the therapist telling the subject, “I have work to catch up on; you sit here until I’m finished.” If the subject engages in hand-clapping, the therapist will interject a brief reprimand (e.g., “stop that”). If the rate of hand-clapping is higher in this condition than others, we will conclude the target behavior is maintained by attention. Finally, the *play* condition will serve as our control; we predict to see the least amount of hand-clapping in this condition because subjects will have noncontingent access to several toys and therapist attention. Visual analysis will allow us to determine the function of hand-clapping for each subject based on differentiation (or lack thereof) in the rate of responding across conditions. We will conclude the behavior is maintained by automatic reinforcement if the target behavior occurs across all conditions or at higher levels in the no-interaction condition compared to the other conditions. If results are undifferentiated, we will confirm the function by including an extended no-interaction phase. Only subjects whose hand-clapping is maintained by automatic reinforcement will be included in the current study. Others will receive treatment for their hand-clapping through their ABA clinics.

Phase II: Sensory Analysis. Before beginning Phase II, we will conduct a forced-exposure session to all stimuli that will be included in the individuals analysis. Because the goal of this phase is to identify an item that competes with subjects’ hand-clapping, exposure will to items prior to the sensory analysis should reduce the likelihood that observed suppression of hand clapping would be due to novelty of the items. This will be similar to methods used by

Piazza et al. (2000) with modifications such as different stimuli included in the sensory analysis. Each subject will be exposed to items to be included in the sensory analysis three times each for 1-min per exposure in a random order. This will give subjects the opportunity to interact with each item prior to the sensory analysis.

Subsequently, a secondary FA, or sensory analysis similar to the previous phase will be conducted; however, this assessment will isolate the source of automatic reinforcement produced by hand-clapping. Additionally, this phase will act as an FA of potential treatments in that different environmental arrangements will be manipulated, and the target response will be measured. We will be able to see which condition results in the lowest level of hand-clapping (as opposed to the highest level as is typical of an FA). A subset of potential sources of sensory reinforcement will be assessed. For example, hand-clapping might be maintained by the tactile stimulation it produces. We will include the following conditions: no-interaction, lights-off, video, sound clip, sound-proof headphones, gloves, and vibrating massager.

The *no-interaction* condition will be identical to the no-interaction condition included in the FA. This condition will serve as our baseline against which we can compare the level of hand-clapping within other conditions. To test if visual stimulation is the source of automatic reinforcement for hand-clapping, a *lights-off* and a *video* condition will be conducted. The lights-off condition will resemble a no-interaction condition except the therapist will turn off the lights. Darkness will act as sensory extinction if hand-clapping is maintained by visual stimulation. Attempts to turn on the lights during sessions will be blocked. Another condition to test for visual stimulation as the source of reinforcement is a video condition. This condition will consist of the therapist noncontingently playing a video of someone else clapping without sound. This condition resembles a matched stimulus treatment in that a video of clapping might provide

similar reinforcement if visual stimulation is the variable maintaining hand-clapping. To test for auditory stimulation, we will introduce a pair of *sound-proof headphones* and an *audio recording* condition. The sound-proof headphones condition will involve the subject wearing sound-proof headphones. Attempts to remove headphones will be blocked. If hand-clapping is maintained by auditory stimulation, this condition resembles a sensory extinction procedure. In the audio recording condition, the sound of clapping will be played throughout the session; this will resemble a matched stimulus procedure if auditory stimulation is the reinforcer for hand-clapping.

To test for tactile sensory stimulation, a *glove* condition as well as a *vibrating massager* condition will be included. For the glove condition, the subject will wear shock-absorbent gloves to eliminate any tactile reinforcement that might be provided by hand-clapping. Attempts to remove the gloves will be blocked. Again, this might resemble sensory extinction if tactile stimulation is the maintaining reinforcer for hand-clapping. Alternatively, a vibrating massager will be tested as a matched stimulus procedure where the subject has access to a vibrating massager for the duration of the session.

A treatment for Phase III will be selected based on which condition produces the lowest level of target behavior in the sensory analysis. If multiple conditions produce lower levels of hand-clapping, relative to the control condition we will implement the caregiver's preferred intervention and/or consider alternating interventions to enhance treatment effects.

If the subject does not engage with the stimuli (for items such as the massager or video), the therapist will prompt him or her to engage with the item every 1 min. This will be done using least-to-most prompting. First the therapist will use a verbal prompt such as "touch the toy," if the subject does not engage with the stimulus after 5 s, the therapist will use a gestural prompt

pointing towards the stimulus. If the subject does not engage with the stimulus again after 5 s, the therapist will use a physical prompt.

