Summer 2017

Explaining unintended consequences of differential reinforcement of alternative behavior procedures using behavioral momentum theory

Meghan C. Herr
James Madison University

Explaining Unintended Consequences of Differential Reinforcement of Alternative Behavior Procedures using Behavioral Momentum Theory

Meghan C. Herr

A thesis submitted to the Graduate Faculty of

JAMES MADISON UNIVERSITY

In

Partial Fulfillment of the Requirements

for the degree of

Master of Arts

Graduate Psychology

August 2017

FACULTY COMMITTEE:

Committee Chair: Dr. Daniel D. Holt

Committee Members/Readers:

Dr. Trevor Stokes

Dr. Keri Bethune

Table of Contents

List of Figures iii

Abstract iv

Introduction 1

Methods 15
Participants & Setting 15
Target Behaviors, Measurements, & Interobserver Agreement 16
Baseline Multiple Concurrent Schedule 16
Extinction Test 18

Results 18

Discussion 19

Appendices
Consent Form 25
Data Sheet 28

References 29

List of Figures

Figure 1: Line Graph representing Rate of Inappropriate Requests per Minute …….. 23

Figure 2: Line Graph representing Proportion of Baseline Responding …………….. 24

Abstract

Behavioral momentum theory is a model that aids in the explanation of why behaviors that undergo popular intervention procedures, such as differential reinforcement of alternative behavior (DRA) and noncontingent reinforcement (NCR), have been found to increase in persistence and become more resistant to change, even with a reduction in frequency. The present study utilized a multiple concurrent schedule with a boy with autism who was non-verbal to increase his usage of an augmentative communication device to appropriately request for attention. Using the device was reinforced both in a context associated with reinforcement for inappropriate requests as well as in a separate context in which the inappropriate requests had never been reinforced. Then during an extinction test, discriminative stimuli from the novel context was combined with the discriminative stimuli in the target behavior context. Strengthening a response in a separate context using DRA resulted in less resistance to extinction than DRA that was implemented in a context associated with reinforcement of target behavior.

Keywords: behavioral momentum theory, resistance to change, persistence-strengthening effects, alternative response, DRA, NCR

Introduction

Behavioral momentum theory has often been used as a model to explain the resistance to change of behaviors both during and after treatment. The metaphor of this theory stems from basic physics. Newton's Law of Motion states that when an outside force is applied to a moving object, the object's change in velocity is directly related to the magnitude of the outside force and inversely related to the object's mass (Nevin & Shahan, 2011). For example, suppose two trains are traveling down the tracks at the same speed of 65 miles per hour (the two trains have the same velocity). Train A is carrying a load of coal, and Train B is carrying nothing; thus, Train A has a greater mass than Train B (Train A is heavier). Now suppose the train tracks end (outside force). According to the Law of Motion, there will be a smaller change in velocity if the object's mass is large. Thus, Train A will produce a smaller change in velocity (the speed will not decrease as quickly) due to having a heavier mass (coal). Conversely, Train B will produce a greater change in velocity (the speed will reduce quicker) due to it having a smaller mass (not carrying coal).

According to behavioral momentum theory, when a behavior has been reinforced, the reinforcement produces velocity- and mass-like properties of the behavior. Velocity in behavioral momentum theory is analogous to the rate of responding (or how frequent the behavior occurs per unit time). For example, suppose the trains in the example given above were traveling at different speeds (velocity). Train A was traveling at 60 miles per hour and Train B traveling at 70 miles per hour, both carrying the same amount of coal (mass was equal). If the train tracks suddenly ended, Train B would take a longer time to decrease in speed because it was traveling at a higher speed than Train A. Thus, Train A will produce a greater change in velocity (the speed will reduce quicker) with a greater magnitude of the outside force due to the smaller velocity. In behavioral terms, suppose two behaviors were occurring at two different rates – Behavior A is occurring at a rate of 10/hr, and Behavior B is occurring at a rate of 100/hr. Because behavioral momentum theory states that the outside force that is acted upon a behavior would be considered the disrupting event, imagine that extinction sessions are run that serve as the disrupting event. According to behavioral momentum theory, Behavior A will produce a greater change in behavior (or will decrease in rate much quicker) than Behavior B because it is occurring at a lesser rate.

The mass-like property is analogous to the behavior's resistance to change despite any disrupting events, such as extinction or satiation (via response-independent delivery of the reinforcer) (Podlesnik & DeLeon, 2015). The resistance to change in behavioral momentum theory describes the behavior's persistence throughout interventions designed to decrease the behavior. The analogy holds that if the behavior has a heavy mass, it has a greater resistance to change; that is, the behavior is more persistent than a behavior that has less mass. For a behavior to become resistant to change, it must have a history of being reinforced at a high rate. Conversely, a behavior that has a history of being reinforced at a lower rate will be less resistant to change. For example, suppose the two trains were both traveling at 65 mph (velocity). However, Train A is carrying coal and Train B is carrying nothing; therefore, they have different masses. When the train tracks end, Train A is going to have a smaller change in velocity (decrease slower) due to the heavier mass. In behavioral terms, if two behaviors are both occurring at a rate of 60/hr, but Behavior A is being reinforced on an fixed-ratio (FR) 10 schedule, and Behavior B is being reinforced on an FR-50 schedule, Behavior A is going to have a smaller change in behavior when extinction takes place. In other words, Behavior A is going to be more resistant to extinction (decrease in rate slower) because it was reinforced more often/at a higher rate than Behavior A.

