EVALUATING THE EFFECT OF INSTRUCTIONS ON RESPONSE PERSISTENCE THROUGH THE FRAMEWORK OF BEHAVIORAL MOMENTUM THEORY

by

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(Under the Direction of Kevin M. Ayres)

ABSTRACT

Instead of simply observing an intervention's effect over time (i.e., maintenance), Nevin and Wacker (2013) emphasized systematic methods to program and assess treatment durability. Specifically, the authors suggested evaluating response persistence after deliberately presenting treatment challenges (e.g., extinction, satiation, low procedural fidelity levels). Following treatment challenges, researchers and practitioners can evaluate response persistence through the framework of behavioral momentum theory (BMT), which quantifies a response's resistance to change. For example, when comparing two conditions (A and B), if condition A resulted in greater proportional resistance to change when challenged, condition A might be more likely to maintain over time. Although various studies evaluate the effect of different contextual variables on response persistence, few studies evaluate the effect of verbal stimuli. Therefore, this study examined the effect of instructions compared to no-instructions on response persistence. This study included four kindergarten students receiving special education services. Following preference, reinforcer, and proficiency assessments, the researcher implemented a within-subject design to systematically assess response persistence when challenged by a distractor (i.e., preferred video clips). Results indicated inconsistent total response patterns (correct and incorrect responses) in both the instruction and no-instruction conditions, across participants. However, three out of four participants exhibited greater persistence of errors in the no-instruction condition, and all four participants displayed greater proportional error percentages in the no-instruction condition. This research expands the literature evaluating various components affecting response persistence and provides implications for future evaluations as well as considerations for applied settings.

INDEX WORDS: behavioral momentum theory, persistence, rules, instructions

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DEDICATION

I dedicate this to my mentors. Dear family, committee members, friends, academic community, and students, thank you for everything you've taught me. Most importantly, you taught me that I am not done, so let's keep learning. In the famous words of the singer, songwriter, and actress, Ariana Grande, "Thank u, next."

ACKNOWLEDGEMENTS

I acknowledge that the current systems of power are inequitable, and I will continue to advocate for change. I acknowledge that the water crisis in Flint, Michigan, was preventable, and the fact that the residents of Flint, Michigan still don't have clean water is inexcusable. Furthermore, I acknowledge the fact that the Individuals with Disabilities Education Act is still not fully funded, which subsequently leads to limited resources resulting in program cuts, increased teacher turnover, and decreased teacher recruitment.

I acknowledge the vast amount of misinformation in the special education community, and I acknowledge how this impacts our society. For example, there are currently no peer-reviewed empirical evaluations supporting facilitated communication, rapid prompting method, or spelling to communicate; yet, parents are led to believe these methods. Furthermore, I, and the scientific community, acknowledge that vaccines do not cause autism, they cause children to experience life without preventable diseases.

I acknowledge the powerful nature of behavior analysis, but I also acknowledge the responsibility as a behavior analyst to continue to protect, advocate for, advocate with, and listen to our communities, including those receiving behavior analytic services.

I acknowledge that I am a better person because of the PhD program at the University of Georgia. I cannot imagine not knowing what I've learned in my four years in Athens, Georgia. Thank you to my parents, sister, brother, and other family members for supporting me in this journey. Thank you to my committee members for shaping my professional and academic behavior. Thank you to my friends and community for

cheering me on along the way. And, Kevin, I am really thankful for everything you've taught me. When given the following equation, $\log\left(\frac{R_1}{R_2}\right) = a\log\left(\frac{r_1}{r_2}\right) + \log b,$ glad you allocated responding my way.

Finally, I would like to remind everyone of a quote by Fred Keller, "I learned one very important thing: the student is always right." Therefore, if there are errors in this document, I have not contacted the contingencies to correct them, yet. However, I am continuing to learn, and it is my promise to this community that I will never stop growing as a person, researcher, advocate, and teacher. Thank you… so much.

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CHAPTER 1

INTRODUCTION

Behavior Analysis Across Species

Behavior analysis is the science of predicting and changing observable and measurable behaviors of living organisms (Cooper, Heron,& Heward, 2007). Generally speaking, behavior analytic principles and methods apply similarly across species, and whether the living organism is a pigeon or a human is irrelevant. Similarly, it should not matter if the organism is a typically developing adult or a toddler with autism, the science of behavior analysis has demonstrated that living organisms follow the same predictable patterns. The scientific belief in determinism, presumes that behavior analysis, similar to other sciences, is lawful and orderly (Cooper et al., 2007).

Pavlovian conditioning. The effect of behavior analysis across species is demonstrated through Pavlovian (i.e., classical) and operant conditioning. Pavlov (1897/1902) evaluated classical conditioning with non-human animals by first observing the effect of presenting a stimulus such as dog food on saliva elicitation. Next, Pavlov paired food presentation with another stimulus (i.e., bell ringing), which, through classical conditioning, also began eliciting salivation. Similarly, Watson and Rayner (1920) demonstrated the same process with humans. During Watson and Rayner’s (1920) experiment, he paired soft furry items that did not elicit fear responses with loud items. Through classical conditioning, the soft furry items began occasioning the same fear responses displayed after loud banging sounds. Subsequently, these experiments demonstrated classical conditioning phenomena across species (human and non-human animals).

Operant conditioning. Operant conditioning phenomena is also observed across species (Skinner, 1938, 1958). In operant conditioning, a contingency between a response and a consequence either increases the likelihood of a behavior occurring in the future (reinforcement; Cooper et al., 2007) or decreases the likelihood of the behavior occurring in the future (punishment; Cooper et al., 2007). This phenomenon is often described through a four-term contingency. A four-term contingency involves an establishing operation (i.e., a state altering reinforcer effectiveness or response rates such as deprivation or satiation), antecedent (i.e., stimuli present prior to the behavior occurring), behavior (i.e., observable and measurable response), and consequence (i.e., stimuli presented after the response; Michael, 1988).

One example of a four-term contingency might involve a hippopotamus, deprived of water for an extended period of time (establishing operation), seeing water (antecedent). The likely behaviors evoked in this context would involve the hippopotamus drinking the water, and the consequence resulting in the hippopotamus' quenched thirst. Similar to Pavlovian conditioning, non-human animals and humans follow similar patterns with respect to operant conditioning (Skinner, 1938, 1953). For example, a human, deprived of water for an extended period of time (establishing operation), walks into a restaurant and sees a drink (antecedent), orders and consumes the drink (behavior), and is no longer thirsty (consequence).

Again, behavior of humans and non-human animals follow similar patterns and their response allocation generally matches the consequences presented after the response. Therefore, if the consequences reinforce the previous behavior, the behavior will continue, or increase, in the future. Alternatively, if the consequences punish the behavior, the behavior will decrease in the future. To return to our previous scenario, if predators attacked the hippopotamus every time it entered the water, assuming this was an aversive event, the hippopotamus would likely avoid getting in the water and find another source of nutrition. Similarly, if a thirsty human ordered a drink and was continuously given the wrong drink, or presented with another aversive event, the human might stop ordering drinks, or avoid the restaurant altogether. These examples illustrate response allocation matching consequences across humans and non-human animals. Furthermore, if there was higher quality and/or quantity water or mating options elsewhere, the hippopotamus would likely travel to the more favorable watering hole. If there were higher quality and/or quantity drinks and/or desirable opportunities elsewhere, the human would likely also travel to another, perhaps more favorable, watering hole.

Verbal Stimuli

Although classical and operant conditioning follow similar patterns across species, in the 1960s, researchers began identifying differences between human responding and behavior predicted by non-human animal models, especially when verbal stimuli are involved (Günther & Dougher, 2013). For example, Kaufman, Baron, and Kopp (1966) discovered human behavior to vary from behavior exhibited by non-human animals during traditional experiments. They explained their findings by suggesting that human responses appeared to be more influenced by instructions rather than contingency fluctuations. Prior to exposing participants to programmed contingencies, Kaufman et al. (1966) provided participants to accurate and inaccurate instructions. The researchers noted that the instructions exerted greater control over response rates than programed contingencies.

Other research from this era demonstrated that humans responded more efficiently in conditions with instructions than without instructions (Baron, Kaufman, & Staber, 1969). Meaning, if reinforcement is unavailable in the absence of instruction, instructions might serve as discriminative stimuli that set the occasion, and indicate the availability of reinforcement, for novel responses without direct exposure to the contingency specified by the instructions (Joyce & Chase, 1990). Skinner (1974) and Joyce and Chase (1990) stated that rules let humans behave more efficiently without prior contact to the contingencies. For example, completing a task (furniture assembly) with instructions (i.e., a task analysis) compared to without the instructions. Additional studies, such as Galizio (1979), evaluated the effect of accurate versus inaccurate rules paired with two different stimuli. Galizio (1979) paired an orange light with accurate rules and a purple light with inaccurate rules. In this study, the participants discriminated between the two conditions and only followed rules provided in the orange light condition, which demonstrated the rule's stimulus control over rule following behavior.

Though determinism is a key component of behavior analysis, aforementioned studies demonstrated that humans do not always follow the same predictable patterns as our non-human counterparts when verbal stimuli is involved. Therefore, when predicting and changing human behavior, researchers and practitioners must account for the potential learning history associated with verbal stimuli. Though operant behavior is ultimately controlled by reinforcement and punishment, these consequences are often paired with stimuli; therefore, verbal stimuli might set the occasion for humans to engage in different patterns of responding predicted by their non-human counterparts. For example, while we might predict the hippopotamus will avoid drinking at the local watering hole after being attacked. However, if the human, that previously experienced an aversive event at the restaurant, is told a friend would be waiting for them, the human might continue traveling to the same watering hole.

Instructions. Skinner (1957) described instructions as antecedents providing the listener with knowledge they did not have prior to receiving the instructions. For example, when traveling to a new destination, a traveler might be told, if they visit a certain museum, they will find a work of art from one of their favorite painters. After receiving the travel tip, the traveler now "knows" information they did not previously know. Although behavior analysts do not typically use the term "know", Skinner (1957) conceptualized the term as a reference "to a hypothetical intermediate condition which is detected only at a later date," (p. 363; Skinner, 1957).

When considering the four-term contingency, Skinner (1938) stated that responses always occur in the presence of stimuli, or stimuli present in the environment might set the occasion for responding (Skinner, 1969). Correspondingly, instructions and/or verbal stimuli can also serve as antecedents (Skinner, 1957). For instance, if in the absence of reinforcement, instructions signal the availability of reinforcement, and responding occurs accordingly, the instructions can also be conceptualized a discriminative stimulus (S^D), or, if signaling the absence of reinforcement, a stimulus delta (S^Δ; Cooper et al., 2007).

Resistance

Relapse. Researchers studying applied behavior analysis (ABA) are called to study socially significant target behaviors (behaviors important to the individual and their community; Wolf, 1978). These behaviors might include those harmful to one self and others, such as aggressive or self-injurious behaviors. Conversely, socially significant behaviors might also include appropriate functional skills directly resulting in increased independence and access to desired items, people, or activities. Furthermore, when creating behavior interventions targeting behavior reduction, behavior analysts might implement extinction procedures. Though extinction can be conceptualized as a process and procedures, extinction procedures involve withholding a previously delivered reinforcer following a target response (Cooper et al, 2007). These procedures result in the extinction process aimed to extinguish the target behavior. For example, if attention maintained crying behavior in the past, extinction procedures would involve withholding attention for crying behaviors. If crying no longer occurs following these procedures, crying is extinguished.

However, when the previously extinguished behavior is exposed to a change in the extinction context, the previously extinguished behavior might reoccur, which is a phenomena called relapse (Bouton, 2004). Specifically, contextual renewal, a particular form of behavioral relapse, involves conditioned stimuli (Podlesnik & Shahan, 2010). For example, contextual renewal occurs when a responding in Context A (e.g., school), is suppressed through extinction in Context B (e.g., clinic), but then returns upon returning to Context A, regardless of whether the same contingencies are now in place in Context A.

Although stimuli might set the occasion for responses to occur, stimulus pairing might mitigate effects of contextual renewal. For instance, Collins and Brandon (2002) evaluated the use of an extinction cue (E-Cue) to attenuate renewal effects. They measured salivation (weighed dental rolls) after exposing participants to smelling beer in different contexts. In Context A, participants smelled the beer in an opaque cup with no other cup present. In Context B, they smelled the beer in an opaque cup with a cup of water also present. In this context, the cup of water served as an E-Cue. The participants later returned to Context A with the presence of the water cup and again smelled the beer. When compared to groups that did not experience an E-Cue, the E-Cue group experienced reduced renewal effects (i.e., reduced salivation). Therefore, Collins and Brandon (2002) demonstrated the potential of harnessing stimulus pairing as a means to mitigate contextual renewal by introducing stimuli from the treatment context (Context B) to original context (Context A).

Maintenance. Maintenance, as described by Shieltz et al. (2017), is evaluated by probing treatment effects over time or probing effects when challenging treatment. Therefore, researchers and practitioners are able to systematically evaluate treatment durability by evaluating a target response’s resistance to change. Whereas relapse is defined as resistance to change in extinction contexts, persistence is resistance following a change in the reinforcer context. For example, when writing a dissertation and presented with a cute dog video on the computer screen, greater persistence is demonstrated when typing behavior continues to occur at similar rates to those occurring prior to video presentation, when compared to reduced typing rates following the video presentation.