Phase III: Treatment. After the sensory analysis has identified the maintaining sensory stimulation for hand-clapping, a functional treatment will be implemented for each subject within a reversal design. We will use data from the no-interaction condition of Phase II as our initial baseline. Treatment will vary across subjects based on the findings of the sensory analysis. For example, if a subject does not engage in hand-clapping least when noncontingent access to sound-proof headphones are provided, we will use that as our treatment. Attempts to engage in hand-clapping will have no programmed consequence; we will prompt subjects to interact with the stimulus as needed in treatment as was described above for Phase II.

Schedule thinning will be conducted using methods similar to Slocum et al. (in press). We will start the treatment with continuous access to the functional item identified in the sensory analysis. A discriminative stimulus (a card with a red side and a white side) will be used to signal continuous reinforcement is or is not available, respectively, in a multiple schedule. Thinning will consist of gradually increasing the time in which the individual will be exposed to the unavailability of reinforcement, beginning with zero unavailability, 10 s, 30 s, and so on until the reinforcer is available for 50% of the session. Thinning will occur once the subject's target behavior has remained low (80% of baseline levels) for two consecutive sessions. Schedule thinning will be complete when the schedule has successfully been thinned to a socially appropriate level, as determined by XXXXXXXXX. If subjects begin to engage in hand-clapping instead of engaging with the stimulus identified in the sensory analysis, we will decrease the schedule of reinforcement to the step where it was last successful in suppressing the behavior.

Expected Results and Discussion

Across subjects, in Phase I, hand-clapping will be found to be maintained by automatic reinforcement, meaning we will see high levels of hand-clapping across conditions or in the no-interaction condition compared to the other conditions. The top panel of Figure 1 displays hypothetical FA data for a single subject with a high rate of hand-clapping across all conditions. We expect to find idiosyncratic effects of sensory stimuli in Phase II; individuals might have low levels of hand-clapping when different items are present. The middle panel of Figure 1 shows hypothetical data for the sensory analysis for the same subject. Results indicate this subject engages in the lowest level of hand-clapping in the presence of the hand massager (indicating tactile stimulation might be the sensory reinforcer for hand-clapping). Therefore, we would select the hand massager as a functional treatment for hand-clapping.

Treatments will be individualized based on the results of the sensory analysis. The hypothetical data for the same subject in treatment are in the bottom panel of Figure 1 (Phase III). In baseline, or the no-interaction condition of the sensory analysis, the rate of the subject's hand-clapping is high. The subject's treatment will be NCR in the form of access to a vibrating massager. Once the hand massager is implemented, the subject will not engage in hand-clapping at nearly the same rate. We will replicate the effects of treatment in a reversal design.

This study will further investigate behavior maintained by automatic reinforcement by replicating a sensory analysis to identify a potential functional treatment. Further, we will implement an NCR procedure based on that analysis and thin the NCR schedule. Previous research has been successful in reducing behavior maintained by automatic reinforcement with punishment procedures (e.g., Dorsey et al., 1980); however, Roscoe et al. (1998) found NCR can have more rapid and better response suppression than sensory extinction. Further, NCR is a

reinforcement-based procedure, which is typically preferred to punishment procedures (SHOULD I CITE CODE OF ETHICS?). Matched stimuli is one type of NCR procedure found to be generally effective (Piazza et al., 2000), and more research is needed in determining the best NCR intervention for individuals with problem behavior maintained by automatic reinforcement and, further, how to thin the schedule of NCR. The current study will address both of these deficits.

Future research should be conducted with different topographies of behavior maintained by automatic reinforcement using similar methods. We chose hand-clapping because we did not want to implement response blocking as it would confound our results. Had we selected a more severe topography, such as SIB maintained by automatic reinforcement, we ethically would need to block the behavior. This research could be used as a guide for how to determine the specific source of sensation producing automatic reinforcement and could be useful in the treatment of problem behavior maintained by automatic reinforcement.

References

Ahearn, W. H., Clark, K. M., Gardenier, N. C., Chung, B. I., Dube (2003). Persistence of stereotypic behavior: examining the effects of external reinforcers. *Journal of Applied Behavior Analysis, 36,* 439-448. doi: 10.1901/jaba.2003.36-439

American Psychiatric Association (2013). Cautionary statement for forensic use of DSM-5. In *Diagnostic and statistical manual of mental disorders (5th ed.).* Washington, DC. doi:dx.doi.org/10.1176/appi.books.978089425596

Beavers, G. A., Iwata, B. A., & Lerman, D. C. (2013). Thirty years of research on the functional analysis of problem behavior. *Journal of Applied Behavior Analysis, 46,* 1-21. doi:10.1002/jaba.30

Centers for Disease Control and Prevention. CDC estimates 1 in 68 children has been identified with autism spectrum disorder. 2014; https://www.cdc.gov/media/releases/2014/p0327-autism-spectrum-disorder.html. Accessed September 20, 2017.