Therefore, a large disruptor, such as the delivery of response-independent reinforcers, will have more of an impact on the response rate (velocity) but less of an impact on the behavior's resistance to change (mass). The behavior's change in response rate (decrease in velocity) is directly related to the magnitude of that disrupting event but also inversely related to the behavior's resistance to change (mass). That is, large disruptors will produce a quicker decrease in the behavior's response rate (velocity) more rapidly than a small disruptor; however, a behavior that has been reinforced at a higher rate (more mass) than others will persist more than a behavior that has not been reinforced at a high rate (less mass) (Greer, Fisher, Romani & Saini, 2016).

For example, suppose a child gets out of his seat during class at a rate of five times in a ten-minute period (the behavior's velocity) and this behavior has been reinforced for the entire school year (the behavior's mass). To try and decrease this behavior, suppose the teacher then satiates the child by presenting reinforcers in the form of candy independent of the child's behavior every 15 seconds (the disruptor). Because of how frequent the candy is being delivered, it can be assumed that the disruptor is large, and its effects will have a greater impact on the rate of getting out of his seat (velocity) but will have less of an impact on changing that behavior (due to the behavior's mass) compared to candy being delivered at a lesser rate. Therefore, the reinforcement will decrease the out of seat behavior (the behavior's velocity) because the child realizes that they do not need to engage in that behavior in order to receive reinforcement. However, the additional reinforcement will also increase the resistance to change because behaviors that occur in contexts that are associated with higher reinforcement rates have a tendency to persist during disrupting events than behaviors that occur in contexts that have lower rates of reinforcement (DeLeon, Podlesnik, & Miller, 2015).

The theory proposes that response rate and resistance to change are independent aspects of operant behavior (Nevin, Mandell, & Atak, 1983). Operant behavior can be described through the three-term contingency: an antecedent/discriminative stimulus (S^D), a behavior (B), and a consequence (C). In the presence of an S^D, an organism responds (B) and produces a consequence (C) that will increase the future probability of the behavior. When a response is reinforced (B → C) in the presence of a particular stimulus (S^D), it increases the likelihood of the response occurring in future situations when that stimulus is present. For example, suppose you are teaching your dog to sit. First, you would reinforce the dog with a treat each time he sat down (B → C). Once he has learned that sitting produces treats, you may then introduce the command of "Sit" which would serve as the S^D. When the dog sits (B) upon your command (S^D) the dog receives a treat (C). Therefore, in the presence of the S^D (the command "sit") the dog sits (B) and receives a treat (C). When this occurs, the likelihood of the dog sitting increases in future situations when the dog hears the verbal command of "sit."

Consequently, through repeated pairings of stimulus and reinforcement, the organism learns to respond in the presence of a particular stimulus because it has led to reinforcement in the past. By repeating these pairings over time, the behavior's mass increases and thus increases the resistance to change. Therefore, the ability for behavior to become resistant to change is heavily influenced by the rate of reinforcement. Behavioral momentum theory predicts that a longer history of reinforcement will cause an increase in the behavior's resistance to change. When a disruptor is present, a behavior's resistance to change depends on the contingencies between the S^D context and the reinforcer. When a behavior is reinforced often in a specific stimulus context, the individual comes to associate that context with reinforcement, which has an impact on whether the behavior will become resistant to change if a disruptor is used within that context (Nevin & Grace, 2000).

A behavior's response rate depends on the behavior and reinforcement contingencies. When a behavior is reinforced frequently, the rate of responding is likely to be higher in order to receive the reinforcer; conversely, if the behavior is not frequently reinforced, the response rate may be lower. Behavioral momentum theory suggests that by degrading the relation between the behavior and consequence by introducing any reinforcement that is independent of a response (noncontingent) or dependent upon a different response will decrease the rate of target responding (Podlesnik & DeLeon, 2015). Thus, through repeated presentations of a noncontingent reinforcer or reinforcement for a different response, the individual can learn that they do not need to engage in the target response in order to obtain reinforcement, and the response rate decreases.

Conversely, adding reinforcement into a stimulus context will increase the resistance to change by enhancing the relation between the antecedent-stimulus context and the response, despite the decrease in target responding (Podlesnik & DeLeon, 2015). When adding reinforcement into a context where responding already produces reinforcement, the value of that context increases. In other words, the individual associates the specific context with reinforcement. Although responding may decrease due to the delivery of noncontingent reinforcers or reinforcers contingent upon a different response, the response becomes resistant to changing when a disruptor is used because the individual has learned that that context has provided reinforcement in the past.

With the metaphor of behavioral momentum theory being analogous to physics, we are able to quantify the relation between resistance to change and the disruptors in the environment that impact the behavior:

$$log\ \left(\frac{B_x}{B_0}\right) = \frac{-x}{(r)^b}$$

The response rates during disruption (B_x) are expressed relative to stable baseline response rates (B_0). The magnitude or value of the disruptor (*x*) is negative due to the decrease in response rates that is observed during disruption. The rate of reinforcement in the discriminative-stimulus context is shown as *r*, and *b* serves the function of scaling "the relation between log proportion of baseline response rates and the reinforcement rate arranged in the presence of the discriminative stimulus" (Podlesnik & DeLeon, 2015). Thus, the equation predicts that a bigger disruptor (*x*) produces a larger change in behavior; however, the disruptor's effects are lessened by higher rates of reinforcement (*r*) (Nevin & Shahan, 2011).