Behavioral Momentum Theory

Researchers evaluate and demonstrate response persistence through the framework of behavioral momentum theory (BMT; Shieltz et al., 2017). Behavioral momentum theory is often described as analogous to Sir Isaac Newton's laws of motion (Nevin & Shahan, 2011). Newton's (1687) first law of motion, describing inertia, states an object in motion continues in motion unless acted upon by a force. In behavior analytic terms, the first law would read, behavior responses occurring in a static environment will continue to occur at the same response rate unless contacted by a disruptor such as extinction or satiation. Furthermore, Newton's (1687) second law, states the momentum of the object (either acceleration or deceleration) is directly proportional to the object's mass and the force applied. Again, behaviorally stated, the increase or decrease of an organism's response rate is directly proportional to the organism's previous reinforcement history associated with responding (i.e., behavioral mass), and the disruptor's magnitude.

When evaluating response persistence through this framework, directly contacting contingencies specified by verbal stimuli might create behavioral mass directly associated with the verbal stimuli (Zettle & Hayes, 1982). Furthermore, the learning history associated with the instructor might also affect responding as a result of the history of reinforcement associated with the instructor rather than simply the effect of verbal stimulus (Zettle & Hayes, 1982). Günther and Dougher (2013) also indicated learning history associated with verbal stimuli might account for response allocation, even if the organism engages in less advantageous responding (i.e., reduced probability the individual accesses reinforcers) in the presence of verbal stimuli.

Furthermore, BMT accounts for antecedent stimulus relations, which compliments conceptualizing instructions as an S^D or an S^Δ. Though stimulus paring has been demonstrated to mitigate renewal effects in the context of Collins and Brandon's (2002) experiment, the question remains whether similar effects occur with verbal stimuli. Therefore, little is known regarding implications for verbal stimuli and maintenance of appropriate behavior. Specifically, when evaluating response allocation through the framework of BMT, what are the effects of different verbal stimuli (i.e., various instructions) on response persistence in contexts with equal schedules of reinforcement?

CHAPTER 2

LITERATURE REVIEW

Much of the BMT literature compares Newton's first and second laws of motion (Newton, 1687) to the behavior of organisms (Nevin et al., 1990). Newton's first law of motion states that an object in motion remains in motion unless acted upon by an external force. The second law states an object's acceleration, or deceleration, is proportional to the relation between the object's mass and the force applied. Regarding Newton's first law, BMT suggests the object in motion described in Newton's laws is analogous to the response rate of a particular behavior, and the external force equates to the presentation of a disruptor (e.g., satiation and extinction). Behavioral momentum theory also compares Newton's second law to increased or decreased response rates inversely related to the magnitude of obtained reinforcement and the disruptor. In other words, the greater the magnitude of reinforcement (i.e., history of reinforcement), the greater resistance to change (i.e., responses persistence) following the presentation of a disruptor (Nevin & Shahan, 2011).

Pavlovian contingencies are among one of the many behavioral processes associated with BMT (Nevin et al., 1990). Through stimulus-reinforcer pairings, the context associated with reinforcer delivery becomes conditioned to elicit target behavior. However, others believe this relation to exist within an operant, rather than Pavlovian, conditioning contingency (Troisi & Mauro, 2017). Specifically, proponents advocating an operant conditioning explanation for response persistence suggest the context associated with reinforcer delivery is not a conditioned stimulus, but instead serves as a discriminative stimulus setting and signaling the occasion for reinforcement availability. Regardless of whether behavioral persistence is attributed to aspects of Pavlovian or operant conditioning, responses occurring in the presence of contextual variables associated with greater rates of reinforcement often result in greater resistance following disruption (e.g., Nevin et al., 1990; Podlesnik & Shahan, 2009).

Variables shown to impact response strength following the presentation of a disruptor involve the response's reinforcement history prior to disruption (Nevin, 2012). Newton's (1687) second law of motion described an object's acceleration or deceleration as directly proportional, and inversely related, to an object's mass and applied force. When discussing variables influencing BMT, Nevin and Grace (2000) described behavioral mass as the behavior's history of reinforcement. Accordingly, responses associated with relatively denser reinforcement histories exhibit greater resistance to change than responses associated with leaner reinforcement histories.

For example, responding associated with different stimuli (or different contexts upon which the response occurs) are paired with the respective reinforcement schedules occurring within each context. In this example, responses in Context A contact reinforcement on a variable interval 120-s schedule (VI 120-s), whereas responses in Context B experience a VI 15-s schedule of reinforcement. Upon contacting a disruptor (e.g., extinction), BMT suggests the behavior associated with the richer reinforcement history (i.e., greater behavioral mass), will occur at proportionally higher response rates compared to baseline than the behavior associated with the leaner reinforcement history (e.g., Sweeney & Shahan, 2015).

Despite many researchers evaluating BMT within the framework of an experimental analysis of behavior with non-human animals (e.g., Igaki & Sakagami, 2004), BMT's utility extends beyond basic applications, as translational and applied studies focus on BMT's implications beyond experimental applications. For example, Ringdahl et al. (2018) demonstrated greater mand persistence when participants' more preferred mand modality (i.e., the mand modality associated with greater response allocation within the context of an equal concurrently available schedule for two or more mand modalities; Ringdahl et al., 2016) contacted disruption. Furthermore, Parry-Cruwys et al. (2011) evaluated response persistence of students with autism in a special education classroom when simultaneously presented with distracting stimuli. In this experiment, researchers evaluated task persistence such as writing responses, bead stringing, or puzzle building on rich (VI 7-s) compared to lean (VI 30-s) schedules. Both of these examples provide researchers and practitioners with valuable information regarding BMT in applied settings.

Although research suggests BMT's utility extends beyond non-human animals, a comprehensive synthesis of the literature is needed to provide practitioners and researchers with information regarding persistence across various conditions. For instance, what is represented in the literature regarding the percentage of participants exhibiting greater response persistence following disruption in rich versus lean conditions. Furthermore, a review of the literature would also provide information related to the effect of different disruptors on response persistence. Therefore, the purpose of this chapter is to provide a comprehensive review of studies evaluating BMT using human participants by synthesizing (a) participant and setting characteristics, (b) study characteristics (c) and study outcomes.

Method

Search Procedures

The authors conducted a literature search following guidelines recommended by Moher, Liberati, Tetzlaff, Altman, and The PRISMA Group (2009). The first author searched a multi database search engine that included Social Sciences Citation Index, PsycINFO, Academic Search Complete, Science Citation Index, MEDLINE, Complementary Index, Academic OneFile, Science & Technology Collection, Education Research Complete, ERIC, Professional Development Collection, ScienceDirect, Psychology and Behavioral Sciences Collection, Sociological Collection, PsycARTICLES, and SocINDEX with Full Text using the term "*behavior* momentum theory*." Studies included in the review were not limited by publication year, but were included based on the following conditions: (a) peer-reviewed, (b) English-language, and (c) academic journals. After removing duplicates, the initial search provided 141 studies in which the author conducted additional reviews using the following two additional inclusion conditions: (d) human participants across basic, translational, and applied studies, (e) comparing two different conditions such as rich versus lean schedules, and (f) evaluating the effect of a disruptor on behavior within the context of BMT. Articles were excluded if their primary purpose involved evaluating behavioral relapse phenomena (i.e., reinstatement, renewal, resurgence), as behavioral relapse occurs with a previously extinguished behavior (Podlesnik & Shahan, 2009), whereas persistence occurs when a response continues to occur when challenged (Nevin & Wacker, 2013). An initial abstract and title review resulted in 42 potentially eligible articles. The full-text screening excluded 30 articles with a remaining 12 articles meeting the criteria. From these 12 articles, the first author conducted an ancestral hand search using the same inclusion criteria listed above. The ancestral hand search involved reviewing every reference cited in the 12 original articles to determine whether cited studies also met the inclusion criteria. The final ancestral search resulted in an additional 12 articles for a total of 24 articles included in the review (See Figure 1).

Coding Procedures

The first author coded descriptive characteristics of all included studies, which included 61 variables. The coding template included participant characteristics and study characteristics. In addition, reviewers coded nine variables related to outcome variables. Participant characteristics included gender, age, and diagnosis. Study characteristics included experimental setting(s), study implementer(s), target behavior(s), reinforcers, and disruptor(s). Study outcomes included coding persistence comparisons between independent variables across each dependent variable.

Participant and setting characteristics. Participant and setting characteristics included gender, age, diagnosis, experimental setting, interventionists, and functional analysis results. When coding participant's ages, reviewers coded whether the participant fell between 0 to 5 years old, 6 to 12 years old, 13 to 18 years old, or if they were older than 18 years old. Participant diagnosis codes included autism or pervasive developmental disorders (PDD), intellectual disability (ID), developmental delays (DD), multiple diagnoses, other diagnoses, or no diagnosis (i.e., participants were typically developing). Experimental settings included hospital rooms, therapy or laboratory rooms, classrooms, work facilities, or living rooms, kitchens, or bedrooms, which were coded as additional settings. Interventionist codes included therapist/experimenter, teacher/paraeducator, or parent/caregiver. Functional analyses results included tangible, automatic, escape, attention, and multiply maintained.

Reviewers coded participant characteristics every time the participant engaged in an experimental evaluation. For example, Vargo and Ringdahl (2015) included multiple experiments with four to five participants. Some participants were included more than one experiment. In these instances, their participant codes were included for each experiment. Similarly, Lionello-Delolf, Dube, and McIlvane (2010) evaluated the effect of three different disruptors (alternative stimulus, prefeeding, distractor) with six participants and an additional distractor with five participants. When evaluating Lionello-Delof, Dube, and McIlvane's (2010) study, reviewers included participant demographic and setting codes for each disruptor evaluation for a total of 23 participant evaluations.

Study characteristics. Study characteristics included dependent variables, reinforcers, signaled or unsignaled stimuli, and disruptors. Dependent variables included functional communicative responses (FCR), task completion, problem behavior (e.g., aggression, self-injurious behavior, disruption), or other behaviors not falling into the three listed categories. The FCRs included various mand modalities such as augmentative alternative communicative devices, picture exchange, or vocal requests. Task completion included studies examining participant responses involving computer navigation such as Dube, Thompson, Silveira, and Nevin's (2017) study involving a computer game written in Python requiring participants to move icons using keys on a modified keyboard, or studies such as Vargo and Ringdahl's (2015) experiment evaluating tasks such as number or letter tracing, and stringing beads. Reinforcer codes included escape, attention, tangible, tokens, or tangible items compared to tokens (Vargo & Ringdahl, 2015).

When coding whether researchers included stimuli associated with different phases, the reviewers noted whether different color task materials, different therapists, or different backgrounds were associated with different experimental conditions. For example, Dube and McIlvane (2001) used different colored backgrounds to signal different conditions (i.e., a white background for Task A and a black background for Task B). Similarly, Lionello-DeNolf and Dube (2011) used different computer icons associated with either the rich or lean conditions (e.g., balloon and gift).

Disruptor codes included alternative stimuli, distractors, extinction, extinction and distraction, prefeeding, non-contingent reinforcement (NCR), or other distractors not falling into any of the six listed categories. Alternative stimuli were defined as stimuli signaling the availability of an alternative concurrent schedule of reinforcement. For example, Lionello-Denolf and Dube's (2011) alternative stimulus test involved an additional stimulus associated with a VI 6-s presented concurrently with either the rich or lean components. Distractors included the presence of items or activities such as preferred toys, movies playing, or the presence of an additional therapist. Prefeeding involved participant presession reinforcer consumption (i.e., satiation). For example, during Vargo and Ringdahl's (2015) prefeeding disruptor phase, participants consumed food prior to beginning experimental sessions in addition to food consumption during intercomponent intervals.

Study outcomes. Reviewers coded each comparison conducted within each experiment. For example, if an experiment compared the effect of rich versus lean schedules for FCRs and task completion, the authors coded results related to rich versus lean schedules on functional communicative responding in addition to coding results variables for the effect on task responding. Independent variable comparisons included studies evaluating persistence of high versus low preferred mand modalities. For example, Ringdahl et al. (2018) evaluated persistence of FCRs associated with high preferred versus low preferred mands. In this example, reviewers coded the number of participants evaluated in each comparison as well as the number of participant exhibiting greater response persistence with high preferred versus low preferred mands. In addition to high versus low preferred mand modalities, comparisons also included rich versus lean schedules of reinforcement. For example, Mace et al. (1990) compared the effect of a rich (VI 30-s) versus lean (VI 60-s) schedule on response persistence, but other researchers such as Lieving et al. (2018) evaluated the combination of a VI plus fixed time (FT) schedule compared to a VI schedule alone. Study outcome codes also included coding results by disruptors. For example, Lionello-DeNolf, Dube, and McIlvane (2010) evaluated response persistence on rich versus lean schedules when presented with an alternative stimulus, prefeeding, and distraction.

Interobserver Agreement

A second graduate student conducted an identical literature search using the aforementioned search terms, inclusion criteria, and multi database search engine. A third graduate student coded 20.83% (N=5) of included articles, and 21.21% of total experiments (N=7), using identical participant, study, and outcome coding templates described above. Each study included 61 demographic variables and nine results variables for each comparison. Interobserver agreement was calculated by dividing agreements by the number of agreements plus disagreements and multiplying by 100. The literature search, conducted by the second graduate student, resulted in 80.95% agreement. Coding, conducted by the third graduate student, resulted in 93.62% overall interobserver agreement for participant, study, and outcome codes.