Chock, J. T., Shlesinger, A., Studer, L., & Bird, F. L. (2012). Description of a practitioner training program on functional analysis and treatment development. *Behavior Analysis in Practice, 5,* 25-36. doi:https://doi.org/10.1007/BF03391821

Dorsey, M. F., Iwata, B. A., Ong, P., & McSween, T. E. (1980). Treatment of self-injurious behavior using a water mist: initial response suppression and generalization. *Journal of Applied Behavior Analysis, 13,* 343-353. doi:10.1901/jaba.1980.13-343

Favell, J. E., McGimsey, J. F., & Schell, R. M. (1982). Treatment of self-injury by providing alternate sensory activities. *Analysis and Intervention in Developmental Disabilities, 2,* 83-104. doi:10.1016/0270-4684(82)90007-6

Hagopian, L. P., Crockett, J. L., Stone, M. V., DeLeon, I. G., & Bowman, L. G. (2000). Effects of noncontingent reinforcement on problem behavior and stimulus engagement: the role of satiation, extinction, and alternative reinforcement. *Journal of Applied Behavior Analysis, 33,* 433-449. doi:10.1901/jaba.2000.33-433

Hagopian, L. P., Rooker, G. W., & Zarcone, J. R. (2015). Delineating subtypes of self-injurious behavior maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 48,* 523-543. doi:10.1002/jaba.236

Hagopian, L. P., Toole, L. M., Long, E. S., Bowman, L. G., Lieving, G. A., (2004). a comparison of dense-to-lean and fixed lean schedules of alternative reinforcement and extinction. *Journal of Applied Behavior Analysis, 37,* 323-337. doi:10.1901/jaba.2004.37-323

Horner, R. D. (1980). The effects of an environmental "enrichment" program on the behavior of institutionalized profoundly retarded child. *Journal of Applied Behavior Analysis, 13,* 473-491. doi:10.1901/jaba.1980.13-473

Horner, R. H., & Day, H. M. (1991). The effects of response efficiency on functionally equivalent competing behaviors. *Journal of Applied Behavior Analysis, 24,* 719-732. doi:10.1901/jaba.1991.24-719

Iwata, B. A., Dorsey, M. F., Slifer, K. J., Bauman, K. E., & Richman, G. S. (1994a). Toward a functional analysis of self-injury. *Journal of Applied Behavior Analysis, 27,* 197-209. Reprinted from Analysis and Intervention in Developmental Disabilities, 1982, 2, 3-20. doi:10.1901/jaba.1994.27-197

Iwata, B. A., Pace, G. M., Cowdrey, G. E., & Miltenberger, R. G. (1994b). What makes extinction work: an analysis of procedural form and function. *Journal of Applied Behavior Analysis, 21,* 131-144. doi:10.1901/jaba.1994.27-131

Kahng, S., Iwata, B. A., DeLeon, I. G., & Wallace, M. D. (2000). A comparison of procedures for programming noncontingent reinforcement schedules. *Journal of Applied Behavior Analysis, 33,* 223-231. doi:10.1901/jaba.2000.33-223

Kuhl, P. K., Andruski, J. E., Chistovich, I. A., Chistovich, L. A., Kozhevnikova, E. V., Ryskina, V. L. (1997). Cross-language analysis of phonetic units in language addressed to infants. *Science, 27,* 684-686. doi: 10.1126/science.277.5326.684

Langthorne, P., & McGill, P. (2011). Assessing the social acceptability of the functional analysis of problem behavior. *Journal of Applied Behavior Analysis, 44,* 403-407. doi:10.1901/jaba.2011.44-403

Lerman, D. C., & Iwata, B. A., (1996). A methodology for distinguishing between extinction and punishment effects associated with response blocking. *Journal of Applied Behavior Analysis, 29,* 231-233. doi:10.1901/jaba.1996.29-231

Love, J. J., Miguel, C. F., Fernand, J. K., & LaBrie, J. K. (2012). The effects of matched stimulation and response interruption and redirection on vocal stereotypy. *Journal of Applied Behavior Analysis, 45,* 549-564. doi:10.1901/jaba.2012.45-549

Patel, M. R., Carr, J. E., Kim, C., Robles, A., & Eastridge, D. (2000). *Research in Developmental Disabilities, 21,* 393-407. doi:10.1016/S0891-4222(00)00051-2