Nevin, Tota, Torquato, and Shull (1990) tested response rate and resistance to change in two separate experiments with pigeons. In their first experiment, the experimenters arranged food reinforcement according to a VI-60s schedule (*r*) when the pigeons pecked at either red or green keys. Although the red and green keys both produced equal rates of response-dependent food reinforcement, they increased the overall food rate by adding response-independent food reinforcers (*x*) in the presence of the red key according to a variable time (VT) schedule (*r*). Therefore, both keys were being reinforced on a VI-60s schedule dependent upon a pecking response, but the red key had an additional VT component that provided reinforcement independent of a pecking response (Nevin et al., 1990; Podlesnik & DeLeon, 2015). Behavioral momentum theory predicts that adding response-independent reinforcement will decrease the rate of pecking, but increase the pecking behaviors' resistance to change.

As a test for resistance to change, the pigeons were either satiated prior to test sessions or all food presentations were eliminated (extinction). Nevin et al. found that the rate of key pecks throughout the red key component decreased, but the response-independent reinforcement produced a greater resistance to change during extinction sessions due to being exposed to a higher reinforcement rate (1990). These findings were produced by degrading the relation between behavior and consequence (reduced response rate) and by enhancing the relation between the antecedent-stimulus context and consequence (increased resistance to change).

In Experiment 2, Nevin et al. were interested in determining if providing food contingent on an alternative response would increase the resistance to change as it had in the first experiment with response-independent food presentations (1990). They hypothesized that providing reinforcement contingent upon a different response may function the same as providing reinforcement independent of responding by increasing the overall reinforcement rate and enhancing resistance to change. Three different pairs of concurrent schedules were signaled by different key colors. In the first pair (Condition A), food reinforcement was given at a rate of 45 food presentations an hour for pecking at the left key (the alternative response), while the right key produced 15 food presentations an hour. In the second pair (Condition B), no reinforcement was provided if the pigeon pecked the left key and 15 food presentations per hour were given for pecks at the right key. In the third pair (Component C), the target response on the right key was the only response that was scheduled for reinforcement at a rate of 60 food presentations per hour. Therefore, Components A and B had equal food rates for the target response on the right key but Component A had additional food presentations for the alternative response. Components A and C had equal overall food rates but they were either exclusively concentrated on the right key in Component C or distributed across both keys in Component A (Nevin et al., 1990).

Nevin et al. (1990) hypothesized that if food contingent on an alternative response functioned the same as food that was not contingent upon any response, then the target response in Components A and C should be more resistant to change due to the higher rates of reinforcement given. Nevin and his colleagues either satiated or ran extinction sessions to test for resistance to change. The results supported their hypothesis by showing that the conditions with more reinforcement produced greater resistance to change. Thus, this finding supported behavioral momentum theory by showing that a behavior's resistance to change was a function of the overall reinforcement rate (1990; Podlesnik & DeLeon, 2015).

To further support behavioral momentum theory, Mace et al. (1990) conducted a study involving two adults with disabilities in a group home setting using a video as a distractor (*x*). Mace and his colleagues were interested in whether resistance to distraction of human performance was dependent upon reinforcer rates on a multiple VI VI schedule (*r*) as it was with nonhuman subjects, or whether resistance to distraction is greater by adding additional response-independent reinforcers (*x*) in one component of a multiple schedule in the same way it is with nonhuman subjects. The subjects engaged in a sorting task with 40 red or green plastic eating utensils in which they were required to remove one utensil at a time and place them into a container (Mace et al., 1990).

Baseline utilized a multiple-schedule and was divided into two parts. In Part 1, sorting red or green utensils was either reinforced on a VI-60s schedule or a VI-240s schedule. In Part 2, sorting both color utensils were reinforced on a VI-60s schedule, but one of the colored utensils produced response-independent reinforcers on a VT-30s schedule. Then, a concurrent distracting stimulus condition was added to test for resistance to distraction of sorting utensils, in which a video was presented to the participants with the multiple-schedule procedure remaining in effect. Behavioral momentum theory predicts that because reinforcement was added independent of a response in addition to an already present schedule of reinforcement in Part 2, that the rate of responding would decrease. The theory also predicts that because of the added reinforcement, the behavior's resistance to distraction should be greater.

Results showed that participants engaged in the sorting task at a higher rate during the VI-60s schedule rather than the VI-60s VT-30s schedule, which demonstrates that response rates decrease when responding is not needed to receive reinforcement. Additionally, results revealed that there was a decrease in responding relative to baseline when the video was being played, as well as a higher rate of responding during the component with the higher rate of reinforcement, suggesting that resistance to distraction was greater in the component where the participants were receiving more reinforcement

(Mace et al., 1990). These findings support behavioral momentum theory – a disrupting stimulus produces a larger change in behavior; however, the change in behavior is lessened as rate of reinforcement increases.

Parry-Cruwys et al. (2011) conceptually replicated and extended the study conducted by Mace et al. (1990) by determining resistance to disruption in a classroom setting. Specifically, they were interested in differing schedules of reinforcement to observe its effect on the strength of task-related behavior while presenting commonly occurring distracting stimuli. Subjects were six boys in special education programs that were asked to complete a task. Baseline sessions included alternating components with two tasks, with one task being on a VI-7s schedule and the other task being on a VI-30s schedule (*r*). Tests sessions were conducted the same way that baseline sessions were conducted; however, during test sessions a distracting item (*x*) was presented either by introducing another experimenter who sat next to each subject and engaged with the item close enough so that the subjects could observe, or by placing the item on a table. The same schedules of reinforcement for responding were applied during test sessions as baseline sessions (Parry-Cruwys et al., 2011).

According to behavioral momentum theory, a disruptor's effect is lessened during a schedule presenting a high rate of reinforcement. It predicts that even when response rate decreases in the presence of the distracting stimulus, the behavior will be more resistant to changing after being exposed to high rates of reinforcement. In Parry-Cruwys et al. study, the task that was associated with a richer schedule of reinforcement (VI-7s schedule) produced greater resistance to change in five out of the six participants (2011). Thus, their findings were consistent with the prediction of behavioral momentum theory.