Results

Participant and Setting Characteristics

Overall, 143 participant evaluations were included in the review (See Table 1). Participant ages ranged from 1 to 68-years-old with more than half of the participants under the age of 18 (66.43%). The review included participants diagnosed with intellectual disability (N=33), autism or pervasive developmental disability (N=69), developmental delays (N=3), or multiple disabilities (N=14). In addition, the studies also included 20 participants without reported disabilities. The review yielded five different settings in which the studies were conducted. One hundred and twenty-two experiments were conducted in a therapy or experimental room (85.31%), eight studies were conducted in a living or bedroom (5.59%), and seven studies were conducted in a classroom setting (4.90%). Furthermore, therapists or experimenters conducted the majority of the included experiments (N=141, 99.30%), whereas a teacher/para conducted one experiment (0.70%).

Study Characteristics

As previously described, dependent variables included FCRs, problem behavior, or task completion (See Table 2). The type of reinforcers in each experiment are also noted in Table 2, with almost half of the experiments (43.36%) using either tangible items (N=62) and 37.76% using tokens (N=53). Experiments included disruptors such as extinction (N=49, 37.27%) and concurrently available alternative schedule (N=33, 23.08%). Thirty-one (21.68%) studies evaluated the effect of distractors such as videos (e.g. Mace et al., 1990), and 12 studies (8.39%) evaluated the effect of pre-feeding.

Study Outcomes

Study outcomes are summarized in Tables 3 and 4. Table 3 displays the number of comparisons and the percent of comparisons displaying greater persistence across dependent variables. When evaluating persistence across rich versus lean reinforcement schedules, responses associated with richer schedules are more persistent in 97.92% of comparisons included in this review. Specifically, comparisons involving DRA associated with rich versus DRA lean reinforcement schedules display greater persistence in 75% of included comparisons.

Table 4 displays study outcomes by authors and also includes dependent variables, disruptors, the number of participant evaluations, independent variable comparisons, as well as comparison results. In the second column, the author identifies independent variable comparisons. For example, Carr et al. (1998) evaluated the effect of a non-contingent reinforcement schedule (NCR) on low verses medium, low versus high, and medium versus high magnitude reinforcers. The third column indicates the dependent variable, which the author coded as task completion in the Carr et al. (1998) experiment. Finally, the last five columns indicate the number of participants (N), and the percent of participants with greater persistence in the first comparison condition.

Discussion

The current review included 24 peer-reviewed articles evaluating BMT with human participants. Many of the experiments evaluated effects of rich versus lean schedules of reinforcement on behavioral persistence. In addition, a large number of experiments also evaluated extinction as a disruptor. Despite only evaluating studies with human participants, few experiments were conducted in applied settings as most were conducted in experimental or therapeutic settings. The review indicates greater response persistence following rich compared to lean schedules of reinforcement.

Limitations

As with any systematic literature review, publication bias might limit search results (e.g., Sham & Smith, 2014; Tincani &Travers, 2018). Sham and Smith (2014) indicated publication bias occurs when journals reject publications indicating null effects. For example, experiments indicating little to no difference between conditions might not survive the peer review process. Furthermore, researchers might not submit datasets demonstrating small treatment effects (Tincani & Travers, 2018). In addition to publication bias, search terms might not result in a comprehensive list of experiments related to the current review. Therefore, the current review might not be fully comprehensive.

Furthermore, the current review did not evaluate the effect of repeated exposures to disruptors. For example, although not included in the review, Wacker et al.'s (2011) experiment evaluated persistence of treatment effects during long-term treatment. In this experiment, Wacker and colleagues (2011) also conceptualized maintenance as treatment durability during treatment challenges. For example, evaluating whether problem behavior relapses when presented with a disruptor such as a newly acquired FCR contacting extinction. The authors discovered decreased resistance to change over extended treatment periods, which implies longer treatment durations might lead to more durable treatment outcomes. The current review did not code number of exposures to disruptors; therefore, this review does not provide information regarding the effect of continued exposure to disruptors on response persistence.

Implications for Practice

Schieltz et al. (2017) described assessment and treatment decisions based on BMT. The authors focused on discrepancies between two ways behavior analytic maintenance effects are measured; (a) treatment effects probed over long periods of time, and (b) evaluating behavioral persistence following the presentation of a disruptor (e.g., extinction). Schieltz et al. (2017) noted the former measurement system does not require an analytical evaluation directly tied to specific behavioral processes. However, the latter definition provides practitioners with a format to evaluate and program durable maintenance effects during treatment rather than conducting post hoc treatment evaluations. Although DRA interventions demonstrate decreased levels of problem behavior and increased rates of appropriate behavior, maintenance of these effects are seldom reported (Schieltz et al., 2017). Moreover, when maintenance effects are reported, they are often reported as effects over time rather than a systematic analysis providing information regarding the circumstances in which maintenance is likely or unlikely to occur (e.g., Nevin & Wacker, 2013; Schieltz et al., 2017). Evaluating maintenance based on BMT (i.e., evaluating persistence following disruption) provides a thorough assessment and treatment framework based on underlying behavioral processes (Schieltz et al., 2017). The second maintenance measurement method described by Schieltz et al. (2017), requires evaluating the effect of systematically manipulating the target response's history of reinforcement (i.e., magnitude and rate) and the presentation of different disruptors.

Therefore, evaluating the effect of different reinforcement and disruptor variables might prove instrumental in programming high levels of treatment durability when designing and monitoring intervention plans. For instance, Ringdahl et al.'s (2018) study indicated higher preferred mands resulted in greater resistance when challenged. Perhaps practitioners can use similar evaluations to determine responses more likely to exhibit greater persistence when challenged. Evaluating variables linked to BMT such as behavioral mass and various disruptors provide valuable information regarding treatment decisions. For example, assessing maintenance through a BMT framework might allow practitioners to program high levels of treatment durability. Furthermore, after evaluating persistence and determining a behavior to be resistant to disruptors, this analysis might also provide a framework to systematically discontinue services.

Implications for Research

When evaluating behavioral mass, the current review indicated researchers often evaluate the effect of rich versus lean reinforcement schedules on patterns of responding post disruption. Future investigations might evaluate the effect of manipulating additional reinforcer dimensions prior to disruption. For example, though not specifically evaluating responding through a BMT framework, Athens and Vollmer (2010) manipulated three different reinforcer dimensions (i.e., quality, duration, delay) in a concurrent schedule arrangement. The authors discovered response allocation favoring the more advantageous schedule (e.g., higher quality reinforcers, longer duration exposed to reinforcers, or shorter delays to reinforcement) rather than behaviors associated with weaker reinforcer dimensions (e.g., lower quality, shorter duration, or longer delays to reinforcement). These findings suggested reinforcer dimensions such as duration and delay to reinforcement influence responding. However, few studies (e.g., McComas, Hartman, & Jiminez, 2008) evaluated the effect of different reinforcer dimensions.

Similar to evaluating different reinforcer dimensions, few studies evaluated different disruptor dimensions. When considering Newton's second law of motion, BMT states response strength is directly proportional and inversely related to reinforcement history and the magnitude of a disruptor (e.g., Nevin & Shahan, 2011). As previously discussed, BMT provides a framework for evaluating and predicting responding based on the target behavior's history of reinforcement and the presentation of a disruptor. Numerous studies evaluated different factors related to behavioral mass, but little or minimal variation exists when examining the effect of different disruptors. Only 8.39% of the included studies evaluated prefeeding as a primary disruptor. Moreover, few researchers evaluated different disruptor magnitudes (e.g., different distractor volumes), or disruptor combinations. Therefore, future investigations might consider quantifying and evaluating the effect of different disruptor magnitudes. Additionally, future investigations might want to evaluate the effect of different disruptor variables on different types of tasks (e.g., multiplication compared to tracing). For instance, does the presentation of a distractor such as music affect tracing differently than multiplication, and what are the effects of distractors compared to extinction on tracing versus multiplication responses.

Furthermore, as previously stated, Schieltz et al. (2017) described the impact of the number of instances target behavior contacts extinction. The authors stated that response extinction pairings correlated negatively with resurgence. Therefore, Schieltz et al. (2017) suggested future research evaluating pre and post treatment exposures to extinction and reinforcement to determine whether or not reinforcement to extinction ratios influence treatment durability. Similarly, researchers evaluating response persistence might consider evaluating the effect of number of exposures to disruptors on resistance to change.

Finally, although a majority of the included studies involved different stimuli associated with different conditions (i.e., blue card associated with VI 30-s and red card associated with VI 12-s), only two included articles (Dube & McIlvane, 2002; and Saini & Fisher, 2016) specifically evaluated the effect of these stimuli or stimulus variations. For example, Dube and McIlvane (2003) evaluated the effect of stimuli with lower and high discrimination when challenged by a change in reinforcement schedules. Similarly, Saini and Fisher (2016) evaluated the effect of different stimuli salience on persistence. Saini and Fisher (2016) stated BMT, "predicts that increasing the discriminatively of the change from variable-interval to variable-time reinforcement should lead to faster reductions in responding," (p. 295).

Purpose of Study

The current review only discovered the two aforementioned studies evaluating stimuli salience. Moreover, none of the studies evaluated the effect of verbal statements such as instructions on responding when challenged, despite experiments demonstrating response differences in the presence of verbal stimuli (Günther & Dougher, 2013). Therefore, the purpose of the proposed investigation is to evaluate the effect of verbal statements on behavioral persistence. Specifically, the proposed investigation seeks to answer the question, what are the effects of instruction compared to no instruction conditions on resistance to change when presented with a distractor.

Table 1

Participant and Setting Characteristics

Characteristics	N	Percent
Gender		
Male	100	69.93
Female	32	22.38
Not reported	11	7.69
Age		
0-5	27	18.88
6-12	34	23.78
13-18	34	23.78
>18	44	30.77
Not reported	4	2.80
Diagnosis		
ID	33	23.08
Typical	20	13.99
Autism/PDD	69	48.25
DD	3	2.10
Other	4	2.80
Multiple	14	9.79
Setting		
Hospital room	1	0.70
Therapy/experimental room	122	85.31
Living room, kitchen, bedroom	8	5.59
Classroom	7	4.90
Work facility	5	3.50
Interventionist		
Therapist/experimenter	142	99.30
Teacher/paraprofessional	1	0.70
Functional analyses results		
Tangible	8	44.44
Automatic	0	0.00
Escape	3	16.67
Attention	13	38.89

Note. DD= Developmental Delay, ID= Intellectual Disability, PDD= Pervasive Developmental Disorder

Table 2

Study Characteristics

Characteristics	N	Percent
Dependent variable		
Functional communicative response	7	4.90
Task completion	119	83.22
Problem behavior	14	9.79
Problem behavior and task completion	3	2.10
Reinforcer		
Other	1	0.70
Food versus tokens	13	9.09
Escape	6	4.20
Attention	13	4.25
Tangible	62	43.36
Token	54	37.76
Discriminative stimulus		
Yes	130	90.91
No	13	9.09
Disruptors		
Extinction and distraction	4	2.80
Extinction	49	34.27
Other	9	6.29
Alternative stimulus	33	23.08
Distraction	31	21.68
Prefeeding	12	8.39
Noncontingent reinforcement	5	3.50

Table 3

Persistence Comparisons Across Independent and Dependent Variables

Independent Variable Comparison	Problem Behavior N	Problem Behavior N 1>2	Problem Behavior % >	Functional Communication N	Functional Communication N 1>2	Functional Communication % >	Task Completion N	Task Completion N 1>2	Task Completion % >
1.Rich vs. 2. Lean	15	11	73				64	46	72
1. DRA Rich vs. 2.Lean							4	3	75
1. Presession Escape vs. 2. Presession Play	1	1	100						
1. Presession Alone vs. 2. Presession Play	1	1	100						
1. High vs. 2. Low Preferred Mand				7	6	86			
1. Unconditioned vs. 2. Conditioned							13	4	31
1. Low vs. 2. Medium Reinforcer Magnitude							5	5	100
1. Low vs. 2. High Reinforcer Magnitude							5	2	40
Medium vs. 2. High Reinforcer Magnitude							3	3	100
1. DRA vs. 2. DRO+DRA							9	6	67
1. High vs. 2. Low Discrimination							13	8	62
1. DRA vs. 2. NCR							8	3	38
1. High vs. 2. Low Preferred Reinforcer							1	1	100

Note. DRA = Differential Reinforcement of Alternative Behaviors, DRO = Differential Reinforcement of Alternative Behaviors, NCR = Noncontingent Reinforcement

Table 4

Study Outcomes

Citation	Comparison	DV	Disruptor	N	IV 1	% N	>	IV2
Berg et al. (2000)	PF ESC vs. PF Play	PBX	PF	1	PF ESC	100	>	PF Play
	PF Alone vs. PF Play	PBX	PF	1	PF Alone	100	>	PF Play
Carr, Bailey, Ecott, Lucker, & Weil (1998)	Low vs. Med Mag SR	TC	NCR	5	Low Mag	100	>	Med Mag
	Low vs. High Mag SR	TC	NCR	2	Low Mag	100	>	High Mag
	Med vs. High Mag Sr	TC	NCR	3	Med Mag	100	>	High Mag
Dube & McIlvane (2001)	Rich vs. Lean	TC	DIST	2	Rich	100	>	Lean
Dube & Mcilvane (2002)	High vs. Low Discrimination	TC	SC	9	High	89	>	Low