Pelios, L., Morren, J., Tesch, D., & Axelrod, S. (1999). The impact of functional analysis methodology on treatment choice for self-injurious and aggressive behavior. *Journal of Applied Behavior Analysis, 32,* 185-195. doi:10.1901/jaba.1999.32-185

Peters-Scheffer, N. C. (2013). Fostering development in young children with autism spectrum disorder and intellectual disability. *A Center-based Discrete Trial Approach (pp.27-70)*

Phillips, C. L., Iannaccone, J. A., Rooker, G. W., & Hagopian, L. P. (2017). Noncontingent reinforcement for the treatment of severe problem behavior: an analysis of 27 consecutive applications. *Journal of Applied Behavior Analysis, 50,* 357-376. doi:10.1002/jaba.376

Piazza, C. C., Adelinis, J. D., Hanley, G. P., Goh, H., & Delia, M. D. (2000). An evaluation of the effects of matched stimuli on behaviors maintained by automatic reinforcement. *Journal of Applied Behavior Analysis, 33,* 13-27. doi:10.1901/jaba.2000.33-13

Rapp, J. T. (2006). Toward an empirical method for identifying matched stimulation for automatically reinforced behavior: a preliminary investigation. *Journal of Applied Behavior Analysis, 39,* 137-140. doi:10.1901/jaba.2006.37-05

Rapp, J. T., & Vollmer, T. R. (2004). Stereotypy I: A review of behavioral assessment and treatment. *Research in Developmental Disabilities, 26,* 527-547. doi:10.1016/j.ridd.2004.11.005

Richman, D. M., Wacker, D. P., Winborn, L. (2001). Response efficacy during functional communication training: effects of effort on response allocation. *Journal of Applied Behavior Analysis, 34,* 73-76. doi: 10.1901/jaba.2001.34-73

Rincover, A., Cook, R., Peoples, A., & Packard, D. (1979). Sensory extinction and sensory reinforcement principles for programming multiple adaptive behavior change. *Journal of Applied Behavior Analysis, 12,* 221-233. doi:10.1901/jaba.1979.12-221

Risley, T. R. (1968). The effects and side effects of punishing the autistic behaviors of a deviant child. *Journal of Applied Behavior Analysis, 1,* 21-34. doi:10.1901/jaba.1968.1-21

Roscoe, E. M., Iwata, B. A., & Goh, H. (1998). A comparison of noncontingent reinforcement and sensory extinction as treatments for self-injurious behavior. *Journal of Applied Behavior Analysis, 31,* 635-646. doi:10.1901/jaba.1998.31-635

Roscoe, E. M., Iwata, B. A., & Zhoe, L. (2013). Assessment and treatment of chronic handmouthing. *Journal of Applied Behavior Analysis, 46,* 181-198. doi:10.1002/jaba.14

Sajwaj, T., Libet, J., & Agras, S. (1974). Lemon-juice therapy: the control of life-threatening rumination in a six-month-old infant. *Journal of Applied Behavior Analysis, 7,* 557-563. doi:10.1901/jaba.1974.7-557

Saini, V., Greer, B. D., Fisher, W. W., Lichtblau, K. R., DeSouza, A. A., & Mitteer, D. R. (2016). Individual and combined effects of noncontingent reinforcement response blocking on automatically reinforced problem behavior. *Journal of Applied Behavior Analysis, 49,* 693-698. doi:10.1002/jaba.306

Slocum, S. K., Grauerholz-Fisher, E., Peters, K. P., & Vollmer, T. R., (in press). A multicomponent treatment for thinning reinforcer delivery during NCR schedules. *Journal of Applied Behavior Analysis.*

Smith, R. G., Russo, L., & Le, D. D. (1999). Distinguishing between extinction and punishment effects of response blocking: a replication. *Journal of Applied Behavior Analysis, 32,* 367-370. doi:10.1901/jaba.1999.32-367

Toussaint, K. A., & Tiger, J. H. (2012). Reducing covert self-injurious behavior maintained by automatic reinforcement through a variable momentary DRO procedure. *Journal of Applied Behavior Analysis, 45,* 179-184. doi: 10.1901/jaba.2012.45-179

Vollmer, T. R., Marcus, B. A., & LeBlanc, L. (1994). Treatment of self-injury and hand mouthing following inconclusive functional analysis. *Journal of Applied Behavior Analysis, 27,* 331-344. doi:10.1901/jaba.1994.27-331

Vollmer, T. R., Peters, K. P., & Slocum, S. K. (2015). Treatment of severe behavior disorders. *In Clinical and Organizational Applications of Applied Behavior Analysis (47-67)*