These findings supporting behavioral momentum theory are especially important for applied behavior analysts. Response-independent reinforcement, or noncontingent reinforcement (NCR), and the use of response-dependent reinforcement, or differential reinforcement of alternative behavior (DRA), are widely used procedures to reduce or eliminate problem behavior in humans, and have proved successful across a wide range of populations and behaviors. NCR is a treatment in which reinforcement is provided on a time-based schedule regardless of the behavior the individual is engaging in; typically, in the same context that problem behavior occurs. The reinforcers given independent of responding are typically those that have shown reinforcing properties in the past, or are the same reinforcers that maintain the problem behavior. When using NCR, the response rate of problem behavior will likely decrease because known reinforcers or the reinforcers maintaining the problem behavior are given freely and responding is not needed to gain access to them. For example, suppose a child frequently gets out of his seat during class and picks up one of his favorite stuffed animals, which gains him access to a tangible. In order to reduce this behavior and increase the behavior of staying at the table, the teacher implements a NCR procedure. The teacher provides the student a piece of candy every 15 seconds (FI-15s) independent of the behavior he may be engaging in (given access to a tangible). If the procedure is effective, the teacher will see a decrease in the behavior of getting out of his seat.

DRA is also widely used as a way of teaching an individual to engage in an alternative behavior to gain access to the same reinforcers that are maintaining the problem behavior. This procedure attempts to eliminate or reduce problem behavior by reinforcing an alternative behavior in the same context where the problem behavior occurs, while simultaneously placing the problem behavior on extinction. For example, suppose a child hits the teacher and frequently gets placed in “time out” on the other side of the room, where he sits alone. A behavior analyst determines that the hitting behavior is being maintained by escaping the situation (perhaps they are doing math, and the child does not like math). A DRA procedure would involve teaching the child to request a break by saying, “Break” when he wants to get away from the table, and is provided reinforcement upon doing so. Therefore, he is still gaining access to what he wants (escape from the situation) but he is doing so in a more socially appropriate manner. If he hits instead of requesting a break, that behavior is placed on extinction by not allowing him to escape from the situation (withholding reinforcement). In this situation, the problem behavior of hitting is likely to decrease because he is gaining access to the reinforcers maintaining that behavior by engaging in a different response.

However, while NCR and DRA treatments are being successively utilized for a variety of behaviors, consequences of these treatments have been shown that pose a problem when implementing them. The treatments either introduce additional sources of reinforcement or provide an alternative source of reinforcement in the same context that problem behavior occurs. As studies have shown, and as behavioral momentum theory predicts, the added reinforcement into a context will increase the behavior’s resistance to change, despite seeing a decrease in that behavior.

For example, Ahearn et al., (2003) implemented an NCR procedure in an effort to decrease stereotypical behavior that was maintained by automatic reinforcement in three children with autism. By conducting a preference assessment, researchers identified two high preference items that were correlated with low levels of stereotypy to be used during

NCR treatment. The first item was presented noncontingently on a VT-30s schedule in one condition, and the second item was used as a test for disruption of stereotypy in a following condition. Additionally, they had a separate situation to serve as a control in which the items were not presented noncontingently but the test condition was still presented. Results concluded that there were reduced levels of stereotypy during the VT-30s exposure condition (NCR), but levels of stereotypic behavior were higher during the test sessions following exposure to the VT-30s schedule compared to the situation where NCR was not given (Ahearn et al, 2003). Thus, implementing an NCR procedure to reduce problem behavior can ultimately make the behavior more resistant to changing, offering an implication of the treatment for behavior analysts.

In contrast, Mace et al. (2010) conducted a study to test the resistance to change after implementing a DRA procedure. Three children with developmental disabilities engaged in problem behavior (hair pulling, aggression, stealing) in order to gain access to attention or to food. Following a baseline condition of varied reinforcement schedules, a DRA treatment was implemented, in which praise was given contingent on appropriate toy-play and access to food was given contingent on appropriate requests. As a test for resistance to change, researchers implemented an extinction procedure by blocking the attempts of problem behavior and withholding reinforcement that was maintaining the problem behavior both after baseline sessions and after DRA treatments. Following DRA treatment, the results of the extinction phase showed a decrease in problem behavior but this decrease took three times as long when compared to extinction after baseline. Therefore, although rate of problem behavior decreased, the resistance to change was greater following DRA treatment (Mace et al., 2010).

However, after achieving these results, Mace et al., (2010) proposed and tested a solution. They were interested in whether teaching an alternative response in a context where the disruptive behavior had not been reinforced would decrease the resistance to change in DRA treatments when introducing the response into the context of disruptive behavior. According to behavioral momentum theory, this would not enhance the antecedent-stimulus relation because the reinforcement for the alternative response would not be given in the context of problem behavior. Reinforcing the alternative response in the novel context would alleviate the additional reinforcement added to the context that problem behavior had been previously reinforced, and should lessen the resistance to change of problem behavior. Mace et al. (2010) taught appropriate communicative responses to two males who engaged in disruptive behavior in order to escape from demands in a context separate from ones associated with reinforcement for that behavior. After combining the alternative response context with the problem behavior context, researchers withheld all reinforcement as a test for resistance to change and results showed that rates of disruptive behavior were low (Mace et al., 2010). This finding provided evidence that teaching the alternative response in a DRA treatment in a context not associated with reinforcement for the problem behavior may avoid the greater resistance to change that is often seen when the alternative response is reinforced in the same context as problem behavior.