(continued)

Table 4

Study Outcomes

Citation	Comparison	DV	Disruptor	N	IV 1	% N	>	IV 2
Dube, Thompson, Silveira, & Nevin (2017)	DRA vs. DRO-DRA	TC	EXT	5	DRA	60	>	DRO + DRA
	DRA vs. DRO-DRA	TC	EXT + DIST	4	DRA	75	>	DRO +DRA
Dube, Mazzitelli, Lombard, & McIlvane (2000)	VI + VT vs. VI	TC	ALT STIM	2	VI+VT	100	>	VI
Dube, McIlvane, Mazzitelli, & NcNamara (2003)	VI + VT vs. VI	TC	ALT STIM	13	VI + VT	87	>	VI
Kuroda, Cancado, & Podlesnik (2016)	DRA Rich vs. Lean	TC	DIST	4	Rich	75	>	Lean
Lambert, Bloom, Samaha, Dayton, & Kunnavatana (2016)	Rich vs. Lean	PBX	EXT (PBX)	1	Rich	100	>	Lean

(continued)

Table 4

Study Outcomes

Citation	Comparison	DV	Disruptor	N	IV1	% N	>	IV 2
Lerman, Iwata, Shore, & Kahng (1996)	Rich vs. Lean	PBX	EXT	3	Rich	67	>	Lean
Lieving et al. (2018)	VI+VT vs. VI	PBX	EXT	4	VI + FT	100	>	VI
Lionello-Denolf & Dube (2011)	Multiple Schedule Rich vs. Lean	TC	ALT STIM	6	Rich	100	>	Lean
	Single Schedule Rich vs.	TC	ALT STIM	6	Lean	67	>	Rich
Lionello-DeNolf, Dube, & McIlvane (2010)	Rich vs. Lean	TC	ALT STIM	6	Rich	50	>	Lean
	Rich vs. Lean	TC	PF	6	Rich	33	>	Lean
	Rich vs. Lean	TC	DIST	6	Rich	50	>	Lean
	Rich vs. Lean	TC	DIST	5	Rich	80	>	Lean
MacDonald, Ahearn, Parry-Cruwys, & Bancroft (2013)	Rich vs. Lean	PBX	EXT	4	Rich	100	>	Lean
Mace et al. (1990)	Rich vs. Lean	TC	DIST	2	Rich	100	>	Lean
	VI+VT vs. VI	TC	DIST	2	VI+VT	100	>	VI

(continued)

Table 4

Study Outcomes

Citation	Comparison	DV	Disruptor	N	IV 1	% N	>	IV 2
Mace, Mauro, Boyajian, & Eckert (1997)	Low vs. High Preferred SR	TC	Low Probability Request	1	High	100	>	Low
McComas, Hartman, & Jimenez (2008).	High vs. Low Mag	TC	EXT	3	High	67	>	Low
Parry-Cruwys et al. (2011)	Rich vs. Lean	TC	DIST	6	Rich	83	>	Lean
Ringdahl et al. (2018).	High vs. Low Preferred Mands	FCR	EXT	3	High Preferred	100	>	Low Preferred
	High vs. Low Preferred Mands	FCR	EXT	4	High Preferred	75	>	Low Preferred
Romani et al. (2016)	VI+VT vs. VI	TC	EXT	3	VI+VT	100	>	VI
	VI+VT vs. VI	PBX	EXT	3	VI	67	>	VI+VT
Saini & Fisher (2016)	High vs. Low S^D Discrimination	TC	EXT	4	Low Discrimination	75	>	High Discrimination

(continued)

Table 4

Study Outcomes

Citation	Comparison	DV	Disruptor	N	IV 1	% N	>	IV2
Sweeney et al. (2014)	rT NCR vs. rT DRA	TC	EXT	3	rT NCR	67	>	rT DRA
	No rT NCR vs. No rT DRA	TC	EXT	5	No rT NCR	40	>	No rT DRA
Thrailkill, Kimball, Kelley, Craig, & Podlesnik (2018)	Rich vs. Lean	TC	EXT	1	Rich	100	>	Lean
Vargo & Ringdahl (2015)	Food vs. Token SR	TC	EXT	5	Token	100	>	Food
	Food vs. Token SR	TC	DIST	4	Token	100	>	Food
	Food vs. Token SR	TC	PF	4	Food	100	>	Token

Note. ALT = Alternative, DIST = Distraction, DRA = Differential reinforcement of alternative behavior, DV = Dependent variable, EXT = Extinction, FCR = Functional communicative response, FCT = Functional communication training, IV = Independent Variable, NCR = Noncontingent reinforcement, NT = Novel Task, PBX = Problem behavior, PF = Prefeeding, rT= analog sensory reinforcement, S^D= Discriminative Stimulus, STIM = Stimulus, TC = Task completion

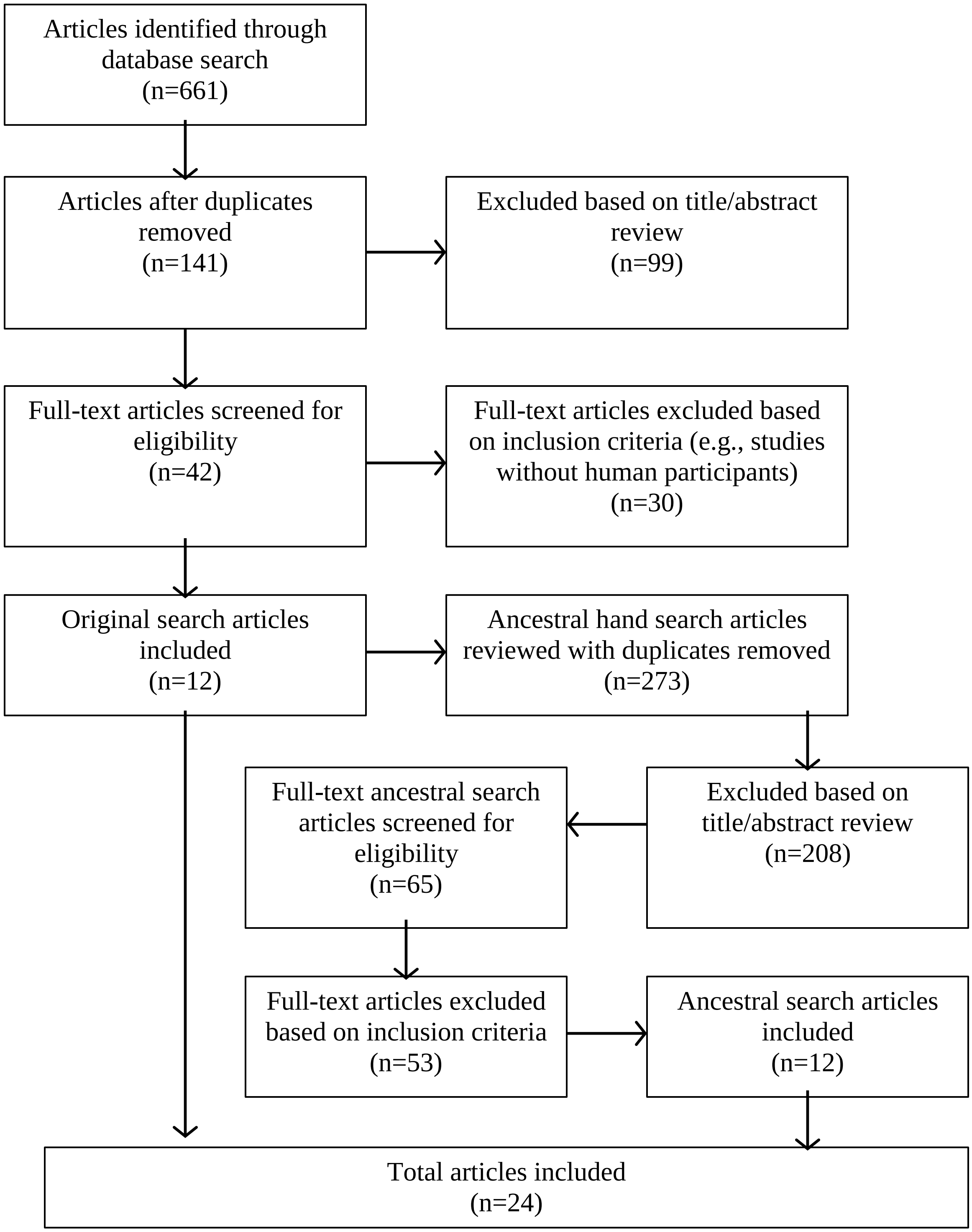

Figure 1. Initial and ancestral search results.

CHAPTER 3

METHODS

Participants

Four participants between the ages of five and six participated in this study. All participants attended the same elementary school and received special education services in a collaborative setting. Participants were selected based on teacher nomination and the students' ability to complete academic tasks. An elementary school teacher and principal recommend students that might benefit from evaluating different ways to increase, or maintain, responding when presented with distractions. Prior to beginning the study, researchers received parental/guardian consent for each student's participation. Table 5 displays participant information including diagnosis, age, and gender.

Setting

The experiment took place in the elementary school the students' typically attended. Researchers conducted the experiment in an unused room, to reduce noise disruption and other variables that might interfere with participant responding (e.g., peer attention). The room (8 m by 15 m) contained four tables, multiple chairs, and additional classroom materials such as books, writing utensils, and math manipulatives. During sessions, the participant sat at a table facing the front wall, and the researcher sat beside the participant. During reliability and fidelity sessions, a second data collector sat behind the behind the participant.

Materials

Task materials. Baseline and disruptor phases included individualized task completion materials. Tasks were selected based on teacher interviews indicating recently mastered classroom activities. See Table 5 for a list of tasks. For example, one participant's task involved tracing the letters of their name. Therefore, this participant's task materials included writing utensils and paper with pre-written traceable letters.

Discriminative stimuli and reinforcers. The researcher divided the table down the middle with tape and used the left side of the table for no-instructions conditions, and the right side of the table for instructions conditions. All experimental sessions also included token boards and tokens. During the instruction condition, token boards and tokens were blue, whereas during the no-instructions sessions, the token boards and tokens were yellow. In addition, the researchers placed a folder on each side of the table as well as two additional folders attached to the wall directly in front of the participant on the left and right side. The folder's colors corresponded with the respective token board color during each condition (i.e., blue folders remained on the right side of the table, and a yellow folder on the left side of the table). The blue folder attached to the wall included written instructions, "First, do you work, then you can trade your tokens for candy." The yellow folder attached to the wall included the written word, "Here." The researcher also placed the reinforcer array on the folder associated with the experimental condition.

Tokens were delivered on variable-interval (VI) schedules cued by a hand-held electronic device. The electronic device notified the researchers when to deliver tokens as it pertained to the VI schedule. For example, on a VI 12-s schedule, the device signaled (i.e., vibrated) an average of every 12 s to indicate token availability following a correct response. At the end of each session, the participants exchanged tokens for reinforcers identified through a multiple stimulus without replacement (MSWO) preference assessment.

Disruptor stimuli. The current experiment, similar to Mace et al.'s (1990) experiment, presented videos in the disruptor test conditions. Prior to beginning the experiment, researchers conducted a video preference assessment. Examples of individual disruptor stimuli are indicated in Table 5. Researchers selected video disruptors due to the ability to complete tasks when simultaneously presented with the disruptor. For example, tracing while also watching a video is not incompatible as the video does not require use of the participant's hands. In addition, to account for potential satiation, the researcher presented various clips from different episodes of the cartoon identified in the preference assessment.

Data collection materials. The primary researcher and secondary data collectors recorded participant responding data using writing utensils and paper data sheets (Appendix A and Appendix B). Furthermore, secondary data collectors also recorded procedural fidelity data on paper data sheets (Appendix C). Following the session, data collectors transferred the data sheets to participant specific folders corresponding with the participant's pseudonym.

Dependent Variables, Response Definitions, and Measurement

The primary dependent variable was task completion. For participants engaged in writing tasks, a response was defined as each instance the participant traced, copied, or wrote a letter. Data collectors evaluated permanent products and recorded total responses, correct responses, errors, and the number of obtained tokens. Two participants (Sophia and Jaden) completed tasks involving writing the beginning letter sound of a given picture. For example, a worksheet contained a picture of a rat with a space and the letters a and t (e.g., _at) beneath the picture. In this example, data collectors recorded either an upper or lowercase r as a correct response. However, any other letter or symbol that did not resemble R or r were counted an error. Another participant (Andre) copied uppercase letters of the alphabet. A response was marked correct if the participant copied the correct letter in the space beside the letter. Responses were marked incorrect if the participant copied another letter, lowercase letter, traced the given letter, or if the participant wrote the letter backwards. The third participant (Imani) traced the letters of her name. Correct responses included tracing the letter within half a centimeter of the pre-written letter, and errors included incomplete responses, or responses over half a centimeter away from the given letter.