Vollmer, T. R., Roane, H. S., Ringdahl, J. E., & Marcus, B. A. (1999). Evaluating treatment challenges with differential reinforcement of alternative behavior. *Journal of Applied Behavior Analysis, 32*, 9-23. doi:10.1901/jaba.1999.32-9

Wunderlich, K. L., Vollmer, T. R., & Zabala, K. A. (2017). Assessment and treatment of automatically reinforced self-inducing emesis. *Journal of Applied Behavior Analysis, 50,* 418-423. doi:10.1002/jaba.371

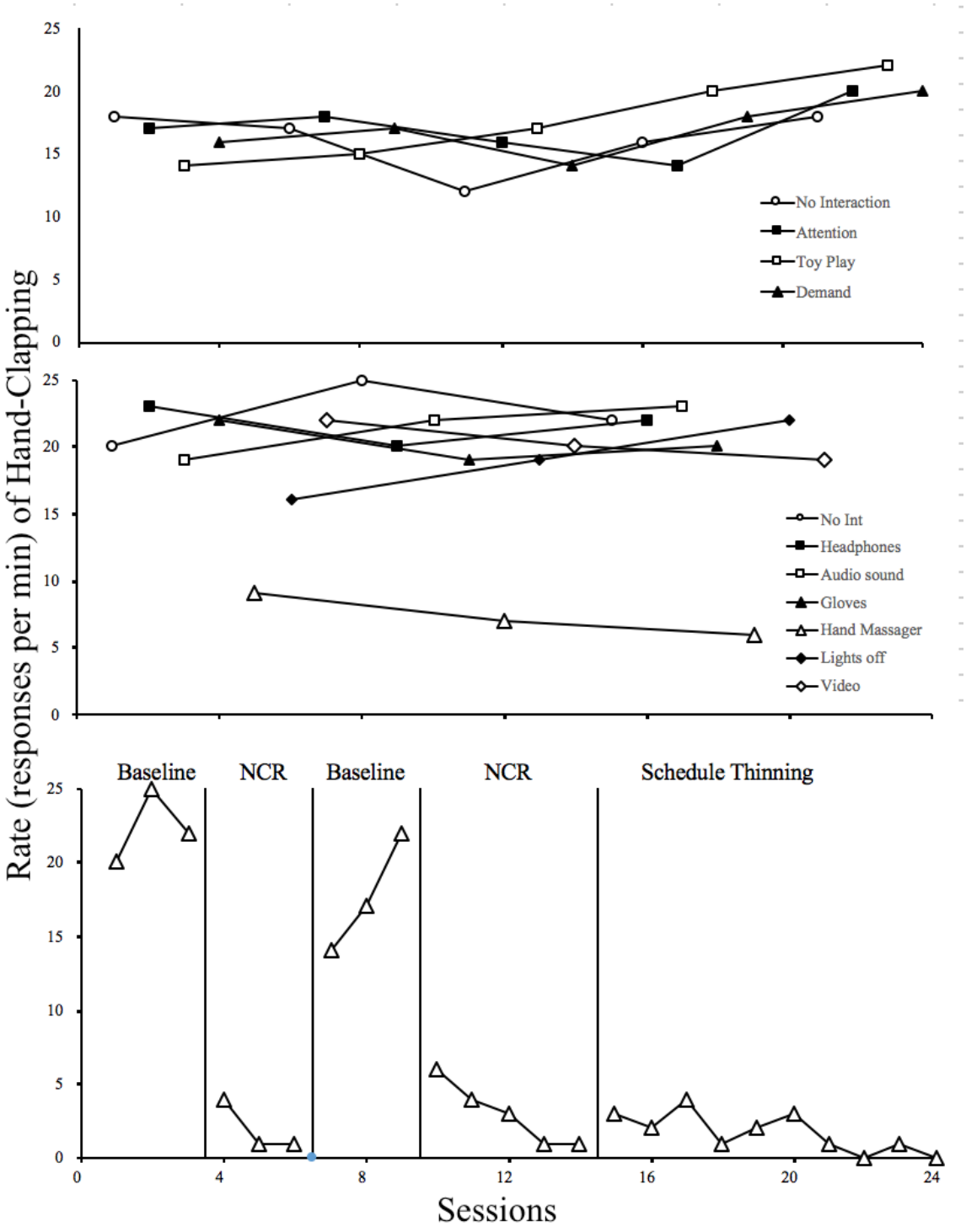

Figure 1. Hypothetical data for one subject during functional analysis (top panel), sensory analysis (middle panel), and treatment (bottom panel) phases.