Mace et al.’s (2010) study addressed an issue that arises when implementing a DRA procedure. Although the procedure works as it should by decreasing behavior, it has been shown that it causes unintended consequences for that behavior. However, the proposed solution provides some evidence for an approach to avoid enhancing the resistance to change of behaviors when utilizing the widely-used procedure. By using this proposed solution, it may improve the usage of the DRA procedure and yield better outcomes.

The present study sought to replicate and expand the findings presented by Mace et al., 2010. One student engaged in inappropriate requesting behavior and was prompted to use a known, but not well established, appropriate communicative response using a DRA procedure. This alternative response was reinforced in a context in which the inappropriate behavior had no reinforcement history as well as a context in which inappropriate behavior frequently occurred. Then, the target response was tested during extinction in the novel context and was compared to responding in which DRA was implemented in the same context where problem behaviors had a history of reinforcement.

Method

Participants and Setting

The participant was one male enrolled in an inclusive preschool classroom. James was a 6-year-old male student with autism. James was non-verbal and used an augmentative communication device (specifically, Vantage Lite™) when prompted in order to communicate with others. Otherwise, his usual means of communication would be engaging in gestures, leading individuals to different places, grabbing or pulling on individuals. The participant's parents provided informed consent prior to participation in this study, which was written consistent with the James Madison Institutional Review Board approved protocol. Appendix A includes a copy of the consent form.

Sessions were conducted in two different rooms in the preschool; one being the general classroom, and the other a room not in use that contained a bookshelf of stored items for staff in the school as well as a few toys and books, and a back room with a computer and table with another bookshelf of toys.

Target Behavior, Measurement, and Interobserver Agreement

James' inappropriate requests for attention were the target behaviors to be measured. Inappropriate requests were defined as any form of gesturing that involved making eye contact, tapping one's chin or face, reaching out towards an individual or an object, grabbing an individual's hands, making eye contact while clapping at least two times in a row, and making eye contact while blowing with his mouth. Appropriate requests served as the alternative behavior and were defined as any input into the Vantage Lite™.

Data for inappropriate requests was collected using count data recording within 10-second intervals during sessions that varied in length. Interobserver agreement(IOA) was calculated on a minimum of 40% of the sessions, and the mean occurrence agreement was 71%. This low percentage for IOA was due to a misunderstanding of the definition of the target behavior between observers.

Baseline Multiple Concurrent Schedule

Components were presented to the participant in random order without replacement and the instructor did not interact with the participant between components. One set of each of the three components were presented per day, 3-4 days per week.

Component 1. This component included reinforcement of the target behavior without reinforcement of the alternative behavior. The sessions began when the class sat down on the carpet and the teacher began "circle time" instruction. The instructor sat next to the participant during the entire session. Contingent on inappropriate behavior, the instructor engaged in the activity that was desired by the participant on a VI-75s schedule. If the participant engaged in the inappropriate behavior before the interval was over, the instructor said "You need to wait." The completion of each interval was signaled to the instructor via an interval app on a Smartphone, in which the instructor wore headphones in order to hear when the interval was over.

Component 2. This component represented positive reinforcement of appropriate behavior in the same context in which inappropriate behavior was positively reinforced. Procedures in Component 2 were identical to those in Component 1, except that an instructor prompted the participator to use the Vantage Lite™ on a fixed interval 20-second schedule (FI-20s). Prompts were "What do you want?" or "Show me." Contingent on usage of the Vantage Lite™, the instructor engaged in the activity that was desired as described in Component 1. If the participant used the Vantage Lite™ prior to the elapse of the FI-20s interval, the instructor said "You need to wait." Inappropriate behavior continued to be reinforced on the VI-75s schedule described in Component 1. The instructor placed a pink sheet of colored paper under the device to signal this component.

Component 3. This component included reinforcement of alternative behavior in a context that provided no previous reinforcement of inappropriate requesting behavior. During this component, the instructor engaged in play activities with the participant and reinforced his usage of the Vantage Lite™ as described in Component 2. However, no reinforcement was provided by the instructor contingent on inappropriate requests. The instructor placed a yellow sheet of colored paper under the device to signal this component.

Extinction Test

Instruction on the carpet or engagement in play activities continued as in baseline during all three components. All reinforcement of inappropriate behavior and appropriate behavior of using the Vantage Lite™ was discontinued in order to test the hypothesis that reinforcement of alternative behavior in a separate context from the context that reinforced problem behavior could reduce or avoid the persistence-strengthening effects of DRA. The discriminative stimuli from Component 1 and Component 2 were the same as baseline during the extinction tests. However, Component 3 was comprised of a compound of the discriminative stimuli from baseline Component 1 and baseline Component 3. This compound component symbolized the clinical situation in which an alternative behavior, such as a socially appropriate communicative response, is first established in a context with no previous history of reinforcement for problem behavior prior to introducing the discriminative stimuli correlated with alternative behavior into the context that has a history of reinforcement for the problem behavior.

Results

Figure 1 presents baseline data from the three components of the multiple concurrent baseline schedule. James had the highest rate of inappropriate requests per minute during Component 1 (M=1.7/min) in which only inappropriate requests were reinforced, despite the decrease in responding seen by the third session. The lowest rate of inappropriate requests was during Component 3 when only appropriate requests were reinforced (M=0.5/min). A steady increase in responding was seen beginning at the sixth session and then dropped by the ninth session. Component 2, which had two schedules of reinforcement, produced a rate of inappropriate requests that were slightly higher than Component 3 (*M*=0.6/min). Rates of responding during this component were fairly steady across all ten sessions.