Quantifying momentum effects. Dependent variables were measured using count and reported as rate (responses divided by time). Specifically, to measure proportion of responding, compared to baseline, the researcher calculated the log proportion of rate during disruption divided by the rate during baseline As previously stated, researchers frequently compare BMT to Newton's laws of motion; subsequently, momentum effects are quantified similar to the quantification of motion in physics. Nevin and Shahan (2011) and Nevin et al. (2017) suggested measure using the following equation:

$$\Delta B = \frac{-x}{m}$$

where ΔB is the change in response rate, x is the disruptor's value, and m represents behavioral mass (i.e., history of reinforcement). In this study, prior to disruptor tests, baseline sessions create behavioral mass in each condition. Furthermore, the value of x will either be negative or positive depending on the disruptor's impact (i.e., increased or decreased response rates).

The second equation, displayed below, evaluates the log ration between rates of reinforcement related to baseline and disruption (Dube & McIlvane, 2001).

$$\Delta B = log\ \frac{B_x}{B_o}$$

Similar to the first equation, ΔB is the change in response rate. However, in the second equation, B_x represents baseline response rate, and B_o represents response rates following disruption, which are then transformed to logarithms to express the log proportion of baseline. According to Nevin and Shahan (2011), evaluating response rates during disruption as proportion of baseline accounts for potential differences exhibited during baseline across different conditions and/or individuals. In other words, merely evaluating differences between response rates during baseline and disruption phases are not sufficient representations of proportional changes as baseline response rates might differ. Furthermore, in analyses involving log ratios of responding, sessions might result in zero responses. Similar to Critchfield, Paletz, MacAleese, and Newland (2003) and Martens et al., (2016), instead of omitting the affected data, the authors added a small constant (.05) to each response count.

Procedural fidelity. When observing procedural fidelity, data collectors simultaneously began a timer matching the researcher's timer indicating the programed schedule. Data collectors then recorded whether the researcher correctly delivered the token based on given schedule. During each phase, researchers delivered tokens on a VI 12-s schedule for appropriate responses. For example, students received a token following the first written mark on the paper after about every 12 s, or students received a token the first response of matching a picture after every 12 s. During these phases, the data collector recorded a correct response if the researcher delivered the token within 2 s of the first correct response following the 12-s schedule. See Appendix C for a sample procedural fidelity form.

Interobserver agreement. Interobserver agreement (IOA) was calculated for 65% of all sessions (Table 6). Due to the within subject experimental design, a secondary observer recorded 65% of both baseline and disruptor conditions. Interobserver agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements then multiplying by 100%. Mean IOA for all participants was 98% (range 98%-99%).

In addition to IOA, secondary data collectors also recorded procedural fidelity data for 65% of all sessions. Observers indicated protocol adherence such as material set up, student instructions, and whether token delivery followed the programmed reinforcement schedule. All procedural fidelity components are included in Appendix C. Mean procedural fidelity for all participants was 99% (range 97%-100%). See Table 6.

Experimental Design

Preference assessment. After receiving parental consent, researchers conducted an MSWO preference assessment (Chazin & Ledford, 2016; Deleon & Iwata, 1996). First, the participant sat across from the researcher and the researcher encouraged the participant to sample six edible items (e.g., gummies, fruit snacks, skittles). Next, the researcher presented an array of the six edible items and instructed the participant to, “Pick one.” If the participant selected an item from the array, the rest of the array was removed while the participant was given time to consume the item. The researcher then shuffled the array and presented the remaining items without replacing the item the participant consumed. See Appendix A.

Reinforcer assessment. Similar to Vargo and Ringdahl (2015), researchers conducted a concurrent chain assessment to determine whether preferred items served as reinforcers. During these sessions, the participant was given three potential reinforcer choice arrays. The choice arrays included completing tasks while earning no tokens, completing tasks to exchange tokens for the top three preferred items identified in the MSWO preference assessment, or completing tasks to exchange tokens for the three least preferred items identified in the preference assessment.

After the participant indicated their reinforcer choice, the researcher presented the participant with the materials and told the participant they may begin. The reinforcer assessment task included simple shape puzzles (kindergarteners). Shape puzzles involved placing shape blocks onto premade puzzle cards. Puzzle cards included the outline of three shapes and were shaded with the corresponding shape color. During the reinforcer assessment, the researcher delivered a token each time the participant placed the three correct puzzle shapes and in the correct position on the puzzle card within a centimeter or less. Researchers evaluated the reinforcer assessment by calculating the number of times a choice (three items most preferred, three items least preferred, and no items) was selected divided by the number of times the item was presented multiplied by 100.

Task proficiency. Following the aforementioned reinforcer assessments, the researcher evaluated task proficiency. These sessions included presenting the participant with the task and assessing task completion. For example, when assessing tracing proficiency, researchers presented the participant with her name, containing six letters, pre-written on tracing paper. If the participant engaged in an incorrect response (i.e., failing to initiate within 5 s or engaging in a behavior not matching the task), the researcher used a system of least-to-most prompts (verbal, model, physical) to guide the student to a correct response. Researchers provided verbal praise after each correct response. Following completion, the researchers allowed participants to select one edible from an array. Participants began baseline sessions following three consecutive sessions with 80% independence. Sample task proficiency data sheets located in Appendix C.

Test sessions. To account for session-by-session baseline variability, the author implemented within-session disruptor tests (Dube et al., 2009). Within-session tests allow researchers to evaluate persistence despite variable baseline rates. This test method begins sessions with four alternating baseline components, followed by presenting alternating disrupter tests during the final two sessions. After conducting the within-session disruptor tests, researchers calculate and compare baseline and disruption responses from the same session. See Table 7.

Similar to Parry-Cruwys and colleagues' (2011) experiment, each session included six components (four baseline and two disruptor tests) with each component lasting 90 s. Researchers also included a minimum intercomponent interval of 20 s, but the researchers allowed time for reinforcer consumption if consumption lasted longer than 20 s. During the intercomponent interval, participants were able to exchange tokens for items identified during the reinforcer assessment. During baseline and test sessions, the researcher delivered a token on the first correct response of each component. Following the first token delivery, each participant received tokens on a VI 12-s schedule

(Dube et al., 2009). Similar to Parry-Cruwys et al. (2011), prior to beginning the study, researchers randomized the VI schedules, which included 8, 10, 12, 14, and 16-s intervals. In addition, no intervals repeated until all interval values occurred.

Baseline components. Baseline consisted of two conditions: (a) instruction condition and (b) no instruction conditions. During all baseline and disruptor test phases, researchers alternated instructions and no-instruction sessions within a multi-element design, which included condition-specific stimuli described above (i.e., blue and yellow stimuli). During the instruction condition, the participant was told instructions correlating with the task and programmed contingency. For example, the participant was told, "First, do your work, then you can trade your tokens for candy." During the no-instruction condition, the researcher did not deliver specific instructions to the participant. Instead, the researcher presented the task materials and said, "Here."

Disruptor components. Following alternating baseline components, researchers introduced disruptor tests. The environmental arrangement was identical to baseline sessions including token boards, tasks, and discriminative stimuli. Researchers also began instruction and no-instruction conditions during the disruptor phase the same way as baseline. However, in the disruptor conditions, the researcher introduced the distractor videos indicated in Table 5. For example, after delivering instructions and beginning the session, the researcher pressed play on a video displayed on a laptop computer approximately 0.5 m from the student. Similar to baseline components, the researcher delivered tokens on a VI 12-s schedule.

Table 5

Participant Demographics and Experimental Features

Participant	Age (years)	Diagnosis	Gender	Task	Distractor Video
Andre (K)	5.25	SDD	M	Copying letters	Clifford
Sophia (K)	5.33	SDD	F	Beginning letter sounds	Super Why
Jaden (K)	5.67	SDD	M	Beginning letter sounds	Super Why
Imani (K)	6.17	SDD	F	Tracing name	Paw Patrol

Table 6

Interobserver Agreement (IOA) and Procedural Fidelity

	Sophia	Andre	Jaden	Imani	Mean
Percent of sessions with IOA	80%	60%	60%	60%	65%
Average IOA	99%	98%	98%	98%	98%
Percent of sessions with procedural fidelity	80%	60%	60%	60%	65%
Average procedural fidelity	99%	97%	99%	100%	99%

Table 7

Experimental Phases and Conditions

Phase	Condition	Schedule	Correlated Stimulus
Baseline	Instructions	VI 12 s	Blue table cloth, blue token board
	No-Instructions	VI 12 s	Yellow table cloth, yellow token board
Disruption	Instructions	VI 12 s	Blue table cloth, blue token board, distractor stimuli
	No-Instructions	VI 12 s	Yellow table cloth, yellow token board, distractor stimuli

CHAPTER 4

RESULTS

This study evaluated the effect of verbal statements on behavioral persistence. Specifically, this study investigated the question, what are the effects of instruction compared to no instruction conditions on resistance to change when presented with a distractor? To answer this question, the researcher analyzed the effect of disruption on total responses (correct and incorrect), errors, and error percentages.

Preference, Reinforcer, and Proficiency Assessments

Figure 2 displays the results of each participant's preference assessments. Sophia, Andre, and Imani's three most preferred items included gummy bears, M&Ms, and Dots. Jaden's three most preferred items included Skittles, Dots, gummy bears.

The top three and bottom three preferences were identified for the reinforcer assessment (see Figure 3). Andre, Jaden, and Imani selected the array with their three most preferred items 60%, 90%, and 90%, respectively. However, during the reinforcer assessment, Sophia selected the array with her three least preferred items 70%. In other words, during the preference assessment, the researcher asked Sophia to select options without completing work in exchange for the items, which allowed the researcher to rank items from most to least preferred. However, when Sophia was asked to complete work in exchange for items, she selected items previously identified in the MSWO preference assessment as least preferred. Therefore indicating preference assessment results to be ordinal, but not necessarily interval.

During the video preferences Sophia and Jaden's each selected *Super Why* as their most preferred video, whereas Andre and Imani selected *Clifford* and *Paw Patrol*, respectively. Figure 4 displays video preference results.

Sophia and Andre each completed five sessions to meet criterion during proficiency assessments. Imani required eight sessions, and Jaden required 14 sessions to meet criterion. See Figure 5 for proficiency results.

Test Sessions

If the instruction condition resulted in higher resistance to change than no-instruction conditions, one would predict a smaller change in proportion of baseline responding than the no-instruction condition. Meaning, rates of responding would maintain at higher rates in the instruction condition than the no-instruction condition during disruptor test sessions. However, if the verbal stimuli do not influence responding, similar proportional changes would occur in response rates across conditions during disruptor tests. The log proportion of baseline for total responses (correct and incorrect responses) are displayed in Figure 6. Figure 7 and Figure 8 display participants' error rates as well as error percentages as represented by log proportion of baseline. Figures 9, 10, and 11 display means of total responses, errors, and error percentages. The mean rates displayed in Figure 9 indicate variability across participants. However, Figure 10 display greater error persistence in no-instruction conditions for three out of four participants. Similarly, Figure 11 depicts greater mean error percentages in the no-instruction condition for all participants.

Sophia. During Sophia's first experimental session, proportional rates of total responding persisted greater in the no instructions condition (Figure 6). However, proportional errors and percent of errors varied across conditions (Figure 7 and 8).

Andre. Andre's proportional rates of total responses, errors, and error percentages persisted at greater rates during the no instruction condition in the first session. However, during the second session, Andre engaged in similar proportional rates of total responses, errors, and error percentages across both conditions. During three out of five sessions, Andre's errors persisted greater in the no-instruction condition (Figure 7). Similarly, error percentages also persisted greater in three out of five sessions, and were similar in the other two sessions (Figure 8).

Jaden. Jaden exhibited variable proportional rates of total responses following disruptor tests.. As indicated in Figure 6, no-instructions conditions resulted in greater proportional persistence for total responses in two out of five sessions. However, proportional rates of total responding during instructions conditions persisted at similar rates or greater in four out of five sessions (Figure 7). Although proportional rates of total responding varied across conditions, Jaden emitted greater proportional error rates during three out of four of the no-instruction conditions. Furthermore, Jaden demonstrated greater proportional error percentages three out of five sessions during the no-instruction condition (Figure 8).

Imani. During four out of five test sessions, Imani's total proportional responses persisted greater in the instruction condition than the no instruction condition (Figure 6). Furthermore, Imani only emitted a single error during baseline instruction conditions and only two errors during instruction test sessions. However, errors occurred in the no-instruction condition during the first disruptor test sessions, and in session four, errors occurred during the no-instruction condition in both baseline and disruptor components (Figure 7 and 8).