Figure 2 presents data from the extinction test for all three components. Resistance to extinction as proportion of baseline response rate was calculated and was greatest during Component 2 (M=0.9) compared to Component 1 (M=0.4) and Component 3 (M=0.7). According to behavioral momentum theory and Mace et al. (2010)'s findings, proportion of baseline responding should be highest during Component 2, which was previously associated with higher rates of reinforcement. Likewise, Component 3 should be high also, because the compound of baseline Component 1 and 3 is equal to the rates of reinforcement from Component 2 in baseline. However, as in Mace et al. (2010)'s study, the average proportion of baseline responding was lower in Component 3 than Component 2.

Discussion

The present study was a replication of Mace et al. 2010's study with some variations. Whereas Mace and colleagues trained an alternative response in a novel context, the current study worked to increase usage of certain known phrases on an augmentative communication device. Despite this variation, a difference between the components was still seen. During baseline, inappropriate requests for attention were highest during the component that only reinforced that behavior (Component 1). The rate of these requests dropped in Component 2 where the participant was reinforced for both inappropriate and appropriate requests. The lowest rate of inappropriate behavior was seen during Component 3, when no reinforcement was given contingent upon such behavior.

During the extinction test, proportion of baseline responding should have been highest during Component 2, as behavioral momentum theory suggests, due to the higher rates of reinforcement during baseline. For this study, the average proportion of baseline responding for Component 2 was 0.9, making responding in this component higher than Component 1 (M=0.4) and Component 3 (M=0.7). However, most noticeably was the rate of responding during Component 3, which was the compound stimulus component. The rate of reinforcement during this component equaled that of Component 2 but the proportion of baseline responding was lower. Although the average difference was not large, it nevertheless provides some evidence that training an alternative response in a context in which problem behavior had never been reinforced would reduce the persistence strengthening effects of DRA procedures.

There were a few limitations in this study. First, with only one participant, it is difficult to discern whether these findings would be the same across different participants. Therefore, future research should work to include more participants. Secondly, unlike the Mace et al. (2010) study, a new communicative response was not taught in the separate context. Instead, phrases on the communication device that were not frequently used were prompted during activities, which could have contributed to the variability in responding. By the third session in baseline, there was a noticeable decrease via visual analysis in James' behavior. This could have been due to medical issues that were occurring with the participant at the time. Additionally, James could have learned that sitting on the carpet and engaging in inappropriate requests did not produce reinforcement as frequently as it once had. It is also possible that the participant was unable to discriminate between the three components and thus not able to understand what each component entailed. Future research should ensure that salient stimuli are used so that participants can distinguish between the components.

Another limitation involved the setting. Sessions were conducted in a naturally occurring setting of the participant's classroom, which decreased the amount of control the instructor had compared to a more contrived setting. This could have posed extraneous variables that influenced the participant's behavior. Future research should consider conducting sessions in more contrived settings compared to naturally occurring settings to allow for more control. Furthermore, due to the sessions occurring in the natural environment, the instructor did not have much control over how long the classroom instruction on the carpet would occur, which thus contributed to the differences in length of the sessions. Because the instructor experienced time constraints, some sessions occurred close together in time, which could have caused carryover effects from one component to another. Additionally, the time constraints caused the instructor to conduct baseline Component 3 last for all 10 sessions, raising an issue for counterbalancing the components, which may also have caused carryover effects. Research conducted in the future should be aware of this possible confound if time constraints are observed. Lastly, the rate of inappropriate requests was not high to begin with, so more of an effect could have possibly been seen had the participant engaged in the behavior at a higher rate.

In conclusion, behavioral momentum theory is a model that is helping behavior analysts understand why resistance to change in behaviors is happening, and thus leading to proposed solutions to circumvent the persistence-strengthening effects of such widely used procedures. Focusing on findings supported by behavioral momentum theory may help to shift the focus more on the long-term effects of behavior change interventions rather than primarily focusing on the more immediate effect, such as a quick behavior reduction. Understanding the role of reinforcement rate can help behavior analysts remain cognizant about how it will affect behavior in the future and thus ensure that procedures such as DRA that are used to establish new behaviors are being implemented as effectively as possible.

Figure 1.

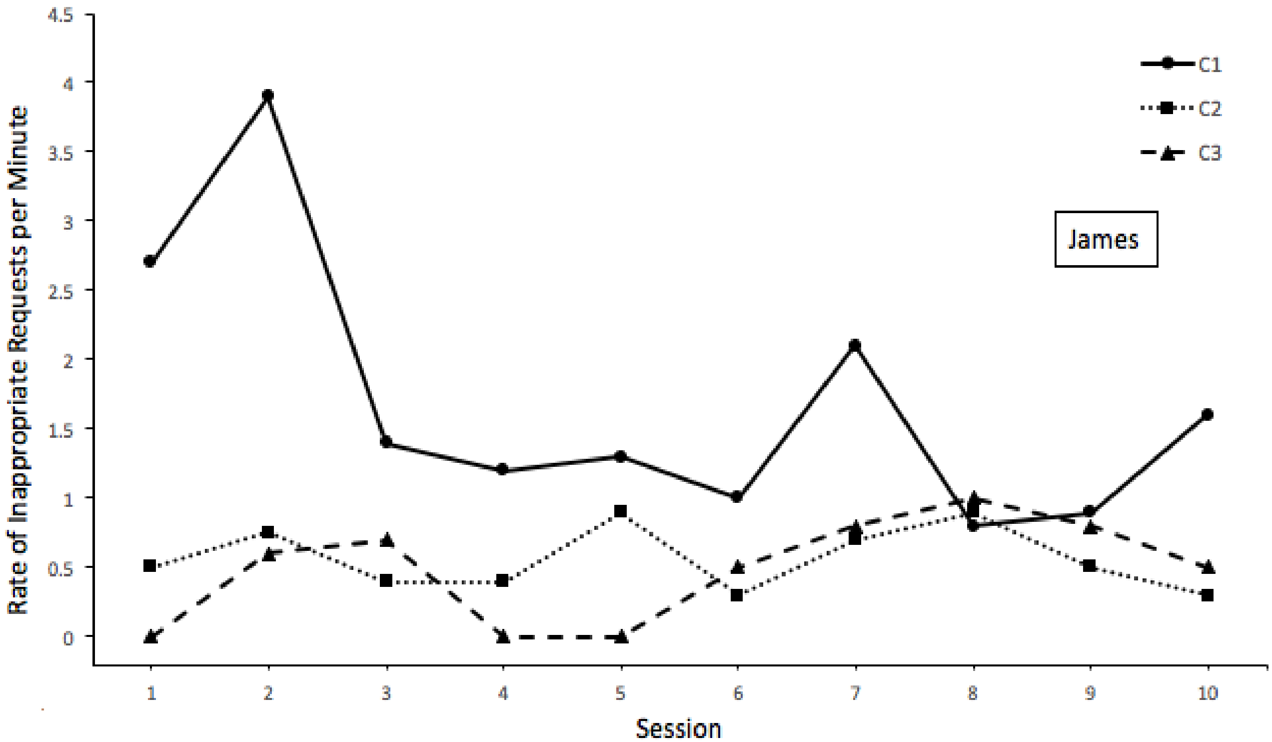

Figure 1 shows the rate of inappropriate requests per minute for James during the three baseline components.

Figure 2.

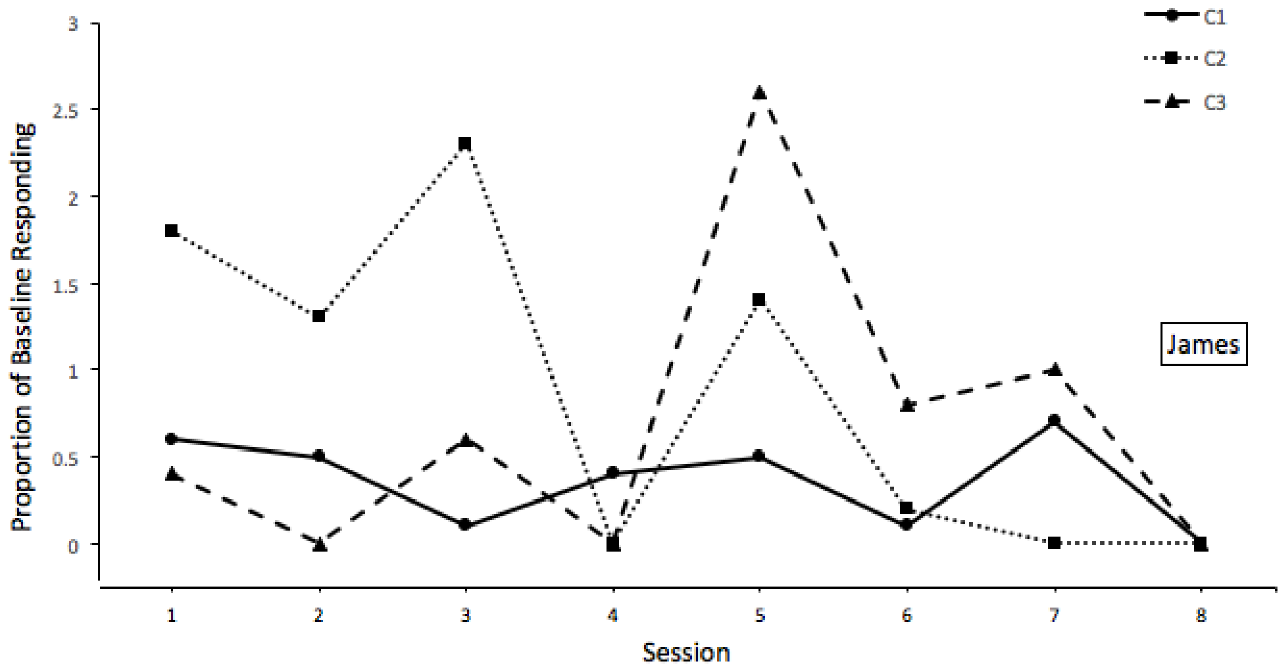

Figure 2 shows the proportion of baseline responding during extinction sessions for James during all three components.

Appendix A: Consent Form

Parent/Guardian Informed Consent

Identification of Investigators & Purpose of Study

Your child is being asked to participate in a research study conducted by Meghan Herr from James Madison University. The purpose of this study is to help teach your child an appropriate communicative response to gain access to the things they want or need in hopes this will decrease problematic behavior. This should help the teacher and assistants understand your child to ensure his wants and needs are being understood and communicated effectively. This study will contribute to the researcher's completion of her master's thesis.

Research Procedures

Should you decide to allow your child to participate in this research study, you will be asked to sign this consent form once all your questions have been answered to your satisfaction. This study consists of different session components that will be administered to individual participants in your child's preschool classroom as well as an unoccupied room in the preschool. Your child will be asked to say a verbal statement in order to gain access to what they want, rather than engage in problematic behavior that makes it difficult for teachers to provide help. With your permission, sessions with your child and the teacher will be video-taped to assist with data collection.