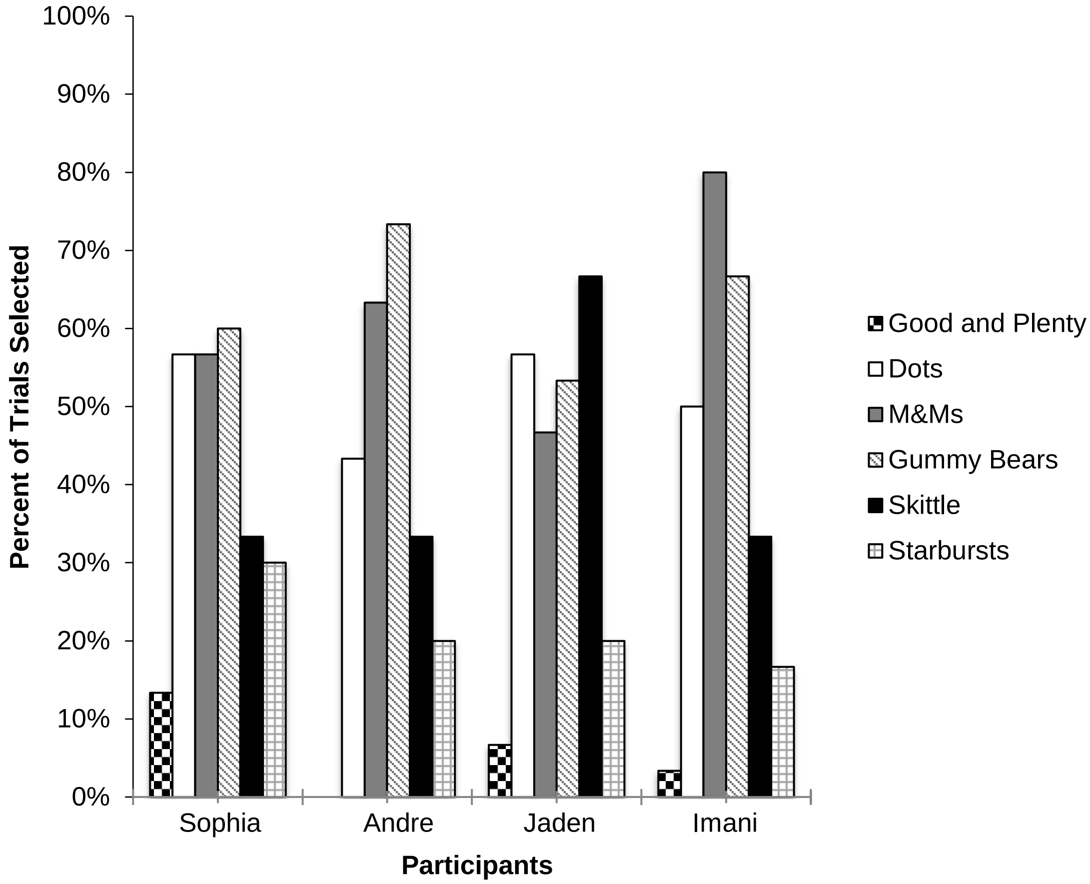

Figure 2. Preference assessment results.

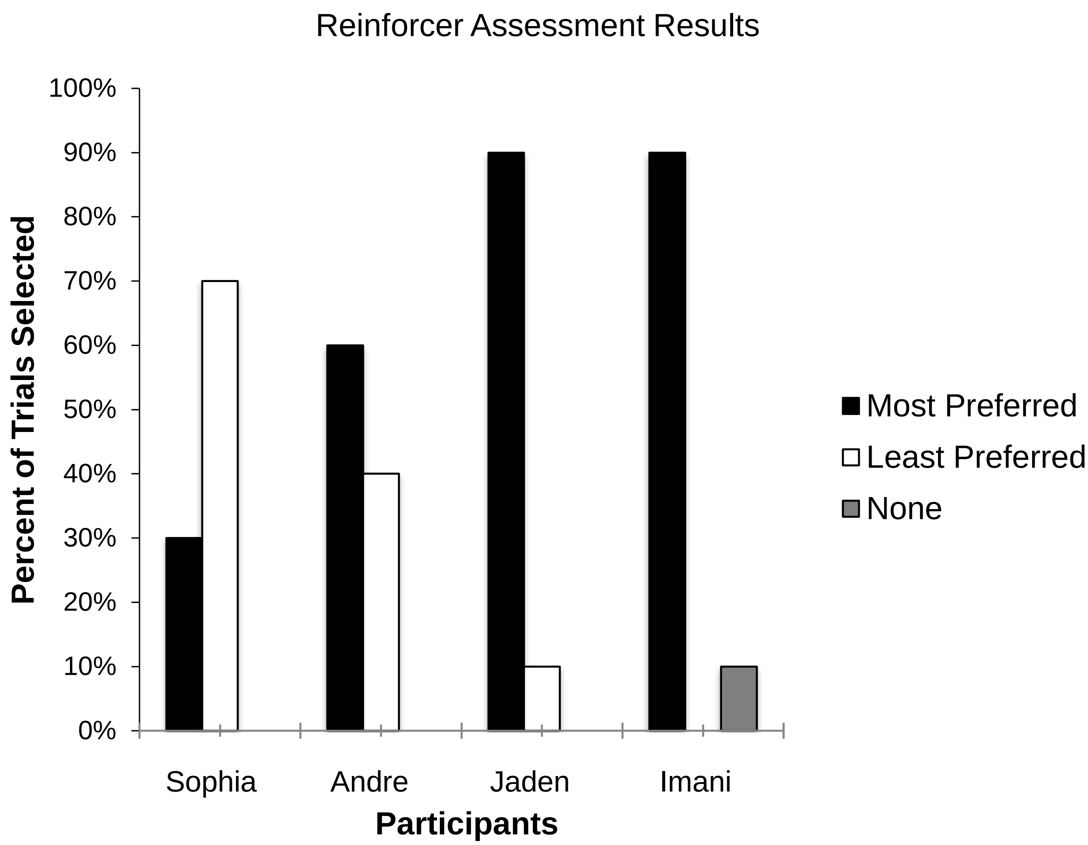

Figure 3. Reinforcer assessment results.

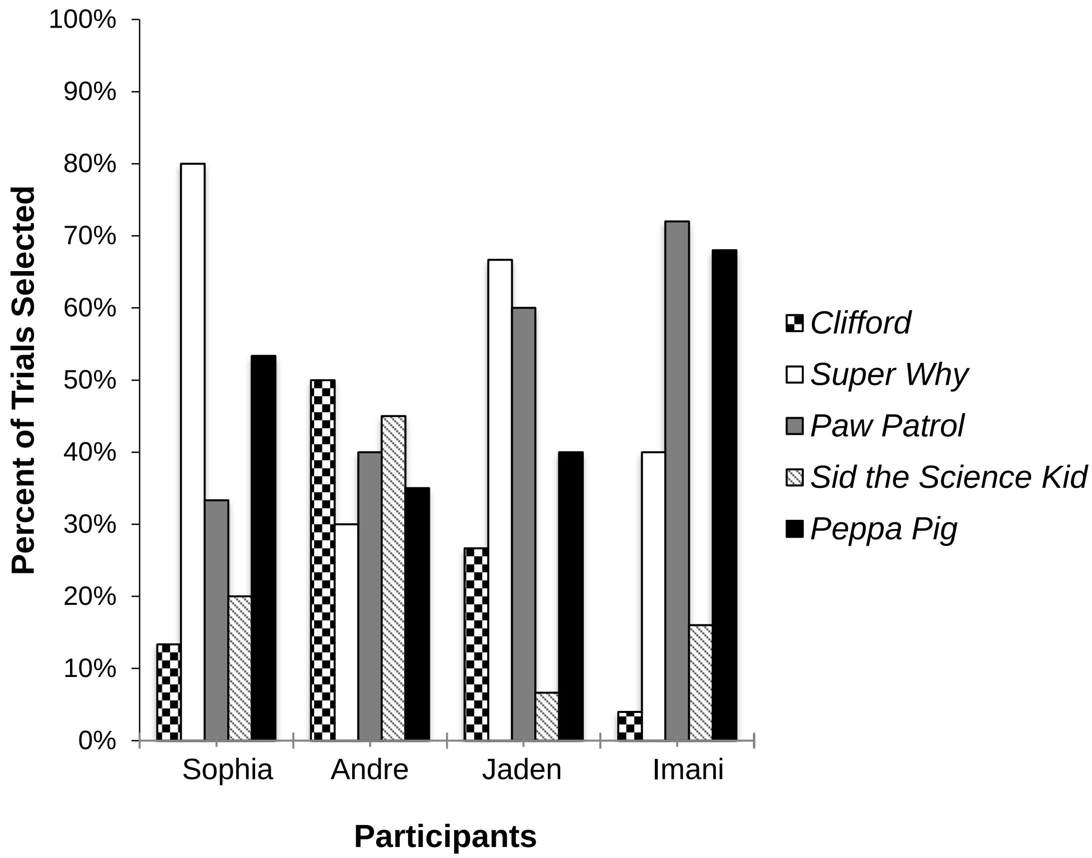

Figure 4. Video preference assessment results.

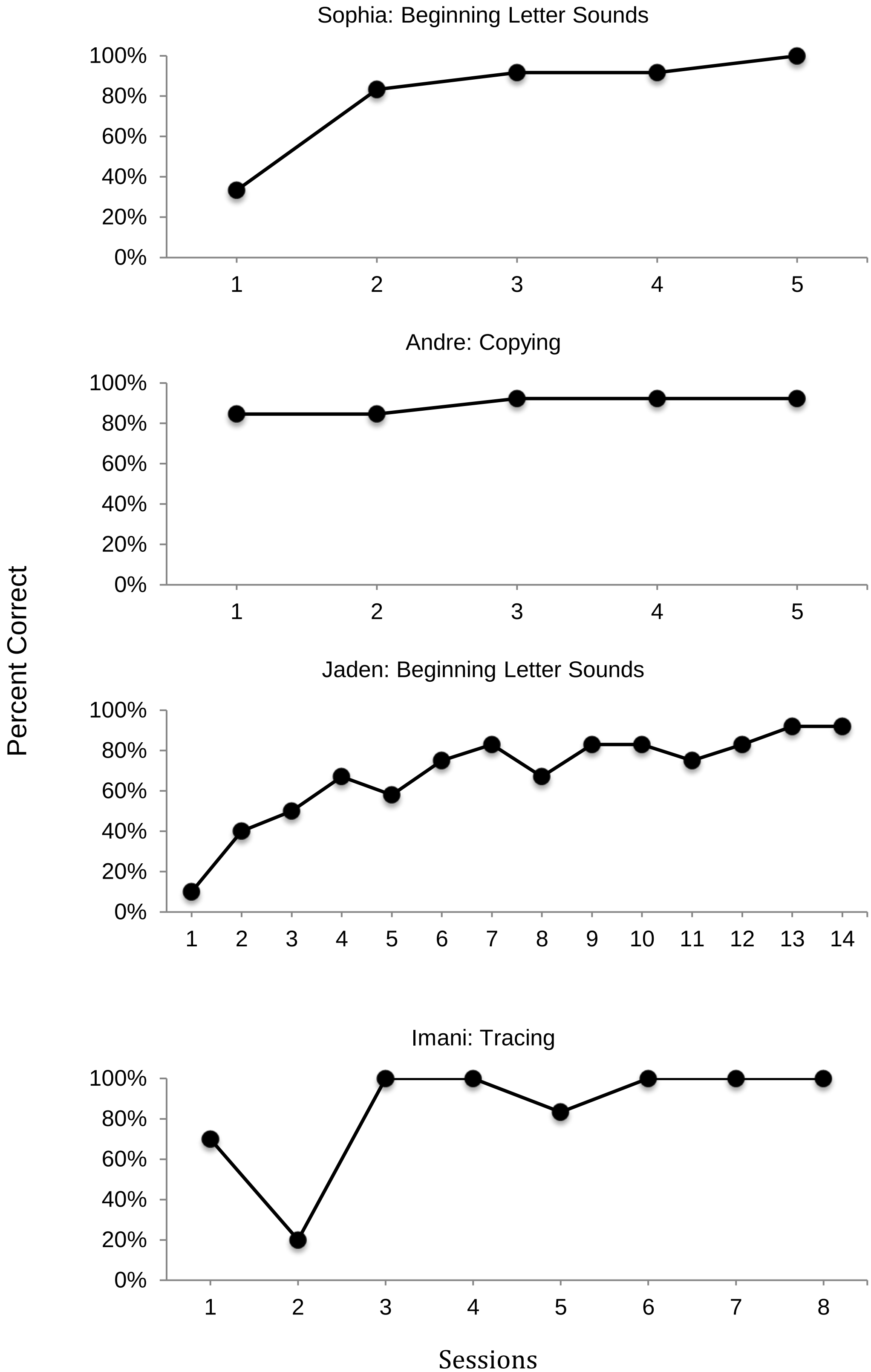

Figure 5. Proficiency assessment results.