Time Required

Participation in this study will require 30 minutes of your child's time, three times per week. There will be three different sessions, each lasting 10 minutes. The first two sessions/20 minutes will be conducted in your child's classroom and will not interrupt the normal routine. The last 10 minutes will be conducted in a separate room, but will still use the materials they are working with in the classroom. In total, this study will require 90 minutes of your child's time per week for 3 weeks, but may require more. If so, the researcher will notify you of the changes.

Risks

The investigator does not perceive more than minimal risks from your child's involvement in this study (that is, no risks beyond the risks associated with everyday life).

Benefits

Potential benefits from participation in this study include teaching your child a behavior that expands their communicative skill set and helps teach the importance of language to gain access to the things they want or need through appropriate behaviors. The benefits of the research as a whole include expanding the findings about the specific procedure used to ensure that it is being implemented as effectively as possible.

Payment for participation
There is no payment for taking part in this study.

Confidentiality
The results of this research will be presented to a committee of professors and professionals at James Madison University to fulfill the master's thesis requirements. Your child will be identified in the research records by a code name or number, and no identifiable data will be kept. The researcher retains the right to use and publish non-identifiable data. When the results of this research are published or discussed in conferences, no information will be included that would reveal your child's identity. All data will be stored in a secure location (a locked room inside a locked filing cabinet) accessible only to the researcher. The videos will be destroyed after viewing and appropriate data is taken.

There is one exception to confidentiality we need to make you aware of. In certain research studies, it is our ethical responsibility to report situations of child abuse, child neglect, or any life-threatening situation to appropriate authorities. However, we are not seeking this type of information in our study nor will you be asked questions about these issues.

Participation & Withdrawal
Your child's participation is entirely voluntary. They are free to choose not to participate. Should you and your child choose to participate, your child can withdraw at any time without consequences of any kind.

Questions about the Study
If you have questions or concerns during the time of your child's participation in this study, or after its completion or you would like to receive a copy of the final aggregate results of this study, please contact:

Meghan Herr
Psychology
Psychology
James Madison University
herrmc@dukes.jmu.edu

Daniel D. Holt
Department of Psychology/Graduate
James Madison University
Telephone: (540) 568-5051
holtdd@jmu.edu

Questions about Your Rights as a Research Subject
Dr. David Cockley
Chair, Institutional Review Board
James Madison University
(540) 568-2834
cocklede@jmu.edu

Giving of Consent
I have read this consent form and I understand what is being requested of my child as a participant in this study. I freely consent for my child to participate. I have been given satisfactory answers to my questions. The investigator provided me with a copy of this form. I certify that I am at least 18 years of age.

☐ I give consent for my child to be videotaped during their sessions._____ (parent's initial)

____
Name of Child (Printed)

____
Name of Parent/Guardian (Printed)

________________________________ ____________
Name of Parent/Guardian (Signed) Date

________________________________ ____________
Name of Researcher (Signed) Date

Appendix B: Data Sheet

Student:

Data collector:

Date:

Behavior: Inappropriate Mand Appropriate Mand

Component: 1 2 3

IOA?: Y N

Minute	10-second Intervals					
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

References

Ahearn, W. H., Clark, K. M., Gardenier, N. C., Bo In Chung, N. C., & Dube, W. V. (2003). Persistence of stereotypic behavior: Examining the effects of external reinforcers. *Journal of Applied Behavior Analysis, 36*(4), 439-448.

DeLeon, I. G., Podlesnik, C. A., & Miller, J. R. (2015). Implications of behavioral momentum theory for intervention in autism spectrum disorder. In *Autism Service Delivery: Bridging the Gap between Science and Practice* (pp. 353-374). Springer, New York.

Greer, B., Fisher, W., Romani, P., & Saini, V. (2016). Behavioral momentum theory: A tutorial on response persistence. *The Behavior Analyst, 39*(2), 269-291.

Mace, F. C., Lalli, J. S., Shea, M. C., Lalli, E. P., West, B. J., Roberts, M., & Nevin, J. A. (1990). The momentum of human behavior in a natural setting. *Journal of the Experimental Analysis of Behavior*, *54*(3), 163-172.

Mace, F. C., McComas, J. J., Mauro, B. C., Progar, P. R., Taylor, B., Ervin, R., & Zangrillo, A. N. (2010). Differential reinforcement of alternative behavior increases resistance to extinction: Clinical demonstration, animal modeling, and clinical test of one solution. *Journal of the Experimental Analysis of Behavior, 93*(3), 349-367.

Nevin, J. A., Mandell, C., & Atak, J. R. (1983). The analysis of behavioral momentum. *Journal of the Experimental Analysis of Behavior*, *39*, 49-59

Nevin, J. A., Tota, M. E., Torquato, R. D., & Shull, R. L. (1990). Alternative reinforcement increases resistance to change: Pavlovian or operant contingencies? *Journal of the Experimental Analysis of Behavior, 53*(3), 359-379.

Nevin, J. A., & Grace, R. C. (2000). Behavioral momentum and the law of effect. *The Behavioral and Brain Sciences, 23*(1), 73-90.

Nevin, J. A., & Shahan, T. A. (2011). Behavioral momentum theory: Equations and applications. *Journal of Applied Behavior Analysis, 44*(4), 877-895.

Parry-Cruwys, D. E., Neal, C. M., Ahearn, W. H., Wheeler, E. E., Premchander, R., Loeb, M. B., & Dube, W. V. (2011). Resistance to disruption in a classroom setting. *Journal of Applied Behavior Analysis, 44*(2), 363-367.

Podlesnik, C. A., & DeLeon, I. G. (2015). Behavioral momentum theory: Understanding persistence and improving treatment. In *Autism Service Delivery: Bridging the Gap between Science and Practice* (pp. 327-351). Springer, New York.