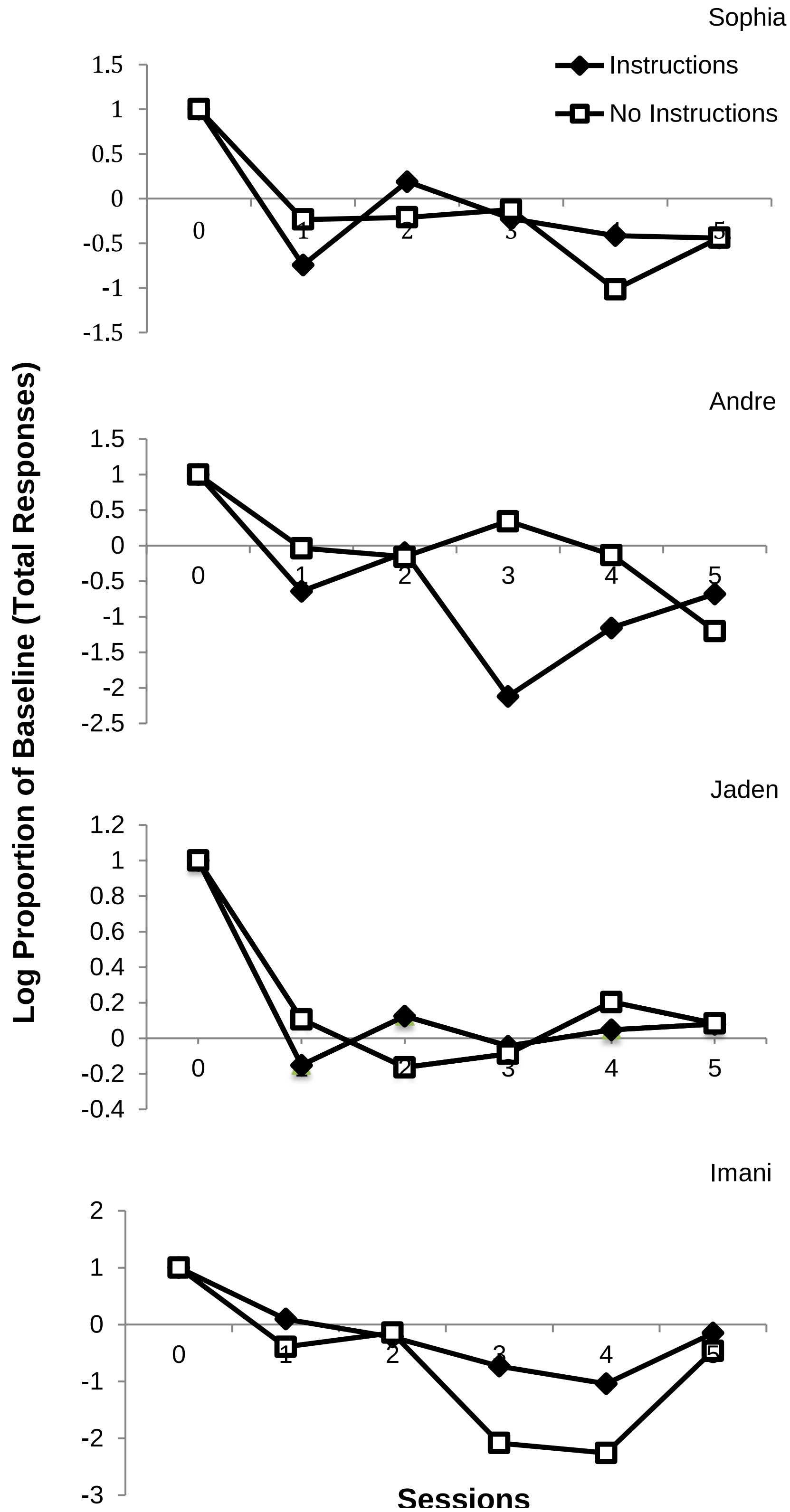

Figure 6. Total response resistance to change.

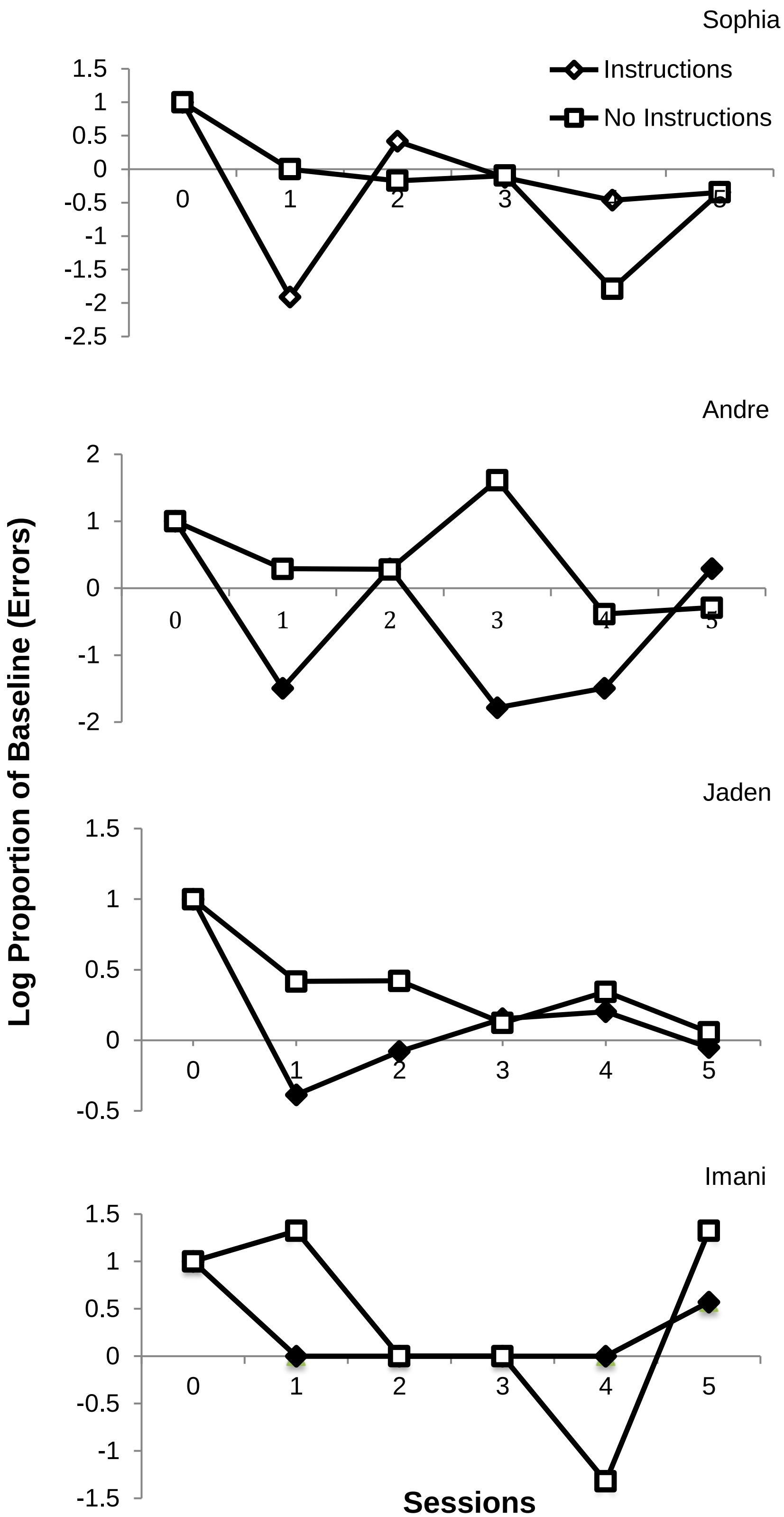

Figure 7. Error response's resistance to change.

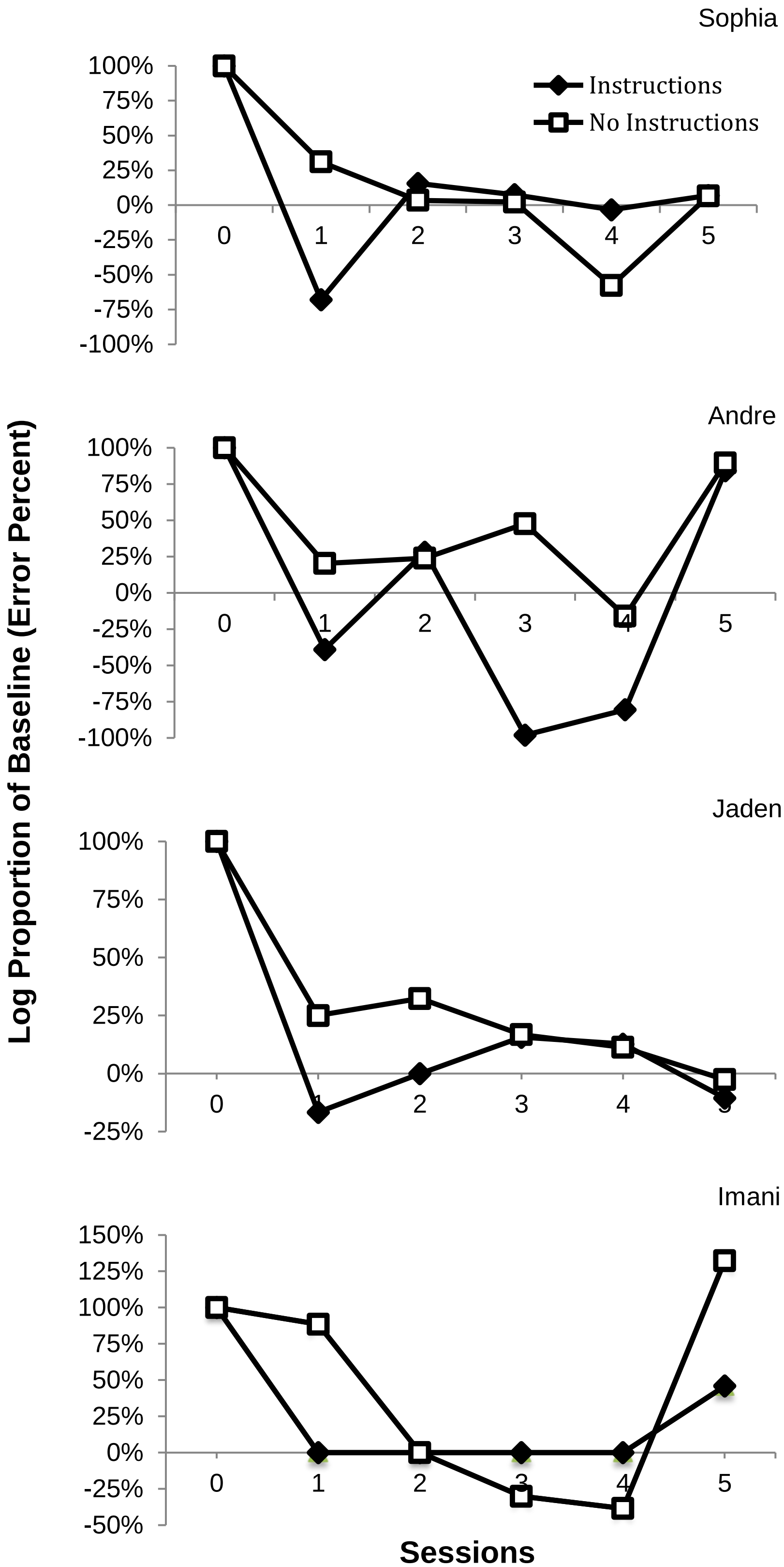

Figure 8. Error percentage's resistance to change.

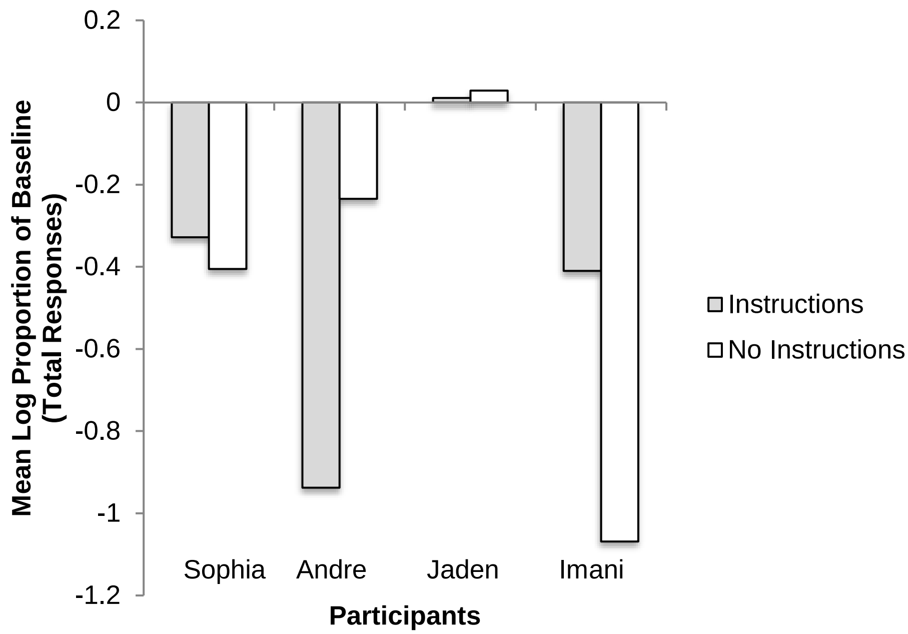

Figure 9. Mean total responses as a proportion of baseline.

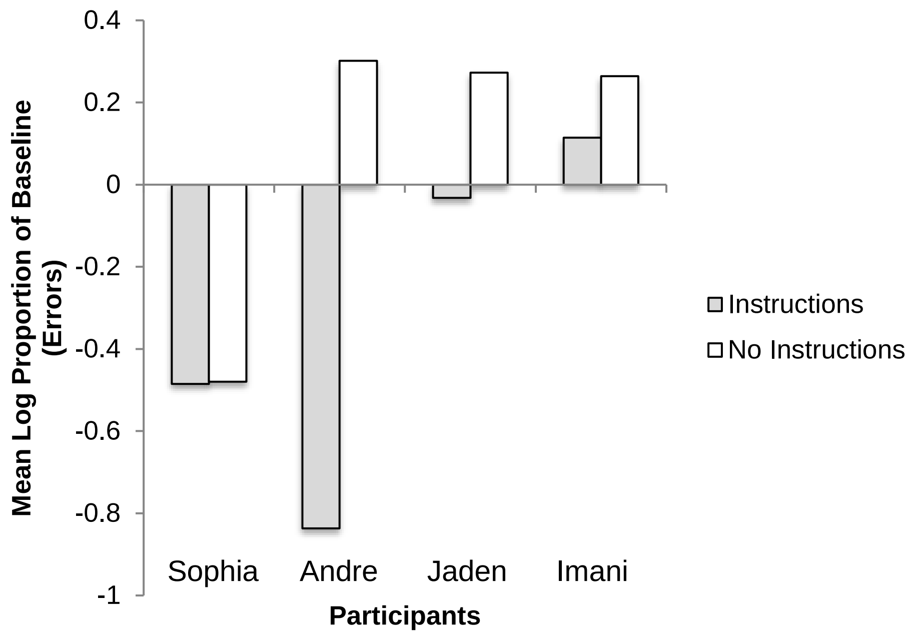

Figure 10. Mean error responses as a proportion of baseline.

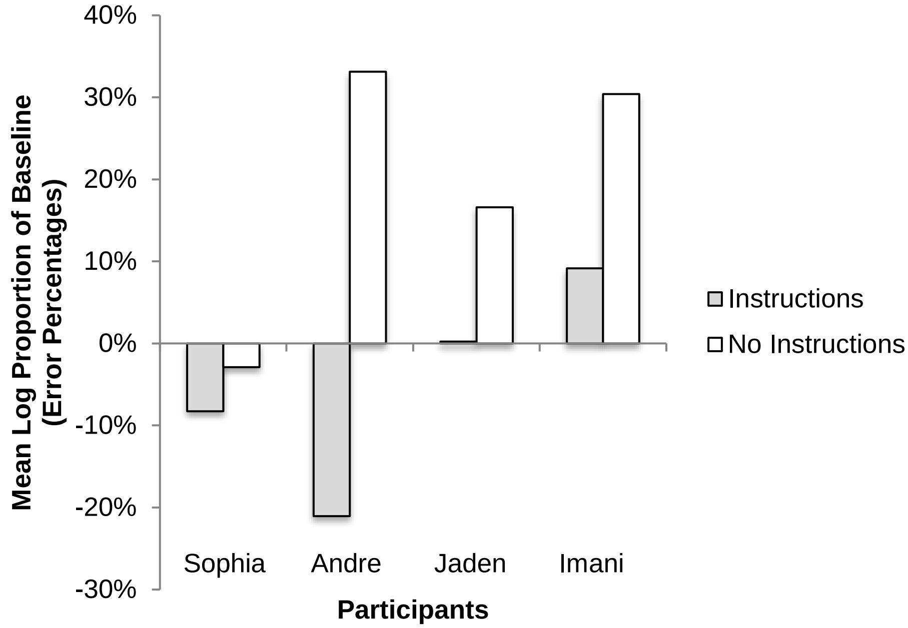

Figure 11. Mean error percentages as a proportion of baseline.

CHAPTER 5

DISCUSSION

When evaluating maintenance, researchers and practitioners often observe intervention effects over time rather than systematically programming maintenance (Dube, 2013). This maintenance evaluation method is analogous to the Train-and-Hope method for generalization described by Stokes and Baer (1977), which involves traditional behavior change techniques (e.g., reinforcement and punishment) followed by monitoring generalization effects. Although Stokes and Baer (1977) stated that the Train-and-Hope method represented half of the literature, the method seemed dubious as it simply involved observation probes following interventions rather than systematically programming generalization.

Consequently, Stokes and Baer (1977) described implicit technologies for generalization, and outlined techniques for teachers, behavior analysts, and other practitioners to systematically program generalization across settings, behaviors, and people. Similarly, Nevin and Wacker (2013) discussed an alternative maintenance evaluation method and suggested systematically challenging interventions to evaluate response persistence following disruption. For example, instead of evaluating response rates under stable conditions, the authors suggested practitioners evaluate response persistence after introducing various treatment challenges such as extinction, different procedural fidelity levels, and distractors. Through this method, practitioners can evaluate the disruptor’s effect on responding through the framework of BMT. Evaluating response persistence through the framework of BMT provides a method to quantify a response’s durability when challenged. Furthermore, analyzing a target behavior's resistance when challenged might inform practitioners of the behavior's likelihood of maintaining over time.

Furthermore, the aforementioned literature review (Chapter 2) revealed multiple factors influencing response persistence, which might also influence maintenance. For example, Ringdahl et al., (2018) discovered participants' more preferred mand modalities led to greater persistence when challenged. In addition, multiple studies demonstrated greater persistence in conditions associated with richer schedules of reinforcement (e.g., MacDonald et al., 2013; Parry-Cruwys et al., 2011). However, none of the studies included in the literature review evaluated the effect of verbal stimuli on response persistence.

Nevertheless, despite limited research evaluating the effect of instructions on response persistence, instructions are common verbal stimuli present in natural environments. In particular, verbal stimuli are frequently present in educational settings. For example, verbal stimuli such as rules are often displayed at the front of classrooms and written instructions can be found at the top of worksheets. In addition to written stimuli, prior to beginning an activity, teachers repeatedly state specific rules and expectations. Given the common nature of verbal stimuli, the purpose of this study was to evaluate the effect of instructions on response persistence including total responses, errors, and error percentages.

The current study involved identical reinforcement schedules (VI 12-s) across both the instruction and no instruction conditions. Researchers observed little response persistence differentiation for total responses across instruction or no-instruction conditions. Although proportional responding for total responses in the current experiment varied across sessions for three participants, one participant, Imani, demonstrated differentiated response persistence across conditions. Meaning, total responses persisted at similar proportional rates in across conditions for three out of four participants. However, Imani's total responses persisted greater during instruction conditions in four out of five sessions, with similar response rates during one session.

Although, the current experiment included identical VI schedules across both the instruction and no-instruction conditions, proportional error rates, as well as proportional error percentages, persisted greater in no-instruction conditions for three out of four, and four out of four participants, respectively. Meaning, during no-instruction conditions resulting in higher resistance to change, proportional error rates and error percentages maintained at higher proportional rates in the no-instruction condition when compared to the instruction condition. This finding adds to the literature evaluating response persistence and suggests in addition to the effect of programmed contingencies or stimuli associated with a particular history of reinforcement (e.g., rich versus lean schedules of reinforcement; Parry-Cruwy's et al., 2011), verbal stimuli also influence response persistence.

Limitations and Future Directions

This experiment contained a few limitations requiring further discussion. First, the current study involved sessions with six components lasting 90-s in duration. However, the 90-s components might not exemplify time allotted for task completion in the natural environment, as teachers rarely request students to complete tasks for six 90-s intervals.

Therefore, future experiments might evaluate the effect of verbal stimuli on response persistence across longer session durations.

In addition, this study involved presenting a preferred video during disruptor tests. For example, researchers simultaneously played preferred video clips after presenting task materials. The preferred video clips included both visual and auditory components, which represented common distractors in classroom environments. However, future investigations might evaluate the effect of various disruptors such as different volumes or the effect of presenting the most versus the least preferred video as a disruptor.

Furthermore, the present study did not evalute the effect of verbal stimuli across different tasks, or task variables. Future investigations might evaluate whether differentiation occurs across different academic tasks or different levels of task difficulty. For instance, researchers might consider evaluating the effect of disruptors on rote tasks such as tracing versus more involved tasks such as multiplication or long division. Perhaps greater disruption occurs across tasks requiring multiple covert behaviors such as mental math.

Moreover, although the present study yielded differentiated results across instructions and no-instructions conditions, further evaluations of the effect of verbal stimuli on response persistence are warranted. The current experiment only evaluated either the presence or absense of one specific instruction. Therefore, future investigations might analyze the effect of different instruction variables, which might include instructions explicitely stating to disregard the video. For example, investigators could evaluate the effect of stating, “Now it is time to do your work, do not watch the video.”

In addition to evaluating different verbal stimuli, future investigations might evaluate different several variables associated with verbal stimuli. For example, researchers might evaluate factors influencing the two types of rule following classifications, tracking and pliance (Zettle & Hayes, 1982). Günther and Dougher (2013) described tracking as behavior specifically maintained by the consequences directly stated by the rule; whereas pliance is conceptualized as rule following as a result of socially mediated consequences directly resulting from compliant and non-compliant behavior. Günther and Dougher (2013) also indicated tracking and pliance might account for rule-following behavior, and in particular, the persistence of rule-following behavior even if doing so is less advantageous (i.e., reduces the probability the individual accesses reinforcers). Therefore, when considering the effect of verbal stimuli through the framework of BMT, researchers might evaluate variables influencing tracking and pliance, which might also influence a target behavior's behavioral mass (i.e., reinforcement history). For example, to evaluate pliance, as described by Günther and Dougher (2013), perhaps future studies could evaluate the effect of different learning histories associated with the person presenting the verbal stimuli..

Though persistence of total responding varied across conditions and participants, the current study also demonstrated increased persistence of errors and error percentages in the absense of instructions such as a contingency specifying statements. Speficically, proportional errors and error percentages persisted greater when participants were handed task materials and told, "Here," than when they were handed task materials and told, "First do your work, then you can trade your tokens for candy." These results indicate the potential influnce of verbal stimuli on correct and incorrect responding during instructional tasks. As a result, introducing, evaluating, and harnessing the effect of verbal stimuli might be instrumental in educational settings in which the primary goal is to increase and maintain correct responding when challenged.

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APPENDICES

Appendix A

MSWO for 6 items

Item A:			**Sum of trial #s for A:**	
Item B:			**Sum of trial #s for B:**	
Item C:			**Sum of trial #s for C:**	
Item D:			**Sum of trial #s for D:**	
Item E:			**Sum of trial #s for E:**	
Item F:			**Sum of trial #s for F:**	

Date:
Child name:
Teacher name:

Trial #	Item Selected	Placement
1		x x x x x x
2		x x x x x
3		x x x x
4		x x x
5		x x
6		x

Date:
Child name:
Teacher name:

Trial #	Item Selected	Placement
1		x x x x x x
2		x x x x x
3		x x x x
4		x x x
5		x x
6		x

Date:
Child name:
Teacher name:

Trial #	Item Selected	Placement
1		x x x x x x
2		x x x x x
3		x x x x
4		x x x
5		x x
6		x

Date:
Child name:
Teacher name:

Trial #	Item Selected	Placement
1		x x x x x x
2		x x x x x
3		x x x x
4		x x x
5		x x
6		x

Date:
Child name:
Teacher name:

Trial #	Item Selected	Placement
1		x x x x x x
2		x x x x x
3		x x x x
4		x x x
5		x x
6		x

Highest preferred items (lowest summed trial #s):

Moderately preferred (moderate summed trial #s):

Lowest preferred (highest summed trial #s):

Modified from Chazin, K.T. & Ledford, J.R. (2016).

Appendix B

Reinforcer Assessment										
Directions: Ask the student to choose whether they want to exchange tokens for their three most preferred items, three least preferred items, or no items. Record choice. Ask the student to begin the task. Deliver tokens on an FR 1 schedule for correct and incorrect responses.										
Participant Initials:						**Date:**		**Primary Data Collector:**		
Reinforcer Options:						**Location:**		**IOA Data Collector:**		
Task	**Reinforcer Selection**	**Trial #**	**1**	**2**	**3**	**4**	**5**	**% Correct**	**IOA %**	
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									
	Most, Least, None									

Prompt Codes: Independent (I) Verbal (V) Model (M)	**Notes:**

Appendix C

Task Proficiency Data Sheet		
Directions: Ask the student to begin the task. If participant does not initiate the correct response within 5 seconds, or emits an error, immediately begin the least-to-most prompt sequence (verbal, verbal and model, verbal and physical). Provide praise after each correct response, even if the response required prompting.		
Participant Initials:	**Grade:**	**Primary Data Collector:**
Task:	**Location:**	**IOA Data Collector:**

Session #	**Task**	**Date**	**Trial #**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**% Correct**	**IOA %**

Prompt Codes: Independent (I) Verbal (V) Model (M) Physical (P)	**Notes:**

Appendix D

Student Initials:					**Observer:**	
Teacher Initials:					**Therapist:**	
Date:						
Condition (I=Instruction, N=No-Instructions):						
VI schedule:						
Session:	1	2	3	4	5	6
Prior to Beginning Sessions						
Alternate conditions (instructions vs. no instructions)						
Place appropriate stimulus on the table. (Blue: instruction sessions; yellow: no-instruction sessions)						
Prepare the interval timer for the appropriate intervals according to the randomized VI schedule						
Prepare task materials (i.e., tracing materials available during tracing sessions)						
During the instruction condition: Say, "First, do your work, then you can trade your tokens for candy.”						
During the no-instruction condition: Say, "Here.”						
Count down to begin the session and start interval timer						
Simultaneously start the distractor (i.e., press play on video)						

Delivers tokens according to the randomized VI schedule (+ indicates correct token delivery, - indicates incorrect token delivery)	1	2	3	4	5	6
AFTER FIRST CORRECT RESPONSE Opportunity 1						
Opportunity 2						
Opportunity 3						
Opportunity 4						
Opportunity 5						
Opportunity 6						
Opportunity 7						
Opportunity 8						
Opportunity 9						
Opportunity 10						
Opportunity 11						
Stops the session after 90-s has elapsed						
Immediately allows the student to exchange the tokens for the item identified in their reinforcer assessment						
Begins next condition after the 20-s intercomponent interval, or after the participant consumes the reinforcer						
Total Percent Correct						